Analyzing Unique-Bid Auctions for Fun and Profit

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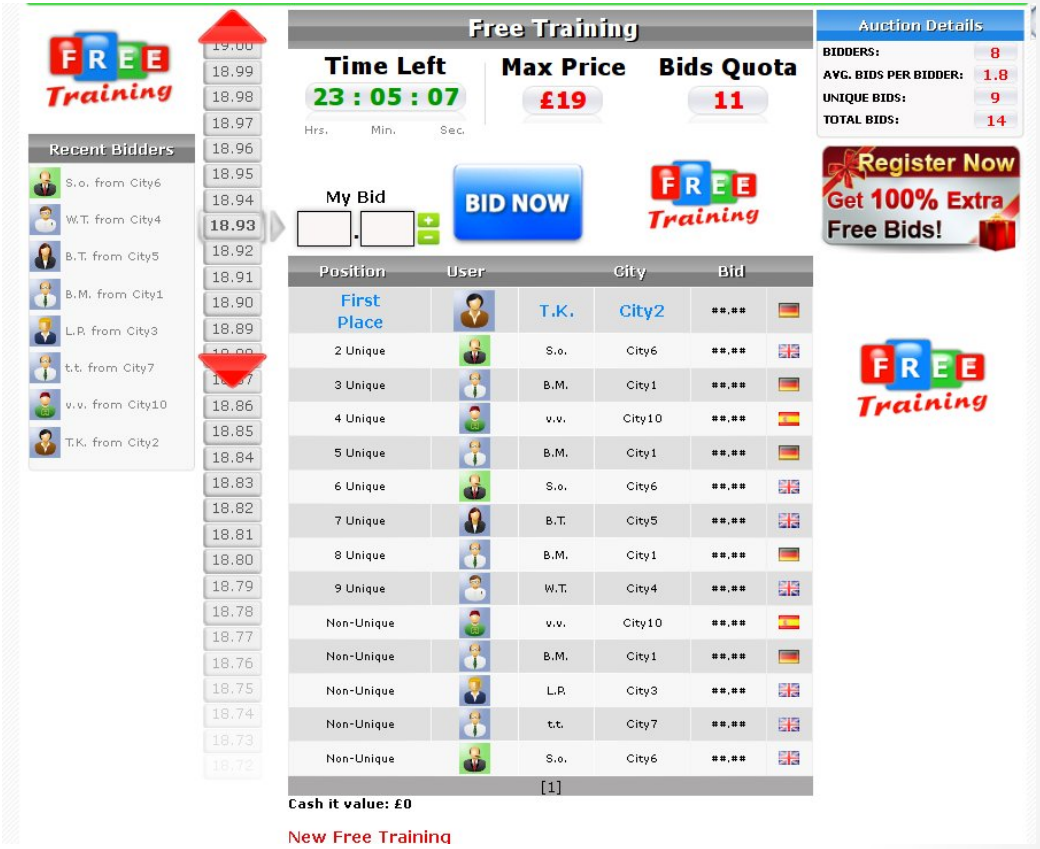
Unique Bid Auctions

- Each bidder can make as many bids as he wants
- Each bid costs a fix amount
- Bids are expressed in cents granularity
- Bids remain private
- The winning bid is the highest bid made by a ***single***(unique) participant
- If some bid is bid more than once, then all of its instances are disqualified and the next highest unique bid is the winning candidate
- The winner pays the winning bid and the fix amount for each bid he made
- The losers also pay for their bids and suffer negative gain

Unique-Bid Auctions

- Auction signals
  - Private:
    - Notifying the bidder after each bid whether his bid is unique together with the position
    - If not unique, the bidder is notified of the unique bid position closest to his disqualified one
  - Public:
    - Sorted positional tables of the current qualified bids (**Q**) and disqualified bids (**DQ**) without the actual values.
- Profitability (auctioneer)
- Legality
  - Randomness/Chance vs. Strategy/Skill
  - No external randomizing device



Related Work

- Equilibrium analysis (single-bid case)
  - No symmetric pure-strategy equilibria in HUBA
  - In any asymmetric pure-strategy equilibria:
    - A single bidder choosing the **maximum bid**
    - The **remaining bidders stay out**
  - Nash(1950): There is a symmetric equilibrium for every finite game.

