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

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: $\varepsilon$-greedy wrt Q vector.

Results

First-Price Auction

Second-Price Auction

FPA leads to collusion, SPA is perfectly competitive.

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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 $\rightarrow$ competition!

Feedback

Google tells everyone minimum-bid-to-win information

$\rightarrow$ bidders can compute counterfactual
$\rightarrow$ competition in FPA!