PhD Proposal

Research Lab: Mathematics Institute of Bordeaux, team OptimAl

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Title of the proposal research subject: Parallelisation based Algorithmic Strategies to Accelerate Benders and Dantzig-Wolfe Decomposition Approaches

Scientific research context: Decomposition approaches are essential tools to tackle large scale complex constrained optimization problems in operation planning. In a divide-and-conquer spirit, Dantzig-Wolfe Decomposition is advocated when multiple resources are used to satisfy requests (each resource has its own set of constraints that define a subproblem); while Benders Decomposition applies when the problem involves two decision stages (design-first-use-second, or here-and-now-decisions-versus-recourse-actions as arising in stochastic optimization). The former decomposition calls for an algorithm relying on dynamic pricing (generating on the fly the promising variables associated with a scenario for a resource usage). The later calls for dynamic cut generation (generating constraints that must be obeyed at the first stage to ensure coherence in the second stage). These decomposition techniques, that are very much related, have recently known a revival in their credibility given very interesting progress in accelerating their convergence and success in solving instances much larger than with any other methods.

Goal: The proposed subject is in line with this research trend, aiming to turn decomposition methods into very efficient algorithms that performs numerically well for even larger instances than today's benchmarks. This requires in particular well designed algorithmic strategies for pricing (testing which variable to add) and cutting (identifying constraints to generate) in the course of the algorithm. We shall build on the team's current research in so-called emstabilization techniques: convergence acceleration by controling the separation point using smoothing and line search, among other strategies [1]. Further progress shall emanate from a theoretical analysis and convergence proof, and shall find their practical utility through auto-adaptative parametrisation of well designed algorithms dictated by the theory.

Project: The PhD research is to consider a broader range of techniques relying on the availability of multiple cores in todays computers. The parallelisation can bring novel opportunities to develop different strategies that were out of reach otherwise: such as coupling intensification and diversification when pricing, using multipe separation points when cutting, or evaluating multiple candidates when branching. These innovative features shall be combined with more obvious benefits of parallelisation such as handling multiple subproblems, or running primal heuristics in parallel to the main exact approach [2].

Required Knowledge and background: This project requires specific training and expertise in both mathematical optimization and parallel programming, with a taste for algorithmic and numerical research in mixed integer programming. Candidates with outstanding academic achievements according to international standards are invited to contact Ruslan.Sadykov@inria.fr to submit their curriculum vitae and a description of their previous experience.

Advisors : R. Sadykov and F. Vanderbeck

References: (1) A Pessoa, R Sadykov, E Uchoa, and F Vanderbeck. Automation and combination of linear-programming based stabilization techniques in column generation. Inria Wp hal-01077984, 2015.

(2) R Sadykov, F Vanderbeck, A Pessoa, I Tahiri, and E Uchoa. Primal Heuristics for Branch-and-Price. Inria WP hal-01237204, 2015.

Keywords: Parallel computing, Integer Programming, Decomposition Approaches.