  → Symmetric mixed-strategies equilibria exists
    - Involves a randomization over a consecutive set of bids, containing the highest possible one

Data Extraction

- Current available data for research
  - Only the final snapshot of qualified bids (**Q**) and disqualified bids (**DQ**) after the last transaction are published
- Dynamic temporal data
  - Individual level bids and timings information can offer many insights into bidding behavior
  - Allows for building a tractable models
- Back-propagation algorithm
  - Sample the partial information of Q, DQ rapidly and saving their instances during the entire auction
  - Starting from the fully exposed information of the last transaction going back through the saved instances, recover the bids of Q and DQ at each transaction
  - Utilize Levenshtein(Edit)-Distances for the propagation

Q

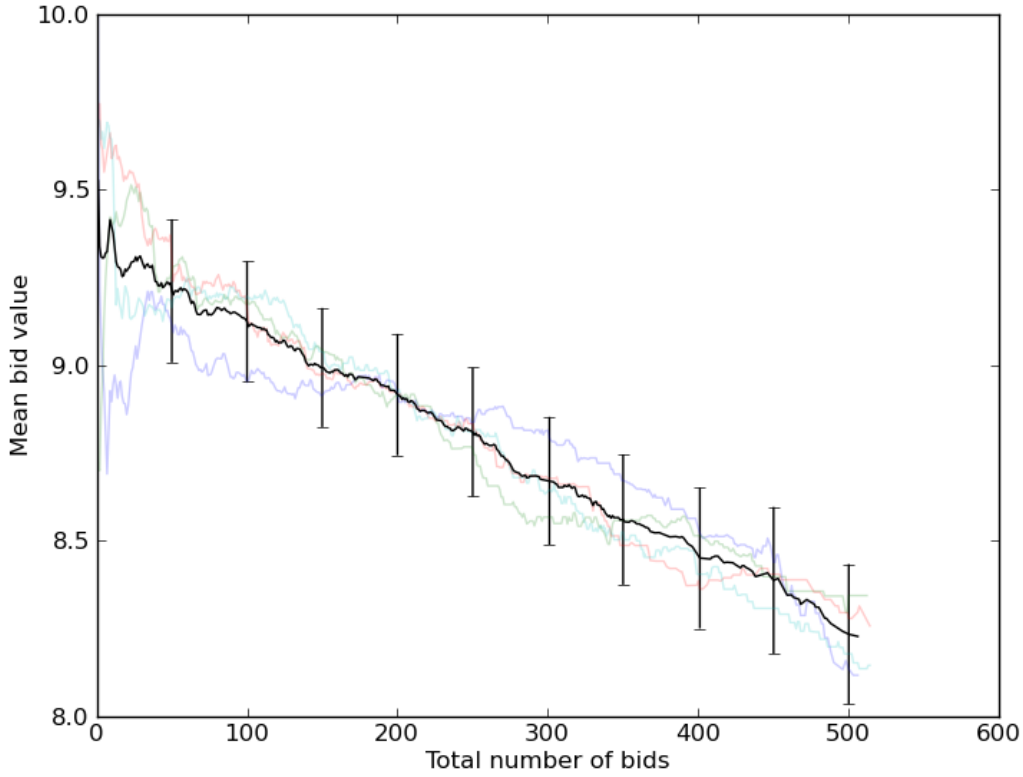
1-Unique	v.v.	City10	18.96
2-Unique	v.v.	City10	18.95
3-Unique	t.t.	City7	18.91
4-Unique	B.T.	City5	18.88
5-Unique	B.M.	City1	18.82
6-Unique	B.T.	City5	18.76
7-Unique	T.K.	City2	18.73
8-Unique	v.v.	City8	18.68
9-Unique	S.o.	City6	18.67
10-Unique	T.K.	City2	18.65
11-Unique	T.K.	City2	18.63
12-Unique	T.K.	City2	18.61
13-Unique	B.T.	City5	18.58
14-Unique	t.t.	City7	18.54

