2018-00393 - PhD - Dynamic Pickup-and-Delivery Problems : efficient decomposition based algorithms to tackle hard variants with rendez-vous and online requests

Level of qualifications required : Graduate degree or equivalent

Fonction : PhD Position

About the research centre or Inria department

Our aim is to develop tight formulations for combinatorial problems by combining the latest reformulation techniques, such as Lagrangian and polyhedral approach, non-linear programming tools and graph theoretics tools. Through industrial partnerships, the team targets large scale problems such as those arising in logistics (routing problems), in planning and scheduling, in network design and control, and in placement problems (cutting stock problems).

Context

Scientific Priorities :

Stochastic mutli-scale models ; environement and sustainable development in urban logistics.

Scientific Research Context :

The Pickup-and-Delivery Problem is an extension of capacited vehicle routing with time-windows where a fleet of vehicles has to cover a set of requests defined by their pick-up and delivery locations along with their vehicle capacity consumption. The coupling of two service nodes associated with pick-up and delivery locations make the problem very hard. Solving realistic size problems that arise in logistics with uncertainty on the requests is beyond today's achievements with exact optimization methods. Our challenge is to make significant progress on solving realistic size instances to near optimality by developing a complex blend of restricted exact optimization tools, strong relaxations, efficient primal heuristics and filtering techniques, along with parallelisation. Our second axis of contribution is to extend such methodologies to a dynamic context of accepting online requests, and considering possible transshipment between vehicles (this requires to setup rendez-vous between routes).

Assignment

The research will build on the body of highly efficient tools for vehicle routing, planning and scheduling problems that are developed within the team [1], while generalizing them :

- dynamic programs for resource constraint shortest path [3] that requires extension to the pick-up-and-delivery context
- branch-and-price-and-cut algorithms including non robust cuts that would need to be generalized to this context
- restriction and relaxation strategies to achieve primal & dual bounds on the pricing subproblem
- master program updating scheme and filtering to limit the size of the formulation; stabilization schemes to reduce the number of iterations [2];
- parallelization to reduce the time of an iteration
- hybridization between branch-and-price, branch-and-bound, and primal heuristics to accelerate the process of achieving “good solutions”.

Beyond these extensions, the second part of thesis shall focus on novel research advances that are required to handle transshipments/rendez-vous between routes and to deal with online requests, including ways to make the original plan robust to dynamic request inclusion; along with the evaluation of the gain that can be expected from transshipments and the robustness of the plannings in their ability to handle online requests.

Main activities

Key words:
Vehicle Routing, Mixed Integer Programming, Dantzig-Wolfe Decomposition, Dynamic Programming, Parallelisation

References:

Skills
Required knowledge and background:
The PhD candidate should have a strong background in mathematical optimization: linear and mixed integer programming, dynamic programming, and constraint programming. Furthermore strong skills in algorithm implementation and numerical work are required.

Benefits package
- Subsidised catering service
- Partially-reimbursed public transport

Remuneration
1982€ / month (before taxes) during the first 2 years, 2085€ / month (before taxes) during the third year.