Experimental Design: Impact of Number of Bidders on the Winner's Curse

1. Auction Format

- **Auction Type**: First-Price Sealed-Bid Auction

    - **Description**: Each bidder submits a sealed bid without knowledge of others' bids. The highest bidder wins and pays the amount of their own bid.

2. Treatment Groups

- **Control Group**: 2–3 bidders

- **Treatment Group**: 5–6 bidders

3. Key Variable

- **Variable**: Number of Bidders (N)

4. Hypothesis

- **Hypothesis**: Increasing the number of bidders in a first-price sealed-bid auction increases the likelihood of the winner's curse occurring.

    - **Rationale**: With more bidders, the competition intensifies, leading bidders to overestimate the item's value to secure a win, thereby increasing the risk of overbidding and suffering from the winner's curse.

5. Literature Support

- **Kagel, John H., and Dan Levin.** "The Winner's Curse and Public Information." *American Economic Review* 76, no. 5 (1986): 894–920.

    - **Summary**: This study demonstrates that inexperienced bidders are highly susceptible to the winner's curse in common-value auctions, and the incidence of this phenomenon increases with the number of bidders.

- **Thaler, Richard H.** "Anomalies: The Winner's Curse." *Journal of Economic Perspectives* 2, no. 1 (1988): 191–202.

    - **Summary**: Thaler discusses how the winner's curse arises when bidders overestimate the value of an item, especially in environments

with multiple bidders, leading to overbidding and subsequent losses.

- **Peeters, Ronald, and Anastas P. Tenev.** "Number of Bidders and the Winner's Curse." *University of Otago Economics Discussion Papers* No. 1802 (2018).

    o **Summary**: This paper examines the relationship between the number of bidders and the winner's curse in affiliated value auctions, finding that both the incidence and expected loss from the winner's curse increase with the number of bidders.

AI Agent Testing

1. Models, Prompt, and Setup

Models Selected:

- ChatGPT (GPT-4 based)

- Doubao

- Tongyi

Prompt Used for All LLMs:

> You are participating in a first-price sealed-bid auction. The item has an estimated value for you: 80.
>
> There are N participants including yourself. Submit your bid as an integer between 0 and 150.
>
> You do not know the bids of other participants. Your goal is to maximize your net payoff, defined as
>
> Payoff = Item Value – Bid if you win, otherwise 0.
>
> Only reply with a single integer number representing your bid. Do not explain your reasoning in this round.

Auction Rules:

- First-price sealed-bid auction

- Bids must be integers between 0 and 150

- Payoff = Item Value – Bid if the bidder wins; 0 otherwise

Interface Setup:

- LLMs were queried sequentially for three different scenarios with the number of participants $N=3,6,12N = 3, 6, 12N=3,6,12$.

- Each response was recorded as the LLM's bid.

- `Decision Logs:`

Number of Bidders	ChatGPT	Doubao	Tongyi
3	53	60	60
6	64	55	50
12	70	50	35

2. Comparison to Human Intuition / Theoretical Predictions

Hypothesis:
Increasing the number of bidders in a first-price sealed-bid auction increases the likelihood of the winner's curse.

Theoretical Expectation / Human Intuition:
In a first-price sealed-bid auction, as the number of bidders increases, competition intensifies, leading participants to bid closer to their valuations. This increases the likelihood of overbidding and suffering from the winner's curse.

3. Analysis of AI Bids

1. **ChatGPT:**

   o Bids increase with more participants (53 → 64 → 70), consistent with the theoretical prediction.

   o This suggests that higher competition drives higher bids, increasing the risk of the winner's curse.

2. **Doubao and Tongyi:**

   o Both models tend to reduce bids as the number of participants increases (Doubao: 60 → 55 → 50; Tongyi: 60 → 50 → 35).

   o This indicates a more conservative approach, potentially to avoid overpaying when facing more competitors.

Interpretation:

- ChatGPT's behavior aligns with the hypothesis and standard auction theory.

- Doubao and Tongyi's conservative strategies show that AI models may adopt different risk preferences or strategic assumptions, resulting in outcomes that diverge from human intuition.

- Overall, AI bidding behavior is model-dependent, indicating that simulated auctions may not fully replicate typical human bidding strategies.

4. Conclusion

- The hypothesis is **partially supported**: ChatGPT demonstrates the expected pattern where more bidders lead to higher bids and a greater risk of the winner's curse.

- Doubao and Tongyi, however, adopt more cautious strategies, showing that AI models

may diverge from human-like behavior in competitive auction scenarios.

- These results highlight the importance of model-specific characteristics when using LLMs to simulate economic or strategic decision-making.