

Internship proposal: Large neighborhood search for variants of the multi-skill project scheduling problem

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1 Context

This internship takes place in the context of a collaboration between Airbus SAS and LAAS CNRS funded by ANITI chair HEROIC¹. The multiskill project scheduling problem (MSPSP) is an NP-hard combinatorial optimization problem extension of the resource-constrained project scheduling problem (RCPSP). It consists of a set of activities linked by precedence relations and that require scarce resources during their execution. The problem aims at assigning a start time to each activity while satisfying precedence and resource constraints with the objective to minimize the total project duration, also called *Makespan*. The particularity of the MSPSP is that activity requirements are expressed in terms of skills. More precisely, for each skill required by an activity an amount of resources is specified. Skilled resource are notably human resources. In practice, the different ways workers may cover the skills required by the activities give rise to several variants of the problem. A worker may have several skills, e.g. electrician and mechanic, and, when assigned to an activity, can cover one of the required skills. In other cases, skills correspond to accreditations, due to security reasons for instance. In this case, a worker may cover simultaneously several skills. In

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¹<https://aniti.univ-toulouse.fr/en/hybridizing-learning-search-and-combinatorial-optimization>

other cases, the skills can be mastered in different levels, which may render task duration longer if performed by lower skill levels. Such hierarchical skills may also have an impact on the objective function such as preferences to assign highly skilled resources on critical tasks. For a description of some of these variants we refer to [1, 3].

2 Internship objective

Large neighborhood search (LNS) is an hybrid generic heuristic scheme based on the integration of exact and local search. It has been widely used to efficiently solve complex scheduling and routing problems and is also integrated in some solvers. In [2], a LNS method has been proposed to solve some (but not all) existing variants of the MSPSP. The objective of the internship is to design a generic and modular LNS scheme to solve a wide variety of variants of the mutiskill problem. The developed algorithm will be integrated in `discrete-optimization`, an open source combinatorial optimization library².

3 Candidate's profile and contact

The candidate (graduate student, M2 or final year in an Ecole d'Ingénieurs in France) should have advanced programming skills and preferably basic knowledge in combinatorial optimization and/or scheduling.

Please address CV, motivation letter and university grades to

- artigues@laas.fr and
- guillaume.poveda@airbus.com.

References

- [1] Oliver Polo-Mejía, Christian Artigues, Pierre Lopez, Lars Mönch, and Virginie Basini. Heuristic and metaheuristic methods for the multi-skill

²<https://github.com/airbus/discrete-optimization/>

- project scheduling problem with partial preemption. *International Transactions in Operational Research*, 30(2):858–891, 2023.
- [2] Guillaume Povéda, Nahum Alvarez, and Christian Artigues. Partially preemptive multi skill/mode resource-constrained project scheduling with generalized precedence relations and calendars. In *29th International Conference on Principles and Practice of Constraint Programming (CP 2023)*, pages 31–1. Schloss Dagstuhl–Leibniz-Zentrum für Informatik, 2023.
- [3] Jakob Snauwaert and Mario Vanhoucke. A classification and new benchmark instances for the multi-skilled resource-constrained project scheduling problem. *European Journal of Operational Research*, 307(1):1–19, 2023.