Lagrangian Dual Approach for Identifying the Worst Contingencies in Power Systems

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We address the problem of identifying vulnerabilities in an electric grid network. The vulnerability identification is modeled as a nonconvex robust optimization, where the upper level must choose attacks that anticipate the lower level decision to minimize the damage from the attacks. In general, nonconvex robust optimization problems are NP-hard, and effective solution approaches make use of the problem structure. Initially, we consider a single-level reformulation to the original problem, but note that its convexity properties do not allow for tractable solution approaches. To address this, we pose a Lagrangian-based reformulation that, preserves the modeling of nonlinear aspects of the power network operation, while having the desired structure amenable to the application of standard solution approaches in mixed-integer convex programming. We present computational experiments based on IEEE and Pegase cases, discuss the effectiveness of the new approach and conclude with questions arising from the experiments that can be addressed in the future.