2018-00406 - Post-doctoral - Dynamic aggregation techniques for formulations mixing integer linear programming and dynamic programming

Level of qualifications required: PhD or equivalent
Function: Post-Doctoral Research Visit

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 theoretic 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:
- Modeling and simulation of systems of systems, large scale hybrid models
- It will also help dealing with uncertainty as an efficient tool for robust optimization
- Several applications to energy, sustainable development and resource management, such as operations management in vineyard.

Scientific Research context:

Integer Linear Programs (ILP) are widely used for modeling combinatorial optimization problems (in transportation, planning, cutting, scheduling…). A classical approach for solving an ILP (which is NP-hard in general) is to use a reformulation splitting the problem into “easy” constraints, typically associated with totally unimodular (T.U.) matrices, and “difficult” constraints. A number of practical problems rely on the consumption/production of limited resources, such as primary materials or time, that enable the use of the Dynamic Programming paradigm to obtain T.U. models of some of their subsystems. Such subsystems can be casted as shortest path problems in graphs whose nodes represent states of the subsystem, whereas arcs are linked with transitions related to decisions. The great quality of those reformulations is obtained at the price of a very large number of states and transitions that forbids solving them directly, even if the problem is theoretically easy to solve. This calls for the design of sophisticated algorithmic strategies.

Assignment

The work aims at solving very large scale ILP formulations obtained by T.U. reformulations of subsystems using dynamic aggregation and disaggregation of variables and constraints, by projecting the subsystems into lower dimension spaces. The expected work contributes to the design and implementation of a generic framework proposing several solving methods based on successive relaxations and restrictions of the state space, such as the Successive Sublimation Dynamic Programming algorithm [Ibaraki and Nakamura, 1994].

Main activities

More specifically, the mission consists in extending the existing framework to cases with multiple T.U. subsystems. Expressing the link between several subsystems requires to mix graph-modeled subproblems with a Linear Programming-modeled master problem, through the use of Dantzig-Wolfe reformulation or Lagrangian decomposition techniques. In this context, the post-doctoral researcher will contribute from a methodological point-of-view to the adaptation of key component techniques (in priority, Lagrangian cost variable fixing) to the case with multiple subsystems. The hybridization of state space relaxation techniques and branch-and-price algorithms might be addressed depending on the time required to achieve priority tasks. The methods developed will be implemented and integrated in the generic framework, and their efficiency assessed on a variety of combinatorial optimization problems.

Keywords: mathematical optimization, dynamic programming, mathematical programming

References:

General Information

- Theme/Domain: Optimization, machine learning and statistical methods
- Town/city: Talence
- Inria Center: CRI Bordeaux - Sud-Ouest
- Starting date: 2018-11-01
- Duration of contract: 1 year, 4 months
- Deadline to apply: 2018-04-19

Contacts

- Inria Team: REALOPT
- Recruiter: Clautiaux François / francois.clautiaux@inria.fr

Conditions for application

Contact: François CLAUTIAUX and Boris DETIENNE

Thank you to send:
- 4 pages CV
- Cover letter
- At least 2 support letters (mandatory)
- List of publication
- PDF of the most relevant publication
- Defense report
- Reviewer thesis report

Defence Security:

This position is likely to be situated in a restricted area (ZRR), as defined in Decree No. 2011-1425 relating to the protection of national scientific and technical potential (PPST). Authorisation to enter an area is granted by the director of the unit, following a favourable Ministerial decision, as defined in the decree of 3 July 2012 relating to the PPST. An unfavourable Ministerial decision in respect of a position situated in a ZRR would result in the cancellation of the appointment.

Recruitment Policy:

As part of its diversity policy, all Inria positions are accessible to people with disabilities.

Warning: you must enter your e-mail address in order to save your application to Inria. Applications must be submitted online on the Inria website. Processing of applications sent from other channels is not guaranteed.


**Skills**

Required knowledge and background: mathematical programming, decomposition techniques, Lagrangian relaxation, dynamic programming, good programming skills in C++

**Benefits package**

- Subsidised catering service
- Partially-reimbursed public transport

**Remuneration**

2653€ / month (before taxes)