Laboratoire d'Informatique de Modélisation et d'Optimisation des Systèmes
LIMOS – UM2R 6158 – Université Clermont Auvergne / CNRS
Ecole Nationale Supérieure des Mines de SAINT-ETIENNE, INP

Thesis proposal

Title of the thesis project - Advanced hybridization of metaheuristics and constraint programming techniques for the integration of energy constraints in assembly line balancing problems.

Location : Laboratory of Informatics, Modelling and Optimization of the Systems (LIMOS UMR CNRS 6158) – Campus des Cézeaux – 1 rue de la Cherbade, 63178 Aubière

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Context of the thesis :

This thesis is part of the IRC ITPS (International Research Centre on Innovative Transportation and Production Systems) framework and focuses on the problem of robotic assembly lines balancing problems, an area of interest for the LIMOS, which has been investing resources in this field for several years, as evidenced by works such as (Gourgand *et al.*, 2007), (Grangeon *et al.*, 2011), (Grangeon *et al.*, 2012), as well as more recent contributions such as the thesis of Youssef Lahrichi (Lahrichi, 2021) or the Master's internship of Arnauld Tuyaba (Tuyaba *et al.*, 2023). While traditional assembly line balancing problems typically focus on minimizing the number of workstations or the cycle time, the laboratory, as part of Arnauld Tuyaba's Master's internship, became interested in considering the energy constraints and objectives that may exist in this issue. This involved proposing solutions to the studied problem that aim to minimize peak energy consumption. Investigating this matter introduces an additional degree of complexity to the problem under study because it involves addressing a highly constrained combinatorial optimization problem with a level of detail more significant than commonly studied variants.

Objective and anticipated methods:

The objective of this thesis is to propose innovative methods for studying assembly line balancing problems that take into account energy constraints. In particular, we will investigate the contribution of constraint programming to this theme and explore a less common form of hybridization between metaheuristics and constraint programming. We believe that this form of hybridization can prove to be very effective in solving optimization problems that decompose into sub-problems, at least one of which is a feasibility problem or a highly constrained problem for which it is difficult to find solutions satisfying all constraints of the problem. We will focus particularly on hybridizations with the boolean satisfiability problem (Biere et al., 2021) or with the constraint satisfaction problem (Ghedira, 2013).

The work could be structured as follows:

- A literature review on energy constraints in scheduling and assembly line balancing problems,
- A literature review on hybridization techniques of metaheuristics with mathematical programming techniques,
- The design of a hybrid algorithm, which would combine the advantages of metaheuristics and constraint programming.
- The implementation of this method to solve an assembly line balancing problem with energy constraints.

References:

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