Parallel Combinatorial Optimization
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The goal of this project is to develop parallel algorithms to solve difficult combinatorial optimization problems, in particular network design problems that have applications in transportation and logistics. The algorithms combine several approaches : (1) Branch-and-Bound and variants, such as Branch-and-Cut-and-Price; (2) decomposition in mathematical optimization, such as Benders decomposition and Lagrangian relaxation; (3) meta- and math- heuristics. Parallel computing will be used to push the limits of the sizes and types of instances that can be solved nowadays.

During this project, we will focus on the solution of large-scale instances of the multicommodity capacitated fixed-charge network design problem. Recently, new types of math-heuristics [1] have been proposed and shown to outperform existing heuristics for the same problem. We plan to incorporate several improvements to these math-heuristics, including the integration of Lagrangian relaxation, combined with the introduction of short-term and long-term memories. In this context, parallel computing has the potential not only to speed up the solution process, but also to improve the quality of the best solutions found by the algorithm. Along this line, one can even exploit parallelism to solve to optimality the smaller-size subproblems generated by the method, which would result in a globally exact algorithm. In this way, parallel computing would be used to turn a heuristic into an exact method, thus pushing the boundaries of the sizes and types of instances that are within reach today.

The algorithms will be coded in C++, making use of existing codes and software, including state-of-the-art mixed-integer linear programming solvers. The extensive computing resources of Calcul Canada will be used to develop and test the algorithms. The intern will be integrated to CIRRELT (Interuniversity Research Centre on Transportation and Logistics Networks), thus benefitting also from the computing network available at CIRRELT, as well as from the extensive professional resources available at DIRO and CIRRELT.

[1] Gendron, B., Hanafi, S., Todosijević, R., "Matheuristics based on iterative linear programming and slope scaling for multicommodity capacitated fixed charge network design," *European Journal of Operational Research* 268(1), 70-81 (2018)