On the Coordination of Value-Maximizing Bidders

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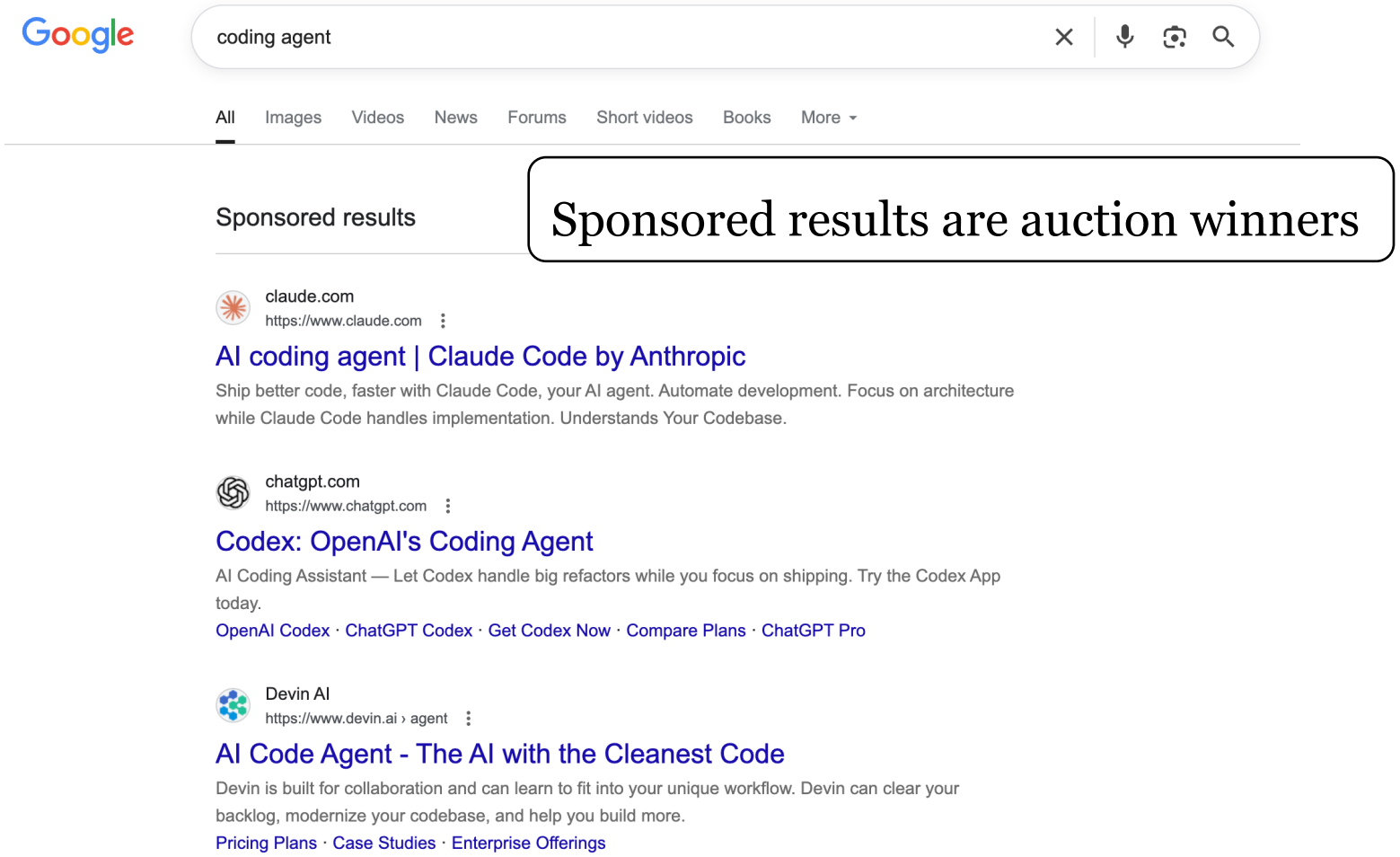
Online Ad Campaign



Online Ad Campaign

More than 80% of Google advertisers are using automated bidding.

Source: Google Internal Data, Global, 2021-03-16 to 2021-04-12.

Auto-bidding:

- The advertiser submits the goal and constraints
- The delegated bidding agent runs an algorithm A for the advertiser
- How to bid over repeated auctions?

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Independent

existing work

Coordination

?

Model

- Repeated second-price auction, T rounds
- Goal: maximize realized value
- Return-on-Spend (RoS) constraint
  - RoS target ratio is normalized to 1
- N bidders $v_{i,t} \sim F$ against 1 outside bid $d_t^O \sim D$

$$\max_{\{b_{i,t}\}_{t=1}^{T}} \sum_{t=1}^{T} v_{i,t} \cdot x_{i,t} \qquad \text{(bidder } i\text{'s value)}$$

$$\text{s.t.} \quad \sum_{t=1}^{T} u_{i,t} = \sum_{t=1}^{T} v_{i,t} \cdot x_{i,t} - \sum_{t=1}^{T} p_{i,t} \geq 0 \qquad \text{(RoS constraint)}$$

