Iterative Approaches for Exact Solutions to Robust Optimization Problems

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Solving robust versions of optimization problems is generally known to be an intrinsically hard task. For many robust optimization problems an iterative solution procedure is the preferred choice for solving them. We consider iterative approaches based on cutting planes for solving robust mixed-integer optimization problems. Iterative approaches start by solving a reduced problem, called optimization problem, with a small, finite uncertainty set. In the next step, a new scenario is determined by some procedure, called pessimization problem, and added to the considered uncertainty set. This procedure is then repeated iteratively until an optimal solution (up to some tolerance) to the robust optimization problem is found. We give a general enhancement to this iterative approach by investigating the concept of solving the optimization and/or pessimization problems only approximately. Solving a subproblem approximately means that we stop the solver for the respective subproblem if an incumbent solution is found whose objective value exceeds a specified bound. We identify under which conditions this enhanced iterative approach still converges to an optimal solution and give bounds on the number of iterations. Furthermore we give a parameterization for choosing the degree of approximation for the optimization and pessimization problems and discuss reasonable bounds for these parameters. Finally we investigate in our computational experiments how different degrees of approximation impact the runtime of the algorithm when applied to robust mixed integer problems. Here we distinguish between hard and easy optimization problems and hard and easy pessimization problems where the latter depends on the structure of the uncertainty set. We give suggestions for good parameter choices. The computational results show that a good parameter choice can lead to significant speed-ups in the runtime of the iterative approach.