Algorithmic Information Design in Multi-Player Games: Possibilities and Limits in Singleton Congestion

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Most algorithmic studies on multi-agent information design have focused on the restricted situation of optimal public signaling with no inter-agent externalities; only a few exceptions investigated special game classes such as zero-sum games and second-price auctions. This paper initiates the algorithmic information design of both *public* and *private* signaling in a fundamental class of games with negative externalities, i.e., atomic singleton congestion games, with a wide range of applications in scheduling, routing, and network design, etc.

For both public and private signaling, we show that the optimal information design can be efficiently computed when the number of resources is a constant. To our knowledge, this is the first set of efficient exact algorithms for information design in succinctly representable many-player games. Our results hinge on novel techniques such as developing certain *reduced forms* to compactly characterize equilibria in public signaling or to represent players' marginal beliefs in private signaling. When there are many resources, we show computational intractability results. Here, we introduce a new notion of (equilibrium)-*obliviously* NP-hardness, which rules out any possibility of computing a good signaling scheme, irrespective of the equilibrium selection.

A full version of this paper can be accessed from the following link: https://arxiv.org/pdf/2109.12445.pdf

CCS Concepts: • **Theory of computation → Algorithmic game theory**; **Exact and approximate computation of equilibria**.

Additional Key Words and Phrases: Information Design in Strategic Games, Bayesian Persuasion, Congestion Games

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