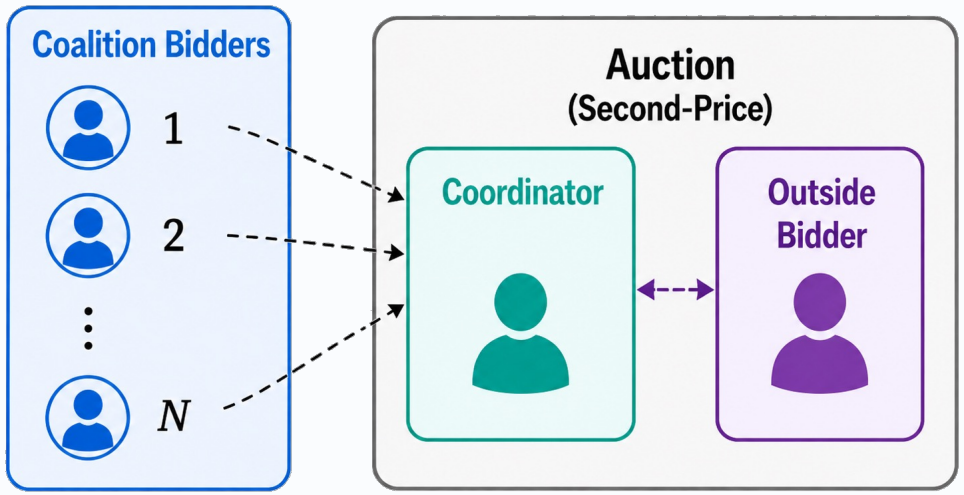
Auto-bidder Coordination

- In practice, multiple bidders are often managed by the same platform or advertiser.
- Compare: whether N bidders form a coalition or not.

Independent

- Each bidder runs a mirror-descent algo [1]
  1. Overbid $b_{i,t} = (1 + 1/\lambda_{i,t})v_{i,t}$
  2. Observe utility $g_{i,t} = v_{i,t}x_{i,t} - p_{i,t}$
  3. Update: $\lambda_{i,t+1} = \lambda_{i,t}e^{-\alpha g_{i,t}}$
- Can be generalized to a class of mirror-descent algo

Coordination



[1] Zhe Feng, Swati Padmanabhan, and Di Wang. 2023. Online Bidding Algorithms for Return-on-Spend Constrained Advertisers. The ACM Web Conference 2023.

Main Results: Simple Coordination Helps

Rule: in each round, only the coalition bidder with **highest value** bids.

1. **Better RoS Compliance:**

   Exact condition* for every bidder's expected utility to improve

2. **Higher Coalition Value:**

   Coordination improves total value asymptotically for any mirror-descent algo

3. **Value Asymptotic optimality:**

   Under the same condition*, asymptotically no better coordination mechanism

* Condition: The top two coalition values are competitive against the outside bid: $\Delta = E\left[\left(v_{(N-1)} - d^{O}\right)^{+} - \left(d^{O} - v_{(N)}\right)^{+}\right] \geq 0$

Experiments

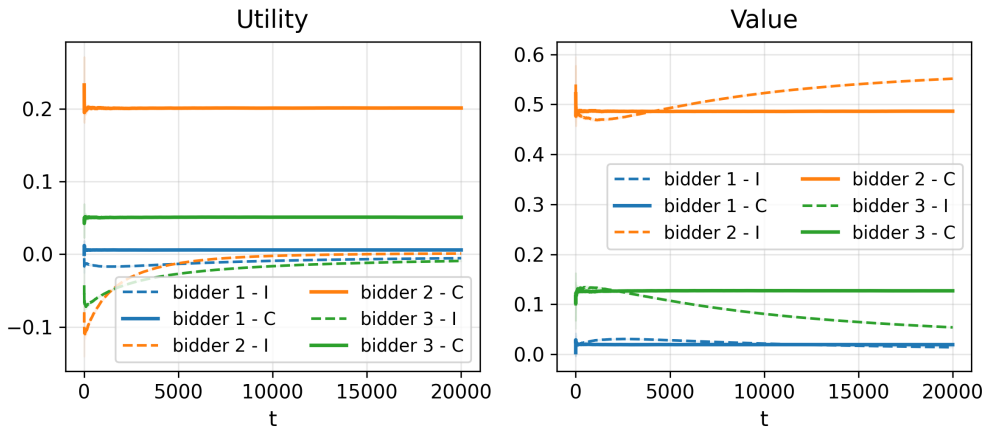


Fig 1. Non-i.i.d. Synthetic Data

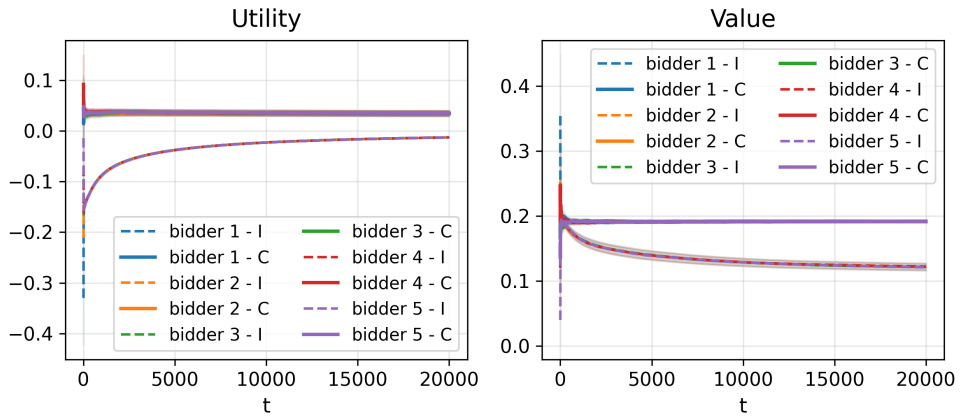


Fig 2. iPinYou Dataset

Coordination improves coalition-level utility/value across synthetic and real-data experiments.

Questions?

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