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Title: An algorithm to solve a class of equilibrium problems with equilibrium constraints (EPECs)

Abstract: We analyze Nash games played between leaders of linear Stackelberg games, which constitutes a subclass of equilibrium problems with equilibrium constraints (EPECs). First we analyze the simplest of these problems - where there are two leaders, each leader with one follower and every player's optimization problem is a linear program. Even in this restricted setting, we show that without strong consequences in complexity theory, no algorithm can find either pure-strategy Nash equilibria (PNE) or mixed-strategy Nash equilibria (MNE) or decide their existence faster than O({2^n}^n) time. However, if all players' feasible sets are bounded, we show that a MNE always exists. We then provide a finite algorithm that computes MNEs (and PNEs) for these problems when they exist or return a proof of infeasiblity if no MNE exists. We then extend the algorithm to include convex quadratic objective functions for the followers, allow multiple followers per leader and allow more than 2 leaders without significant increase in the complexity. Then we propose ideas to improve the performance of the algorithm using a primal-dual approach where outer and inner approximations are computed for the feasible region of the leaders and that these approximations converge to the convex hull of the leaders' feasible regions. To the best of our knowledge, this is the first algorithm that gives a guarantee that the output is the Nash equilibrium (without relaxations) or a proof that no Nash-equilibrium exists. We apply this formulation to model energy trade between the Argentinian and Chilean government (who act as the leaders), their domestic taxation policies and the indigenous energy producers (who act as the followers), to identify a Nash equilibrium.

Key words: EPEC