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Computing better approximate pure Nash equilibria in cut games via semidefinite programming

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Abstract:

Cut games are among the most fundamental strategic games in algorithmic game theory. It is well-known that computing an exact pure Nash equilibrium in these games is PLS-hard, so research has focused on computing approximate equilibria. We present a polynomial-time algorithm that computes 2.7371-approximate pure Nash equilibria in cut games. This is the first improvement to the previously best-known bound of 3, due to the work of Bhalgat, Chakraborty, and Khanna from EC 2010. Our algorithm is based on a general recipe proposed by Caragiannis, Fanelli, Gravin, and Skopalik from FOCS 2011 and applied on several potential games since then. The first novelty of our work is the introduction of a phase that can identify subsets of players who can simultaneously improve their utilities considerably. This is done via semidefinite programming and randomized rounding. In particular, a negative objective value to the semidefinite program guarantees that no such considerable improvement is possible for a given set of players. Otherwise, randomized rounding of the SDP solution is used to identify a set of players who can simultaneously improve their strategies considerably and allows the algorithm to make progress. The way rounding is performed is another important novelty of our work. Here, we exploit an idea that dates back to a paper by Feige and Goemans from 1995, but we take it to an extreme that has not been analyzed before.

Joint work with Zhile Jiang (to appear in STOC 2023)

Host: Kevin Schewior