

# Summary of “Mechanism Design: Beyond Traditional Models, Beyond Traditional Settings”

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**BEYOND TRADITIONAL MODELS IN REVENUE MAXIMIZATION.** Whether it is scheduling tasks in the cloud, routing traffic in a network, selling goods in electronic marketplaces, or assigning ad-slots on search engines, an auctioneer often sells multiple items to multiple potential buyers, and the seller has prior knowledge of the distributions from which each buyer’s item values are drawn. What is the revenue-optimal auction that the seller can implement? Unfortunately, despite decades of research on this problem, we are still far from a full understanding of the answer to this question. My work addresses specific yet tractable problems in revenue maximization by studying models that incorporate the uncertainty and specific constraints that mechanisms face in practice.

**BEYOND RESTRICTED DISTRIBUTIONS: LEVERAGING STRUCTURE.** In contrast to optimal auction results for only very simple or specific distributions, my work identifies real-world settings where buyer preferences have additional structure that can be leveraged to exactly characterize the optimal auction without placing any restrictions on the distributions. In “The FedEx Problem” [16], with collaborators, I consider the setting where buyers have a package to ship, a deadline  $d$  that they want it received by, and a value  $v$  for having the package received by its deadline. We use duality to characterize the optimal auction exactly, without case analysis. I have identified a number of other problems, including current work on the “Multi-Unit Pricing Problem” [13], where I believe using our duality approach to characterize optimal auctions is a promising approach.

**BEYOND COMPLICATED MECHANISMS: POSTED PRICINGS.** Optimal mechanisms are often very complicated and involve offering buyers a complex menu of lotteries. A major focus of recent research in the field has been on understanding the efficacy of simple mechanisms that post prices on each service or item that is offered, and then let buyers arrive in any order and take any item they want given the prices. In ongoing work with collaborators, I am working to give an algorithm for setting non-adaptive thresholds for the matroid prophet inequality problem, which would translate to posted pricings that achieve a constant-fraction of the optimal revenue.

**BEYOND KNOWN DISTRIBUTIONS.** While the bulk of revenue maximization reasons about buyers with unknown values drawn from known distributions, it is not always realistic to assume that the seller has access to this information. In joint work with Anna Karlin [18], we construct a prior-independent mechanism for multiple additive bidders that achieves a constant fraction of the expected profit of the optimal mechanism that is tailored to the prior distributions. Key prior-independent mechanism design questions remain in other settings where approximations have been developed, such as when buyer values are matroid-constrained [8], XOS [6], and subadditive [24].

**BEYOND RISK-NEUTRAL, TRUSTED SELLERS, AND CENTRALIZATION.** There are three other domains that I have begun work on: (1) maximizing revenue from risk-averse buyers who prefer outcomes with certainty to those with uncertainty; (2) designing auctions that give good guarantees and are verifiable from a third-party who may not trust that the seller is implementing the mechanism that he claims; and (3) designing mechanisms for Bitcoin and other blockchain-based systems, a dynamic setting where the auctioneer may change each time step and cannot be trusted.

**BEYOND REVENUE MAXIMIZATION: MECHANISM DESIGN FOR SOCIAL GOOD.** I am beginning to explore real-world problems where current market and government mechanisms are failing, and where algorithmic mechanism design can help play a role to improve social welfare, mitigate inequality, or disincentive the waste of resources. I am running a remote reading group [1] to identify applications in this domain that give rise to interesting theoretical mechanism design questions. Beyond existing work in kidney exchange and school choice, I am focused on problems in low-income housing, healthcare, income inequality, the online labor market, transportation, and climate change/resource conservation. In my statement, I pose research questions in housing and healthcare.

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