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An Efficient Branch-and-Cut Algorithm for Submodular Function Maximization

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The submodular function maximization is an attractive optimization model that appears in many real applications. Although a variety of greedy algorithms quickly find good feasible solutions for many instances while guaranteeing $(1 - 1/e)$-approximation ratio, we still encounter many real applications that ask optimal or better solutions within reasonable computation time. In this paper, we present an efficient branch-and-cut algorithm for the non-decreasing submodular function maximization problem based on its binary integer programming (BIP) formulation with an exponential number of constraints. Nemhauser and Wolsey developed an exact algorithm called the constraint generation algorithm that starts from a reduced BIP problem with a small subset of constraints and repeats solving a reduced BIP problem while adding a new constraint at each iteration. However, their algorithm is still computationally expensive due to many reduced BIP problems to be solved. To overcome this, we propose an improved constraint generation algorithm to add a promising set of constraints at each iteration. We incorporate it into a branch-and-cut algorithm to attain good upper bounds while solving a smaller number of reduced BIP problems. According to computational results for well-known benchmark instances, our algorithm achieves better performance than the state-of-the-art exact algorithms.

Improving Approximation Ratios for the Clustered Traveling Salesman Problem

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The clustered traveling salesman problem (CTSP) is a generalization of the traveling salesman problem (TSP) in which the set of cities is divided into clusters and the salesman must consecutively visit the cities of each cluster. It is well known that TSP is NP-hard, and hence CTSP is NP-hard as well. Guttmann-Beck et al. (2000) designed approximation algorithms for several variants of CTSP by decomposing it into subproblems including the traveling salesman path problem (TSPP). In this paper, we improve approximation ratios by applying a recent improved approximation algorithm for TSPP by Zenklusen (2019).