

Experiment #3: Bidding on the Spectrum

In the US radio spectrum auctions, licenses were divided into different geographic areas across the northeast corridor. That is, there was a license for the Philadelphia metro area, a license for New York, a license for Boston, a license for DC and so on. Most of the individuals in the telecommunications business anticipated that a company securing rights to contiguous areas or the entire corridor would have a significant competitive advantage over rivals who secured licenses for only part of the area. While these synergies were expected to be large, no one was exactly sure how large they would be.

The designers of the auction worried about the impact that these synergies might have on the allocation of licenses. Under the Telecommunications Act authorizing the auctions in the first place, Congress stressed the role of *efficient* allocation as being the main goal of the FCC in its auction design. By efficiency, Congress meant that it was important that the auction design deliver the licenses to the companies who would put them to best (i.e. most consumer friendly) use. This is presumably highly correlated with the value that the firms themselves place on the licenses. The auction actually used in selling the spectrum in the US was the simultaneous ascending auction. See the article: [Putting Auction Theory to Work](#) for details of what was actually done. Please read the article [Selling Spectrum Rights](#) for an overview of what happened.

An alternative auction form, the Vickrey auction, was proposed but ultimately not adopted.

In this exercise, you will be bidding on behalf of a telecommunications consortium interested in acquiring licenses. Specifically, there are two licenses that are being auctioned. One license (license A) covers the Philly metro area while the other license (license B) covers New York. You will be competing for these licenses under two different auctions: the simultaneous ascending auction---the form actually used---and the Vickrey auction.

There are 3 key valuations per team per iteration (round) of the game: valuations for the A license, the B license, and both licenses. For the A and B license separately, your valuation is a random draw from \$0 to \$100 million. The “synergy” term for acquiring the pair of licenses is a random draw from \$0 to \$25 million. In other words:

$$\text{valuation for A and B} = \text{valuation for B alone} + \text{valuation for A alone} + \text{synergy}$$

Vickrey Auction

Under the Vickrey auction, please submit a bid for license A, a bid for license B, and a bid for both licenses combined. (This is called a combinatorial auction because combination bids are allowed.) Bids can be any amount from \$0 to whatever amount you wish. In addition, your bid for both items (package bid) must be at least as large as the sum of your bids for the individual items.

Your payment is then determined by the bids of your rival in the following way.

1. If you are awarded both licenses, then you pay your *rival's* bid for the combination of A and B.
2. If you were awarded license A and your rival was awarded license B, you pay your rival's bid for both less his bid for B.
3. If you were awarded license B and your rival was awarded license A, you pay your rival's bid for both less his bid for A.
4. If you were awarded no licenses, you pay nothing.

Your job is to maximize your profits which are equal to the value of the licenses you receive less the amount that you pay.

A variation: The Simultaneous Ascending Auction

This auction is conducted in multiple rounds. At the start of the first round, each team is free to make a bid on each object. The bid must be at least \$5 million. The high bidder is revealed at the end of the round. In the following round, a team that is *not* the high bidder for an item can choose to outbid the current high bidder. The minimum bid increment is \$5 million. The auction continues until there is a round in which no improving bid is received. At that point, each object is awarded to the current high bidder who pays the bid amount.

Example: Suppose that team 1 bids \$5 million each for A and B while team 2 bids nothing in round 1. In round 2, team 2 bids \$10 million for B. Since there was a bid improvement, the game continues. In round 3, team 1 bids \$15 million for object B. In round 4, team 2 bids \$10 million for A. Notice that, even though there were no improving bids for A over a couple of rounds, it is still active. All objects are simultaneously in this auction. There are no new bids in round 5, so the auction ends. Team 2 gets object A for \$10 million while team 1 gets B for \$15 million.

Again, your job is to maximize profits.

Bidding on the Spectrum - Details

You will design 2 “bots” to represent you against other teams - one for each auction type. Each bot will take the set of 3 valuations - for A alone, for B alone, and for A and B together - as inputs. Let these be denoted V_A , V_B , V_{AB} respectively and be in millions of dollars. Note that valuations will be drawn after the bots are submitted.

Tribe with highest total average payoff in games against the opposing tribe will get Immunity for Survivor. I.e. games where competing bots are from the same tribe do not count towards Survivor.

Vickrey Auction Bot

For the Vickrey auction your bot will output a corresponding set of 3 bids: P_A , P_B , and P_{AB} . To implement this please write a function for each P that takes V_A , V_B , and V_{AB} as inputs.

For example if you want to bid half your valuation for A, write:

$$P_A = V_A/2$$

Simultaneous Ascending Auction Bot

In addition to your valuations, for each round your bot takes as inputs the highest existing bid for each object and whether your bot made those bids. Your bot can then submit a bid on each object for which you are not the highest bidder (min. increment is \$5 million). Note that you can only submit bids for A alone and B alone - there is no separate bid for the synergy term in this auction.

The auction ends when there are no new bids.

Examples will be discussed in class.