Exact Separation of *k*-Projection Polytope Constraints

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Cutting planes are often used as an efficient means to tighten continuous relaxations of mixed-integer optimization problems and are a vital component of branch-and-cut algorithms. A critical step of any cutting plane algorithm is to find valid inequalities, or cuts, that improve the current relaxation of the integer-constrained problem. The maximally violated valid inequality problem aims to find the most violated inequality from a given family of cuts. k-projection polytope constraints are a family of cuts that are based on an inner description of the cut polytope of size k and are applied to $k\times k$ principal minors of a semidefinite optimization relaxation. We propose a bilevel second order cone optimization approach to solve the maximally violated k projection polytope constraint problem. We reformulate the bilevel problem as a single-level mixed binary second order cone optimization problem that can be solved using off-the-shelf conic optimization software. Additionally we present two methods for improving the computational performance of our approach, namely lexicographical ordering and a reformulation with fewer binary variables. All of the proposed formulations are exact. Preliminary results show the computational time and number of branch-and-bound nodes required to solve small instances in the context of the max-cut problem.