

# Development of Machine Learning algorithms to improve the optimization of recurrent combinatorial problems

---

## Application to power generation re-planning



Contact : Emmanuel Rachelson  
Département d'Ingénierie des Systèmes Complexes  
[emmanuel.rachelson@isae-supero.fr](mailto:emmanuel.rachelson@isae-supero.fr)

### Topic

Recurrent combinatorial optimization problems — ie. problems that require the resolution of several successive instances — are a major industrial challenge. For instance, matching airline crews and flights for a given day, electricity production planning, re-scheduling of satellite photo shots are highly combinatorial problems where the problem for day D and the one for day D+1 are variants of the same initial problem and where finding a (quasi-)optimal solution is important. Often, the re-optimization process is time-constrained, leading to an optimality versus computation time compromise. The approach developed by the internship's host team consists in exploiting the experience of past resolutions to guide the current optimization process.

For this purpose, a theoretical framework and several tools in Optimization and Machine Learning have been developed but many aspects of the problem remain unexplored. The goal of this internship is thus to evaluate the efficiency of the approach above, draw lessons from this evaluation and suggest new ideas to improve the learning / optimization interaction.

The bottom-line industrial problem for this internship deals with the intra-daily replanning of electricity production for the French network but other applications may be used to evaluate the contributions. The host team develops Mixed Linear Programming models for this problem. The development of innovative Machine Learning methods allowing for an efficient guidance of these MIP problems resolution is hence at the core of the internship.

### Références

- [1] C. Bessiere, R. Coletta, E. Hébrard, G. Katsirelos, N. Lazaar, N. Narodytska, C.-G. Quimper and T. Walsh, *Toby, Constraint Acquisition via Partial Queries, IJCAI'2013 : 23rd International Joint Conference on Artificial Intelligence*, 2013.
- [2] D. Zupanic. Value suggestion in mixed integer programming by machine learning algorithm. *in Electronic Notes in discrete Mathematics*, 1 :74—83, 1999.
- [3] P. Stuckey, P. Van Hentenryck and T. Walsh, Lifelong Optimization, *Tec. report NICTA ADA614742*, 2015.
- [4] E. Rachelson, A. Ben-Abbes and S. Diemer, Combining Mixed Integer Programming and Supervised Learning for Fast Re-planning, *22nd IEEE International Conference on Tools with Artificial Intelligence (ICTAI)*, 2010.
- [5] B. Cornelusse, G. Vignal, B. Defourny and L. Wehenkel, Supervised learning of intra-daily recourse strategies for generation management under uncertainties, *IEEE PowerTech*, 2009.

## **Student profile**

Master of Science (or equivalent) in Machine Learning, Operations Research or a related discipline.

## **Context**

ISAE-SUPAERO is a worldwide reference in aerospace higher education programs and research for aerospace engineering. Located in the lively city of Toulouse, European capital for Aeronautics and Space, it is nested within the university scientific campus in a rich research environment. Within the Department of Complex Systems Engineering, the Operations Research group works on industrial engineering models and develops innovative resolution methods.

Toulouse, hosting the Airbus headquarters, is known worldwide as one of the aeronautics industry's capitals. Often ranked among the best living places for students, Toulouse is a lively city with a strong scientific environment.

Supervision : Emmanuel Rachelson et Alain Haït.

This internship is funded by the Programme Gaspard Monge pour l'Optimisation (PGMO), in collaboration with EDF R&D.

Continuation in a PhD program after the internship is possible.

Salary : 554.40€/month (net), housing opportunities on campus.

Duration : 6 months.

Informations and applications : [emmanuel.rachelson@isae-supaero.fr](mailto:emmanuel.rachelson@isae-supaero.fr).