Escaping Cannibalization? Correlation-Robust Pricing for a Unit-Demand Buyer

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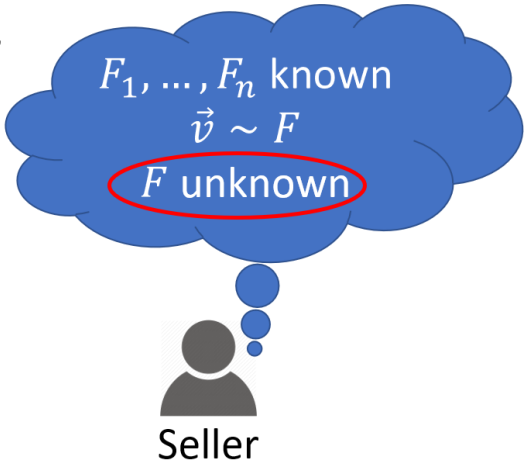

- Setting with Unknown Correlation:
  - 1 seller, 1 buyer, n items

- Terminology:
  - $F_1, \dots, F_n$ = marginals for the n item values
  - Correlated distribution F is "compatible" if the marginals of F are $F_1, \dots, F_n$
- Correlation-Robust Mechanism Design studies mechanisms whose worst-case (across all compatible distributions) revenue guarantee is highest [Carroll].
  - Selling separately is optimal for an additive buyer [Carroll'17].

"Best robust mechanism"

Our Research Question

- Correlation-robust pricing for a unit-demand buyer
  - (For unit-demand, item pricing is wlog)

In particular:

- Consider the best robust pricing
  - Is it correlation-agnostic?
  - Is it otherwise simple?
- If not, what about approximately-best robust pricing?

= Pricing whose worst-case (across all compatible distributions) revenue guarantee is approximately highest

- Questions posed/inspired by [Gravin-Lu'18,Bei-Gravin-Lu-Tang'19]

Our Results: General Marginals

- Starting point: Best robust pricing is not correlation-agnostic.
- Theorem: Worst compatible distribution F can be computed in polytime.

- Q: Given $F_1, \ldots F_n$, what is the (approximately-)best robust pricing $\vec{p}$?

$$\max_{\vec{p}} \min_{compatible\ F} \mathbb{E}_{\vec{v}\sim F}[\text{revenue from buyer given } \vec{v}, \vec{p}]$$

- Theorem [main]: Computing the best robust pricing $\vec{p}$ is NP-hard.
  - NP-hard even for an approximately-best $\vec{p}$ up to approx. factor $O(n^{1/2-\epsilon})$.
  - To our knowledge, first hardness result in the correlation-robust framework.

“Nice” Marginals

- Theorem: For MHR marginals there is a simple, correlation-agnostic, approximately-best robust pricing with approximation factor 3.5.
  - Offer the item with highest median for price equal to median.
- Open Question: For regular marginals, can the (approximately)-best robust pricing be computed in polytime?
  - Challenge: If so, would require using many distinct prices.

- What Makes Unit-Demand Complex? Cannibalization!
  - A term from marketing strategy referring to a reduction in sales […] of one product as a result of the introduction of [another] product by the same producer”.