DQ

Non-Unique	W.T.	City4	19
Non-Unique	S.o.	City6	19
Non-Unique	W.T.	City4	18.99
Non-Unique	v.v.	City10	18.99
Non-Unique	B.T.	City5	18.98
Non-Unique	v.v.	City8	18.98
Non-Unique	B.M.	City1	18.98
Non-Unique	v.v.	City10	18.98
Non-Unique	T.K.	City2	18.97
Non-Unique	t.t.	City7	18.97
Non-Unique	v.v.	City10	18.97
Non-Unique	v.v.	City8	18.97
Non-Unique	B.M.	City1	18.97
Non-Unique	L.P.	City3	18.94
Non-Unique	t.t.	City7	18.94
Non-Unique	L.P.	City3	18.93
Non-Unique	W.T.	City4	18.93
Non-Unique	T.K.	City2	18.93
Non-Unique	L.P.	City3	18.92
Non-Unique	v.v.	City8	18.92
Non-Unique	M.G.	Colmenarj	18.92
Non-Unique	W.T.	City4	18.92
Non-Unique	W.T.	City4	18.9
Non-Unique	B.M.	City1	18.9
Non-Unique	T.K.	City2	18.9

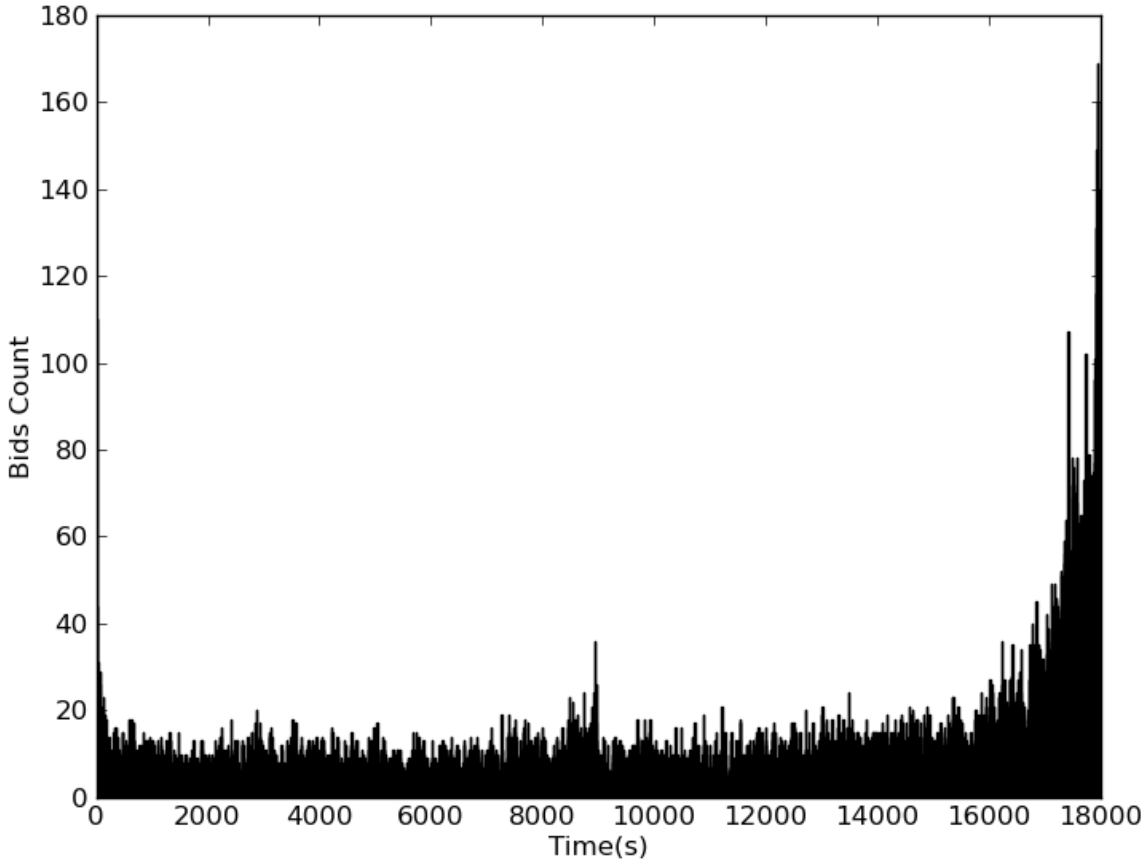
Macro Behavior

- Average bid price drops linearly with number of bids



Macro Behavior

- Last minute bidding (“Sniping”)



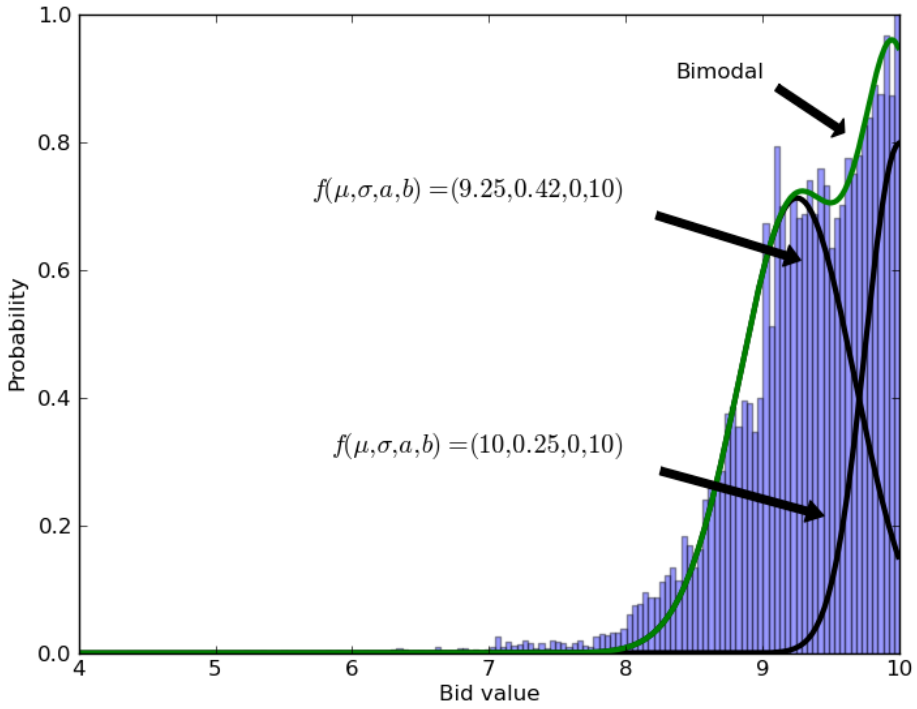
Individual Bidders Behaviors

- 7% of the bidders generated 43% of the bids (***heavy bidders***)
- 93% of the bidders place only 2 bids (***2-offers bidders***)
  - The auctions we sampled provided each bidder with 2 free bids

