Simple Economies are Almost Optimal

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Optimal mechanisms are often unnatural or hard to implement. Thus, an influential line of work in Algorithmic Mechanism Design attempts to develop suboptimal but simple mechanisms that are almost as good as optimal ones. Some of the numerous examples include [2, 6–8].

Other papers suggest to tackle the inapplicability of optimal auctions by approaching the problem from a different perspective: instead of changing the mechanism, change the market. The seminal paper of Bulow and Klemperer [1] initiated this line of research: it shows that the optimal revenue that can be extracted from an economy with \( n \) bidders whose values are drawn i.i.d. from some regular distribution \( D \) is at most the revenue of a second price auction with \( n + 1 \) bidders, all drawn i.i.d. from \( D \). That is, recruiting a single additional bidder allows the auctioneer to use the simple second-price auction without losing much revenue. Follow-up papers presented approximate versions of similar statements in other settings, e.g., for certain non-regular distributions [9], when the distributions are not identical [5, 6], and when there are multiple heterogeneous items [3, 4].

In this paper we suggest to explore a new market-changing approach. Consider a hypothetical scenario of a seller who intends to auction some item. The seller can invest money and effort in advertising in different market segments in order to recruit bidders to the auction. Alternatively, the seller can have a much cheaper and focused marketing operation and recruit the same number of bidders from a single market segment. Which marketing operation should the seller choose? Our goal is to compare the effectiveness of the different strategies.

More formally, let \( D = \{D_1, \ldots, D_n\} \) be a set of distributions. An economy \( E \) consists of \( n \) bidders, where the value of each bidder \( i \) is independently drawn from some \( D \in D \). For each economy \( E \), let \( R_E \) be the revenue of the optimal auction for the economy \( E \). The ideal revenue is defined to be \( \max_E R_E \).

Our goal is to determine whether there exists some distribution \( D \in D \) such that the revenue of the optimal auction for an economy where the values of the bidders are drawn i.i.d. from \( D \) (a homogeneous economy) provides a good approximation to the ideal revenue of the economy. In other words, we would like to determine whether the revenue that can be extracted by recruiting all bidders from the same population is comparable to the revenue that can be generated by...
handpicking the bidders in a way that maximizes the revenue. Our main result shows that it is always possible to extract a constant fraction of the ideal revenue with a homogeneous economy:

**Theorem:** Let \( D = \{ D_1, \ldots, D_n \} \) be a set of distributions. There is a homogeneous economy \( E \) where the value of each bidder \( i \) is independently drawn from the same distribution \( D \in D \), such that the revenue of an optimal auction for \( E \) is at least a \( \frac{1}{2} \cdot (1 - \frac{1}{e}) \)-fraction of the ideal revenue.

The mechanism designer is often unable to freely choose an auction format. Thus, we now consider situations in which the mechanism designer is constrained to use a second price auction in all economies, either because, e.g., it is not allowed to tailor a mechanism based on the specifics of the distributions or because of the simplicity of a second price auction. For each economy \( E \). We prove that homogeneous markets approximate well the ideal second-price revenue.

**Theorem:** Let \( D = \{ D_1, \ldots, D_n \} \) be a set of distributions. There exists a homogeneous economy \( E \) where the value of each bidder is independently drawn from the same distribution \( D \in D \), such that the revenue that can be generated by a second price auction in \( E \) is at least a \( c \)-fraction of the ideal second-price revenue, for some constant \( c > 0 \).

Next, we consider whether being able to recruit bidders from a small number of market segments (in contrast to just one, as in homogeneous markets) allows to significantly extract more revenue. We answer this question in the affirmative, at least when restricted to the second-price auction:

**Theorem:** Let \( D = \{ D_1, \ldots, D_n \} \) be a set of distributions. There exists some function \( f \) that depends only on \( \varepsilon \), such that for every constant \( \varepsilon > 0 \) the following holds: there exists a set \( D' \subseteq D \), \( |D'| = f(\varepsilon) \), and an economy \( E \) where the value of each bidder is drawn independently from some distribution \( D \in D' \), such that the revenue that can be generated by a second-price auction for \( E \) is at least a \( (1 - \varepsilon) \)-fraction of the ideal second-price revenue.

The full paper can be found at: http://arxiv.org/abs/2106.01019

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