Pricing with a Hidden Sample

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Abstract

We study prior-independent pricing for selling a single item to a single buyer when the seller observes only a single sample from the valuation distribution, while the buyer knows the distribution. Classical robust pricing approaches either rely on distributional statistics, which typically require many samples to estimate, or directly use revealed samples to determine prices and allocations. We show that these two regimes can be bridged by leveraging the buyer's informational advantage: pricing policies that conventionally require the seller to know statistics such as the mean, L^η-norm, or superquantile can, in our framework, be implemented using only a single hidden sample.

We introduce hidden pricing mechanisms, in which the seller commits ex ante to a pricing rule based on a single sample that is revealed only after the buyer's participation decision. We show that every concave pricing policy can be implemented in this way. To evaluate performance guarantees, we develop a general reduction for analyzing monotone pricing policies over α-regular distributions, enabling a tractable characterization of worst-case instances. Using this reduction, we characterize the optimal monotone hidden pricing mechanisms and compute their approximation ratios; in particular, we obtain an approximation ratio of approximately 0.79 for monotone hazard rate (MHR) distributions. We further establish impossibility results for general concave pricing policies and for all prior-independent mechanisms. Finally, we show that our framework also applies to statistic-based robust pricing, thereby unifying sample-based and statistic-based approaches.

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