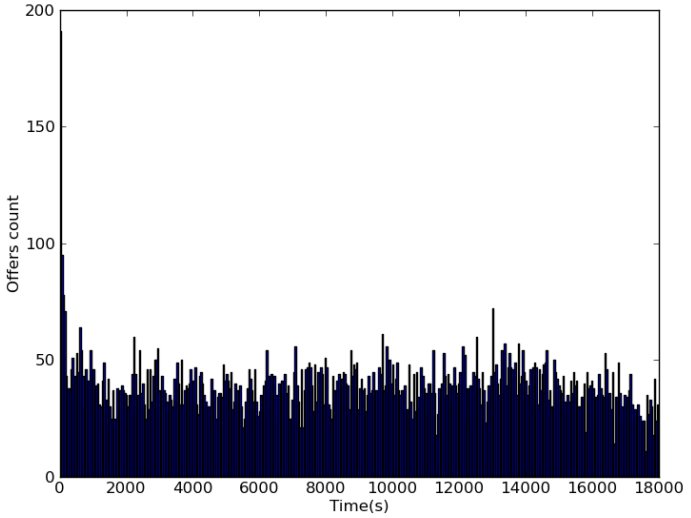
	2-offers	Heavy
Bids count	57%	43%
Bidders count	93%	7%
Auctions won	16%	84%

2-offers bidders

- Empirical distribution of bids made by 2-offers bidders superimposed with a bimodal truncated normal curve

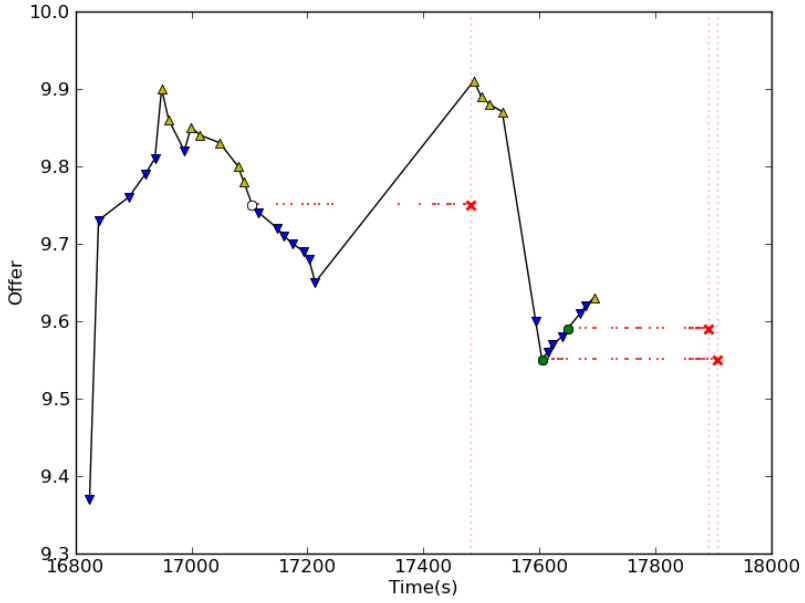


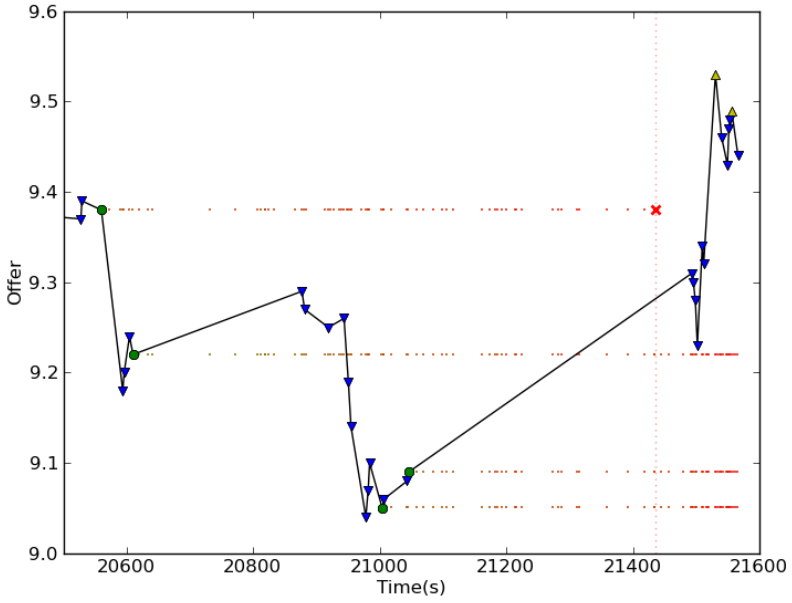
- Number of bids placed by 2-offers population over time



