

English Auction with Option to Buy: Study of The Risk in the Auction of WPI Students

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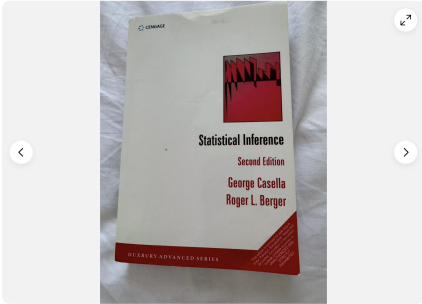
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Figure 1: Example of English auction with the option to buy

English Auction with Option to Buy?

The screenshot shows an eBay product page for a book. The main image is the book cover for 'Statistical Inference, Second Edition' by George Casella and Roger L. Berger. The cover is white with a red graphic at the top and bottom. To the left of the main image are three smaller thumbnail images of the book. Below the main image is a navigation bar with left and right arrows. To the right of the image is a sidebar with the book's title, author, and a 'Buy It Now' button. The main content area on the right shows the current price of US \$20.00, the number of bids (0), and the time left (1h 11m 25s). Below this is a 'Buy It Now' button and a 'Place bid' button. Further down are buttons for 'Add to cart' and 'Add to watchlist'. The shipping and delivery information is also visible, including the shipping cost (\$4.87) and the estimated delivery date (between Tuesday, April 23 and Saturday, April 27, 2019). The payment methods section shows logos for PayPal, Google Pay, Visa, Mastercard, and American Express. At the bottom, there is a section for 'Similar Items' and a 'Feedback on our suggestions' link.

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Figure 1: Example of English auction with the option to buy

Question: Should we buy it now or participate in the auction?

eBay Auction: Naive Model

- Suppose we have N bidders: P_1, P_2, \dots, P_N . They can choose to
 - Buy the item now
 - Play the auction
- Suppose i th player has the value of a particular item ν_i and suppose the seller is proposing the selling price ξ .
- For simplicity, let $\nu_1, \dots, \nu_N \stackrel{\text{iid}}{\sim} \text{Uniform}(0, \tau)$ where $\tau > \xi$ and ξ is fixed at $\tau - \kappa$ for some $0 < \kappa < \tau$.
 - This ensures that immediate needs or happiness is captured within the model without explicitly defining it.
- Assume the risk neutrality.
- Only P_i can choose to buy the item. (Why?)

Question: What is the optimal action and optimal bid (if we choose to)?

eBay Auction: Naive Model



Question: What is the optimal action and optimal bid (if we choose to)?

- We don't know the ending price. Thus, we want to bid until we reach the target valuation.
 - We either lose or win with no profit.
- The probability of P_i winning the auction is

$$p = \left(\frac{\nu_i}{\tau} \right)^{N-1}$$

eBay Auction: Naive Model

- If $\nu_i < \xi$, P_i always auction.
- If $\nu_i \geq \xi$, P_i can choose to buy or to auction.
 - Expected cost of bidding is

$$\begin{aligned}\mathbb{E}[B|B < \nu_i] &= \int_0^{\nu_i} \frac{b}{\tau} db \\ &= \frac{\nu_i^2}{2\tau}\end{aligned}$$

- That means if $\nu_i \geq \sqrt{2\tau\xi}$ then you should buy. If not, you should auction.
- Expected payoff is

$$\mathbb{E}[\pi_i] = \underbrace{\left(1 - \sqrt{\frac{2\xi}{\tau}}\right) (\nu_i - \xi)}_{\text{Payoff if buy}} + \underbrace{\sqrt{\frac{2\xi}{\tau}} (\nu_i - b_i)}_{\text{Payoff if auction}}$$

Experiment Design

Experiment Design: Number of Experiments

- There are 3 variables that can be tuned
 - N : Increase/Decrease the number of participants
 - κ : Increase/Decrease the threshold for the valuation (equivalent to moving ξ)
 - τ : Increase/Decrease the value
- Suppose we are looking at
 - $N = 2, 5, 10, 20$
 - $\kappa = 0, 5, 10, 20$
 - $\tau = 10, 20, 50, 100$

We have to perform at least $4^3 = 64$ experiments with different parameters (320 if we perform five repeated experiments)

- Target group: WPI students
- (Worst case) estimated budget: \$150K

Experiment Design: Auction

- Participants use the website to perform the auction and start with τ as money for every auction round.
- Participants are auctioning the gift card with value ξ with the option to buy it for ξ .
 - If the item is brought, that experiment ends.
- Random valuation is assigned for each participant; specifically, it is how much they can redeem after the experiment ended (induced value)
- Compensate the participant with 40% of what they earned from selling back the item and the number of hours they participated.

- Observing the following values:
 - The probability of choosing to buy it now.
 - How much they bid
- Comparing this value with the theoretical results.

Reference

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