DISSERTATION DEFENSE

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"ESSAYS ON POSTOPTIMALITY, LIFT-AND-PROJECT, AND SCHEDULING"

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This thesis offers methodological and computational contributions to integer and mixed-integer linear programming. The first area is postoptimality, in which we explore how decision diagrams can be used to compactly store and query near-optimal solutions. Our contribution is on characterizing a particular form of decision diagram relaxation, the sound decision diagram, where solutions worse than a given threshold are tolerated in order to obtain smaller decision diagrams. We introduce an operation that we denote as ``sound reduction'' that, if applied a sufficient number of times, leads to one among the sound decision diagrams of minimum size. The second area is lift-and-project, in which we explore alternative formulations of the cut generating linear program (CGLP) as well as the equivalence between lift-and-project cuts and intersection cuts. Our first contribution is the introduction of a new formulation, the reverse polar CGLP, where the conventional roles of the objective function and of the normalization constraint are switched. We show that cuts from CGLP optima always define supporting hyperplanes of the disjunctive hull and that, if the objective function minimizes the slack of the cut for a point in the interior of the disjunctive hull, then the resulting cut is facet-defining with respect to the disjunctive hull. Our second contribution in this area is a method to identify irregular lift-and-project cuts, which are cuts from non-split disjunctions that are not equivalent to intersection cuts from any basis of the linear relaxation. Based on the CGLP formulation, we present a mixed-integer formulation that determines if such an equivalence exists and we report computational results on several instances where many cuts from elementary t-branch disjunctions are not equivalent to cuts from t rows of the simplex tableau. The last area is an emergent scheduling application, in which we study a last-mile passenger transportation service using autonomous vehicles. Our contribution consists of an approach to solve this optimization problem within the required time frame. We show that a convenient restriction of this problem has optimal solutions with a certain structure, propose heuristics that preserve such structure for warm-starting a mixed-integer formulation, and report a significant improvement as a result.