Heavy Bidders

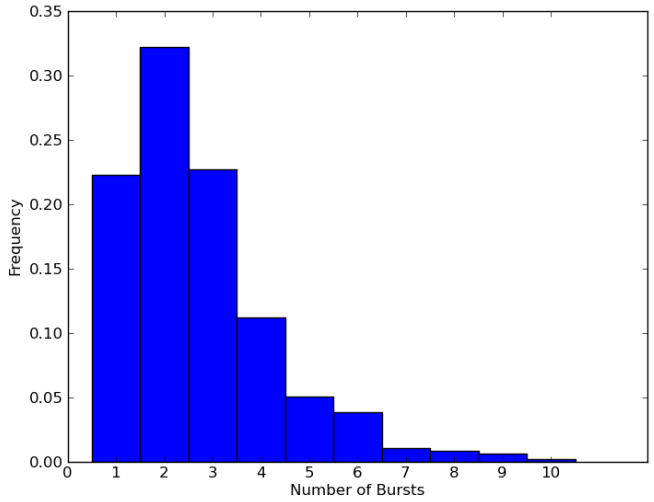
- Extracted behaviors graphs
  - Down-point triangles are bids lower than the leading bid.
  - Up-pointing triangles are disqualified bid above the leading bid.
  - Filled circles are qualified bids. Empty circles are qualified leading bids.
  - X marks indicate disqualifications





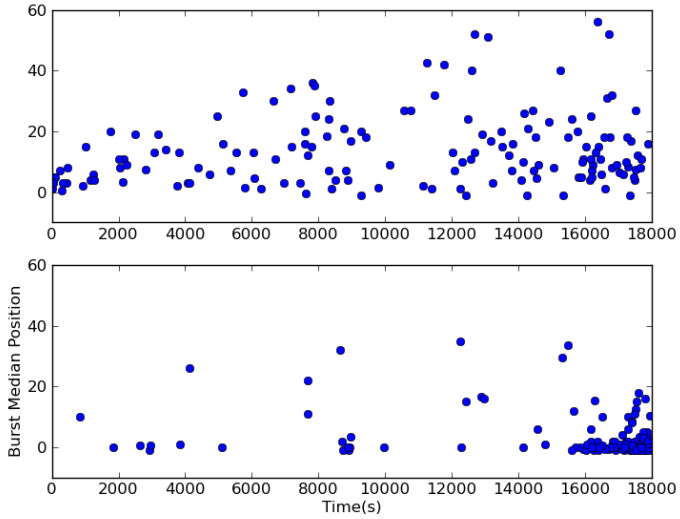
Bid Burstiness

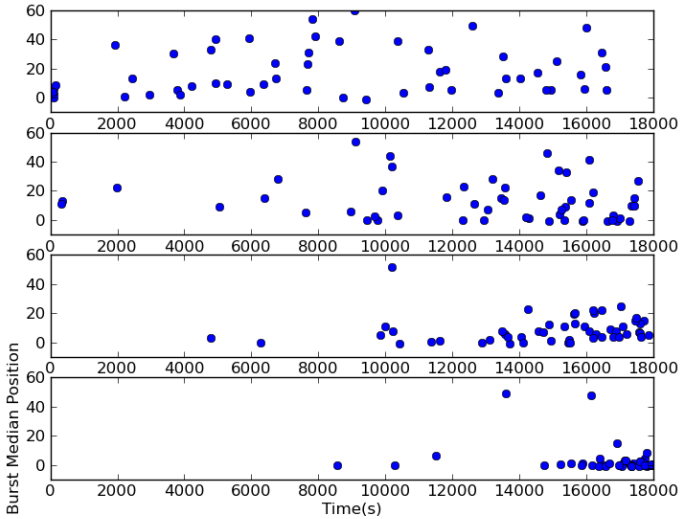
- Bid burst – A series of bids made in rapid succession
- Heavy bidders bid in bursts
- The number of bursts varies:



