Primal Recovery Strategies for Lagrangian Dual Subgradient-Based Methods*

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Abstract

Lagrangian duality is a frequently used technique for solving specially structured linear programs, which is relatively easy to solve. It is well-known that Lagrangian dual can be solved via a cutting or tangential approximation approach to recover both primal and dual optimal solutions. However, a more popular approach to solve the Lagrangian dual is subgradient optimization techniques. This is particularly useful when such problems arise via linear programming relaxations LP of non-convex discrete or continuous optimization problems and several instances of these relaxations might need to be solved within the framework of a branch-and-bound approach. In such cases, subgradient optimization techniques can provide a significant computational advantage over simplex based or interior point solvers. The reason for this is the quick and simple manner in which an optimum can be found for Lagrangian dual via this approach. While such a subgradient optimization approach can be quite powerful in providing a quick upper or lower bound via the solution of Lagrangian dual, the disadvantage is that a primal optimal solution is not usually available via this scheme. The availability of a primal solution can provide a natural stopping criterion based on the duality gap for the subgradient optimization procedure that otherwise lacks such a feature. Sen and Sherali[1986] and Sherali and Ulular[1989] show how a primal penalty function can be coordinated with the Lagrangian dual problem in a primal-dual subgradient optimization approach. However, this now requires the optimization to be conducted in the joint primal-dual space. Alternatively, one can attempt to obtain a primal feasible solution after enforcing complementary slackness on the derived dual optimal solution. But again, this might involve a significant additional computational burden, particularly in the case of dual degeneracy. On the other hand, by adopting certain restricted step size strategies, and accumulating a specific convex combination of the primal subproble.

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