

A Diagonalization and Implicit Programming Approach to the Numerical Solution of EPECs

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Abstract

Equilibrium problems with equilibrium constraints (EPECs) constitute an important class of hierarchical equilibrium models with applications, for instance, in electricity markets and other multi-leader common-follower settings. Their numerical solution is challenging due to the combination of equilibrium constraints, nonsmoothness, and the game-theoretic interaction among the leaders.

In this contribution we study a class of EPECs for which the follower response is single-valued and locally Lipschitz, so that an implicit programming reduction can be employed. This allows us to reformulate the original problem as a single-level Nash game with nonsmooth leader objectives. To solve the reduced problem, we combine a Gauss–Seidel type diagonalization scheme with nonsmooth optimization techniques for the arising subproblems.

The proposed approach is supported by a stationarity analysis for the reduced game and by convergence results for the diagonalization procedure. In particular, we introduce a suitable generalized differential construction that provides the closedness properties needed in the convergence analysis. The resulting algorithm is implemented with a bundle-trust strategy and subgradient information computed via SCD/SC-derivative calculus.

Finally, we present numerical experiments on electricity-market-type models, showing that the method is practically effective and capable of computing stable equilibria in structured EPEC instances. The results indicate that combining diagonalization with implicit programming provides a promising computational framework for this class of equilibrium models.