Bid Burstiness

- We observed that bursts aim towards a target position
- Median positions in 2-bursts bidders and 4-bursts bidders:



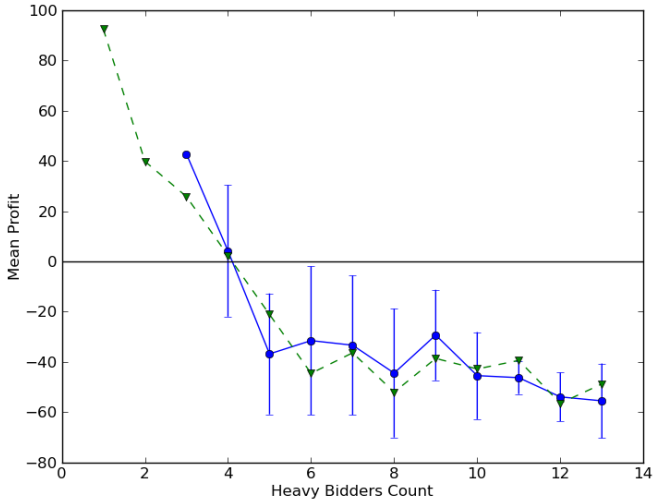


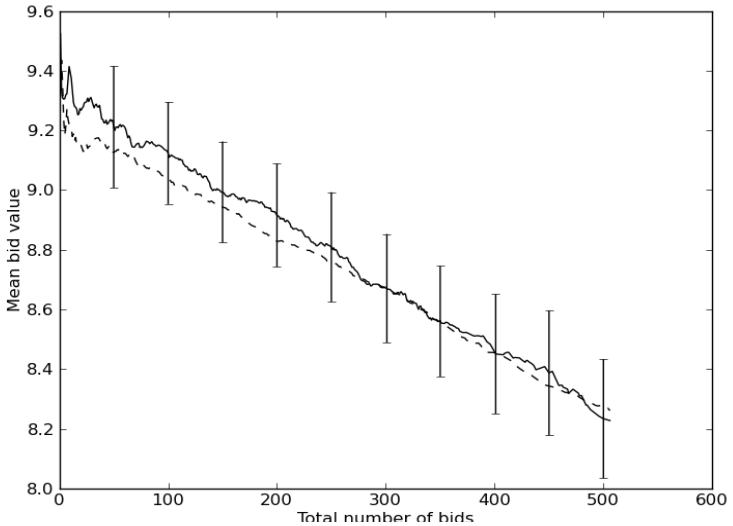
Simulation

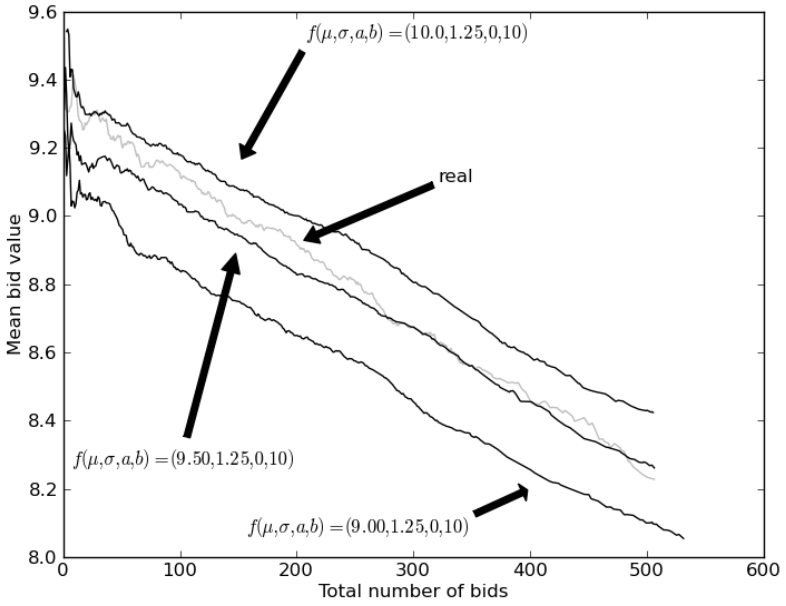
- The simulation model was constructed based on observation we made from 90 real auctions
- We included the 2-offers bidders and heavy bidders population (2-bursts and 4-bursts)
- Simulation parameters were calibrated with the sampled auctions, e.g.:
  - Auction duration: 18000 sec
  - Numbers of bidders: $\mu = 132.41$ $\sigma = 29.216$
  - Max bid price: 10.00
  - Cost per bid: 6
  - Free bids: 2
  - Bidders ratio: $\mu = 13.5$ $\sigma = 5.8$

Model Validation

- Replicative validity







Automated Strategies

- "Catch all non disqualified bids":
  - Track Q and DQ through all auction transactions to obtain a complete view of the **ordering** of all the bids, without the actual values
  - Introduce actual bids by bidding at intervals
  - Find gaps of non-disqualified bids at DQ by counting the disqualified groups in the interval
  - Gaps are either qualified bids or unique unbid values
  - Using binary searches, bid until hitting the gap
  - Repeat until having as many leading qualified bids as wanted

Catch all non-disqualified bids

ID	bid
5	
8	
2	

ID	bid
3	
4	
8	
1	
4	

ID	bid
8	
2	

ID	bid
3	
4	
8	
1	
4	
5	
2	

ID	bid
8	
2	

ID	bid
3	
4	
8	
7	
1	
4	
5	
2	

Catch all non-disqualified bids

ID	bid
8	
2	

ID	bid
3	
4	
8	
7	
1	
4	
5	
2	

ID	bid
8	
2	

ID	bid
3	
4	
8	
7	
10	**10.0**
1	
4	
5	
2	

ID	bid
8	
2	

ID	bid
3	
4	
8	
7	
10	**10.0**
