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A Study of Using Multiple Subproblems in Dantzig-Wolfe Decomposition of Linear Programming

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Abstract : This paper is to study the use of multiple subproblems in Dantzig-Wolfe decomposition of linear programming (DW-LP). Traditionally, the decomposed LP consists of one LP master problem and one LP subproblem. The master problem and the subproblem is solved alternatively by exchanging the dual prices of the master problem and the proposals of the subproblem until the LP is solved. It is well known that convergence is slow with a long tail of near-optimal solutions (asymptotic convergence). Hence, the performance of DW-LP highly depends upon the number of decomposition steps. If the decomposition steps can be greatly reduced, the performance of DW-LP can be improved significantly. To reduce the number of decomposition steps, one of the methods is to increase the number of proposals from the subproblem to the master problem. To do so, we propose to add a quadratic approximation function to the LP subproblem in order to develop a set of approximate-LP subproblems (multiple subproblems). Consequently, in each decomposition step, multiple subproblems are solved for providing multiple proposals to the master problem. The number of decomposition steps can be reduced greatly. Note that each approximate-LP subproblem is nonlinear programming, and solving the LP subproblem must faster than solving the nonlinear multiple subproblems. Hence, using multiple subproblems in DW-LP is the tradeoff between the number of approximate-LP subproblems being formed and the decomposition steps. In this paper, we derive the corresponding algorithms and provide some simple computational results. Some properties of the resulting algorithms are also given.

Keywords : approximate subproblem, Dantzig-Wolfe decomposition, large-scale models, multiple subproblems
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