Non-Monetary Mechanism Design without Distributional Information: Using Scarce Audits Wisely

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Editors: Nika Haghtalab and Ankur Moitra

Abstract

We study a T-round repeated resource allocation problem with K strategic agents where monetary transfers are disallowed and the central planner has no prior information on agents' utility distributions. In light of Arrow's impossibility theorem, acquiring information about agent preferences through some form of feedback is necessary. We assume that the central planner can request powerful but expensive audits on the winner in any round, revealing the true utility of the winner in that round. The objective of the planner is to optimize the social welfare (*i.e.*, ensure efficiency) in presence of strategic agents (*i.e.*, handling incentives) via the wise usage of the scarce audits.

While there has been various non-monetary resource allocation mechanisms ensuring (approximate) incentive-compatibiliy for the agents, for example the artificial currency approach (Gorokh et al., 2021b) or the future promise paradigm (Balseiro et al., 2019; Blanchard and Jaillet, 2024), they heavily relied on the usage of agents' true utility distributions. The only exceptions are (Yin et al., 2022) that assumed agents with homogeneous distributions, and (Gorokh et al., 2021a; Banerjee et al., 2023; Fikioris et al., 2025) that focused on β-Utopia, a very different notion of efficiency.

Our main contribution is the `AdaAudit` mechanism, which achieves T-independent $\mathcal{O}(K^2)$ social welfare regret while only requesting $\mathcal{O}(K^3 \log T)$ audits in expectation – that is, when only focusing on the dependency on T, we ensure constant regret via a logarithmic number of audits. To complement this positive result, we also show an $\Omega(K)$ lower bound on the regret, as well as an $\Omega(1)$ lower bound on the number of audits when enjoying $o(\sqrt{T/\log T})$ regret.

Algorithmically, we show that incentive-compatibility can be mostly enforced via the imposition of *adaptive future punishments*: We audit the winner with a probability inversely proportional to their expected future gain when staying alive, and threating them with elimination once caught lying. This incentivizes agents to (almost always) be truthful via only $\widetilde{\mathcal{O}}_T(1)$ audits. To yield accurate estimation of agents' future gains, we introduce a *flagging* component, which allows agents to flag any biased estimate. We show that doing so is well-aligned with agents' individual incentives.

On the technical side, without monetary transfers and distributional information, the central planner cannot ensure that truth-telling is exactly an equilibrium for all possible distributions (while the revelation principle concludes for *every fixed* agents' utility profile, a mechanism ensures truth-telling is an equilibrium, such mechanisms may not remain the same for *all possible* profiles). Instead, we characterize an equilibrium via a reduction to a simpler *auxiliary game*, in which agents cannot fully strategize until it is close to the end of the game. We show that any equilibrium in the auxiliary game corresponds to a "well-behaved" strategy in the actual game. Further establishing properties of such strategies, we conclude that even in the fully strategic actual game, unilateral deviation is still not beneficial, *i.e.*, the actual game enjoys a "well-behaved" equilibrium. This conclusion consequently leads to bounds on the regret and expected number of audits. The tools developed therein, which we call the auxiliary game approach, may be of independent interest for other mechanism design problems in which the revelation principle cannot be readily applied. [1]

1. Extended abstract. Full version appears as `arXiv:2502.08412v2`.

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