Is Dutch Auction Suitable for Decomposable Tasks in Competitive Crowdsourcing Markets?

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INTRODUCTION

- Crowdsourcing environment: competitive.
- Success of competitive crowdsourcing: depends on the auction strategy.
- Aim to study: viability of Dutch auction for competitive crowdsourcing markets.
- Characteristic of task: decomposable.
- Winner: multi winners is better than single winner.

MOTIVATION

Our aim is to understand and control competitive crowdsourcing environments, where the tasks are decomposable.

An example of competitive bidding with 2-decomposable tasks. Bidding cost of the $P_{th}$ worker is denoted as $C_{P} = \{C_{P}, C'_{P}\}$, where $C_{P}$ and $C'_{P}$ denote the costs for two different parts of the task.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$W_m$</td>
<td>Minimum bidder</td>
</tr>
<tr>
<td>$c_m$</td>
<td>Minimum bid value</td>
</tr>
<tr>
<td>$c_m$ and $c_m'$</td>
<td>Two nearest bid values</td>
</tr>
</tbody>
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BASIC DEFINITIONS

1. Definition 1 (Time-variant Dutch auction): Time-variant Dutch auction refers to the open descending price auction in which the time of bidding is also given importance while selecting the winner.

2. Definition 2 (Time-invariant Dutch auction): Time-invariant Dutch auction refers to the open descending price auction in which the time of bidding is not considered while selecting the winner.

3. Definition 3 (Minimum time-variant bidder in Dutch auction): Given a set of bidders $W = \{w_1, w_2, ..., w_n\}$, participating in a time-variant Dutch auction with their corresponding bid values $C = \{c_1, c_2, ..., c_n\}$, and the time of bidding $T = \{t_1, t_2, ..., t_n\}$ respectively, the minimum time-variant bidder is denoted as $w_m$, such that

$$m = \arg \min_i (\arg \min_j c_j t_i)$$

4. Definition 4 (K-nonempty decomposable task): A task is K-nonempty decomposable if it is divisible into K nonempty subtasks that consume positive bid values.

THEORETICAL INSIGHTS

Lemma 1: The minimum bidder $w_m$ in a Dutch auction has the following winning probability if the bidders are allowed to collaborate and the tasks are 2-nonempty decomposable.

$$\mathbb{P}_{\text{win}}(w_m) \begin{cases} > \frac{1}{2}, & \text{if time-variant} \\ \frac{1}{2}, & \text{if time-invariant} \end{cases}$$

- $c_m$ is the minimum time-variant bid value posted by $w_m$.

- The two closest bidder are $w_m$ and $w_m'$ and their bid values are $c_m$ and $c_m'$ respectively, such that $c_m = c_m + \delta'$ and $c_m' = c_m + \delta''$ where $\delta', \delta'' > 0$.

CONCLUSION

- Minimum time-variant bidder has a higher probability of winning the auction than the closest bidders.
- Strategy of selecting multiple winners based on time-invariant Dutch auction forces the current minimum bidder to further collaborate.
- Limitation of time-invariant Dutch auction for the control of such environments suggest an appropriate model for a better completion of decomposable tasks in a competitive crowdsourcing platform.

REFERENCES