1	
4	
5	
2	
10	**9.97**

Automated Strategies

- Bid Block:
  - Binary search for the leading position very close to the auction's end, and disqualify it
  - Make a series of decrementing bids until getting some qualified ones
- Real auction results showed that the average distance between the winning bid an the next unbid bid is

  $\mu = 29.76$ $\sigma = 27.4$

  allowing a positive gain

Simulation with Automated Strategies

- "Catch all non-disqualified bids"
  - 100% win rate
  - Mean expense – 170.45
  - Mean profit – 129.55
- "Bid Block"
  - 93% win rate
  - Mean expense – 163.51
  - Mean profit – 118.12
- (Cost per bid – 6 ; Prize value – 300)

Live Experiments

- Automating the strategies on actual site:
  - Reverse-engineering the site protocol
  - Automating the bidding process in a program
- Results
  - We played the simple Bid Block strategy
  - Won 13/14 bid-credits auctions (50₤ each)
    - Resembling the auctions of the simulation
  - 3/3 SanDisk Clip (32₤ each)
  - 4/5 Kindle devices (80₤ each)
  - (We did not claim the prizes)

Conclusion

- We extracted partial data from 90 real auctions, and using a back-propagation algorithm we successfully recovered the missing bid values
- With our detailed auctions dynamic temporal data we built a simulation model, and validated it
- We devised several automated strategies that performed well on our simulated environment
- Reversing and actual UK unique-bid auction site communication protocol allowed us to implement a program to deploy the automated strategies
- We let our program participate in several real auctions, to achieve 91% win rate and over 1000₤