Artificial Intelligence and Auction Design

Martino Banchio, Andrzej Skrzypacz
{mbanchio, skrz} @stanford.edu

Background

According to standard auction theory, First Price auction and Second Price auction are very similar. However, Nash paradigm does not capture the behavior of AI algorithms.

Model

Repeated auctions $t = 1,2,\ldots$
2 bidders, same value $v = 1$.
Bids from $[0, \frac{1}{m+1}, \ldots, \frac{m}{m+1}]$

Q-learning

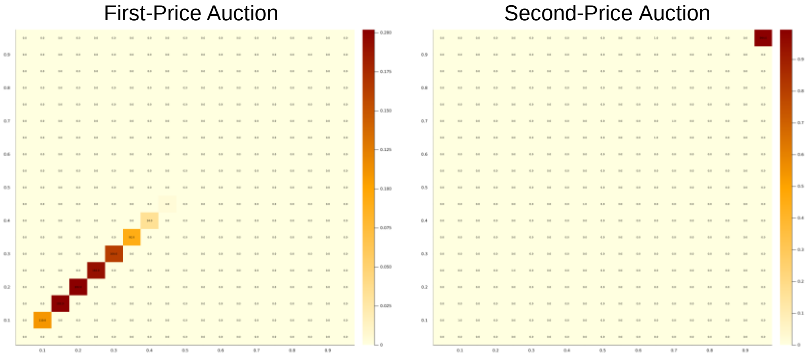
Q-learning estimates an action-value function $Q_t(a)$:

$$Q_t(a) = (1-\alpha)Q_{t-1}(a) + \alpha[r_t + \gamma \max_{a'} Q_{t-1}(a')]$$

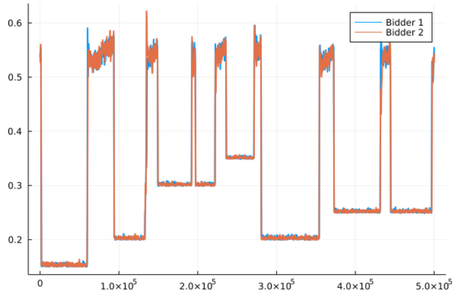
Convex combination between past estimate and new best estimate

Actions: ε-greedy wrt Q vector.

Results



FPA leads to collusion, SPA is perfectly competitive.



In the FPA, we don't find stationarity: bidders coordinate on a low bid, then after a period of deviations they re-coordinate on a (potentially different) new low bid.

The Mechanism

Suppose that after coordinating on $(0.3, 0.3)$, bidder 1 deviates to 0.6.

- Bidder 2 has an incentive to increase her bid, to match 0.6
- In an FPA, bidder 1 has an incentive to lower his bid: overbidding decreases profits.
- In an SPA instead, bidder 1 has no incentive to decrease his bid!

In FPA, two forces lead to cycles. No force in SPA → competition!

Feedback

Google tells everyone minimum-bid-to-win information

→ bidders can compute counterfactual
→ competition in FPA!