Draft: Provider Selection on Zennet

Ohad Asor

January 10, 2015

Recall that on Zennet, a publisher publishes their need for computational power, and many providers connect to them and tell their prices and settings. Providers do not know about each other's offer. On Auction Theory this setting is called "Sealed Bid Auction" or "Blind Auction".

From first sight, one would anticipate that the publisher will select the providers offering the lowest price. But Auction theory points to a subtle but significant phenomenon, called the Winner's Curse.

To understand "why is it so bad to win an auction", imagine I bid some auction with some price which I believe makes me profitable enough after my expenses are taken. When I get to know I won, I realize that other bidders may have thought that they'd lose in such a deal. So maybe by winning I just discover I mis-priced my bid and going to lose?

On 1961, William Vickery described an auction that he was able to prove that it is optimal, at the sense that it incentivezes the bidders to bid their "true" bid, in contrast to overbidding or underbidding. Players aren't incentivized to manipulate the market, but to be honest. On Auction theory this is referred as Incentive Compatibility. On 1996, Vickery awarded a Nobel prize in economics for his auction.

The proof of the optimality is out of our scope and can be found easily online. We will state only the crux of Vickery auction, which on first sight is counter-intuitive, but turns out optimal: the winner is the bidder offering the lowest price, but they will receive a larger reward than they offerect, at the amount of the 2nd best bidder. This is called "Second-Price Sealed-Bid Auction".

While Vickery auction is intended for auctioning one item, on Zennet prices are given per resource, as described on the pricing document, so one would expect to have a combinatorial auction. This is not the always case. Combinatorial auctions (like VCG auctions) deal with ability to bid only on a part of the items. On Zennet, one cannot separate the RAM from the CPU, for example. So the publisher has to estimate the overall utility given the providers' offerings, which puts it back as single item auction.

Sometimes, publishers are indeed interested with combinatorial auctions. Say I need both massive computation and massive storage of the results. If I'd not take into account the bandwidth of the providers for transferring the data, then VCG auction fits. But the bandwidth and its price might be significant.

My utility function is therefore:

$$U(\mathbf{a}, \mathbf{b}) = C_{\text{CPU}}(\mathbf{a}) + C_{\text{STORAGE}}(\mathbf{b}) + s\left[C_{\text{UP}}(\mathbf{a}) + C_{\text{DOWN}}(\mathbf{b})\right]$$

where $\mathbf{a}, \mathbf{b}$ are two sets of providers where $\mathbf{a}$ provide CPU and $\mathbf{b}$ provide storage, $C_x(y)$ returns the cost of x offered by provider y, and s denotes the size of the data to be transferred. Setting $U(\mathbf{a}, \mathbf{b}) = U_1(\mathbf{a}) + U_2(\mathbf{b})$ by:

$$U_1(\mathbf{x}) = C_{\text{CPU}}(\mathbf{x}) + sC_{\text{UP}}(\mathbf{x})$$

and

$$U_2(\mathbf{x}) = C_{\text{STORAGE}}(\mathbf{x}) + sC_{\text{DOWN}}(\mathbf{x})$$

showing that this case can be casted into VCG by this linear transformation.