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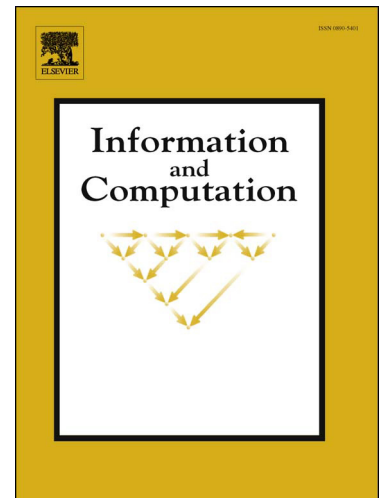
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Inapproximability Results for Constrained Approximate Nash Equilibria[☆]

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Abstract

We study the problem of finding approximate Nash equilibria that satisfy certain conditions, such as providing good social welfare. In particular, we study the problem ϵ -NE δ -SW: find an ϵ -approximate Nash equilibrium (ϵ -NE) that is within δ of the best social welfare achievable by an ϵ -NE. Our main result is that, if the exponential-time hypothesis (ETH) is true, then solving $(\frac{1}{8} - O(\delta))$ -NE $O(\delta)$ -SW for an $n \times n$ bimatrix game requires $n^{\tilde{\Omega}(\log n)}$ time. Building on this result, we show similar conditional running time lower bounds on a number of decision problems for approximate Nash equilibria that do not involve social welfare, including maximizing or minimizing a certain player's payoff, or finding approximate equilibria contained in a given pair of supports. We show quasi-polynomial lower bounds for these problems assuming that ETH holds, where these lower bounds apply to ϵ -Nash equilibria for all $\epsilon < \frac{1}{8}$. The hardness of these other decision problems has so far only been studied in the context of exact equilibria.

Keywords: Approximate Nash equilibrium, constrained equilibrium, quasi-polynomial time, lower bound, Exponential Time Hypothesis.

1. Introduction

One of the most fundamental problems in game theory is to find a Nash equilibrium of a game. Often, we are not interested in finding any Nash equilibrium, but instead we want to find one that also satisfies certain constraints. For example, we may want to find a Nash equilibrium that provides high *social welfare*, which is the sum of the players' payoffs.

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