on the tradeoff between complexity and accuracy in preference elicitation for combinatorial auctions

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motivation

- in combinatorial auctions, the possible number of bundles is exponential $\rightarrow$ declaring valuations for every possible subset is computationally infeasible, and would require exponential communication between bidders and seller.
- what if we try to settle for an approximate, instead of an exact valuation for a bundle? would that make the problem any easier?
- can we design a procedure by which we can get valuations as close as we wish to their exact values at the expense of more computation time?
- can these procedures be such that we can get good approximations in polynomial time?

problem definition

- we consider problems with no complementarities. furthermore, we assume our valuation function fulfills the following assumption. if A and B are bundles such that $f(A) \leq \alpha f(B)$, for some $\alpha > 0$, then for any item c, we have $f(A \cup c) \leq \alpha f(B \cup c)$.

- given a desired accuracy parameter $\epsilon \geq 0$, we are interested in computing a polynomial amount of information, in time polynomial in the number of items as well as the size of the data and $1/\epsilon$, such that for any given bundle U, we can use this information to evaluate an *approximate valuation function* $f'(U) \leq (1 + \epsilon)f(U)$.

what we can show

- we have a rather convoluted procedure to solve the previous problem (i think!)
- the procedure relies on dividing the valuation space into 'strips' or 'boxes', and dealing with these boxes instead of items. since the number of boxes is bounded, this implicitly assumes budget-constrained bidders.
- the number of boxes depend on our accuracy parameter ϵ.
- we thus obtain a tradeoff between accuracy and complexity. for an extreme case, we can choose ϵ such that each item is its own box, and the problem takes exponential time to solve. clustering the items into boxes leads to faster solutions that are less accurate.

extensions and things we cant do

- the analysis should be the same as long as the blow-up factor is bounded, i.e. $f(A \cup c) \leq \alpha^k f(A \cup c)$ for some positive constant k.

- submodular valuations $\rightarrow$ decreasing marginal utilities. this *could* fit in this framework using the previous observation.

- for auctions with complemetarities, this approach will not work. actually, its not clear that this notion of tradeoff between accuracy and complexity will work at all (as long as we require a provable guarantee on accuracy) unless the complementarities exhibit some structure.