

# An Auctioning Reputation System Based on Anomaly Detection

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# Online Auctioning

- Huge volume: eBay hosted 440,100,000 new listings in Q2 2005
- In this talk: trustworthiness of online auctioning
- Why do we buy in an online auction?
  - A. to find a rare/collectable item
  - B. to find a bargain; commodity at a “good” price
- eBay financial report (expected 2005):
  - Clothing & Accessories --- \$3.3 billion (2nd)
  - Consumer Electronics --- \$3.2 billion (3rd)
  - Computers --- \$2.9 billion (4th)

Data suggests that most people use eBay to find bargains

# Finding a Bargain is Tricky

- Inherently untrustworthy environment:
  - Pseudonymous sellers
  - Pseudonymous buyers
  - Delivery? Warranty? Quality?
- Reputation system: a tool to establish trust

# Finding a Bargain is Tricky

- ⊕ Great product as advertized Great E Bay'er !! A++++
- ⊕ Great seller, extra quick shipping thanks A++++
- ⊕ Fast service many thanks A+++++

- eBay's reputation system provides little help
  - Based on feedback: vulnerable to “poisoning” attack

# Finding a Bargain is Tricky

+ ANOTHER GREAT DEAL !! I WILL BE BACK !!

+ WORKS GREAT !! GREAT DEALER!! My GOD I Can't SPELL!!

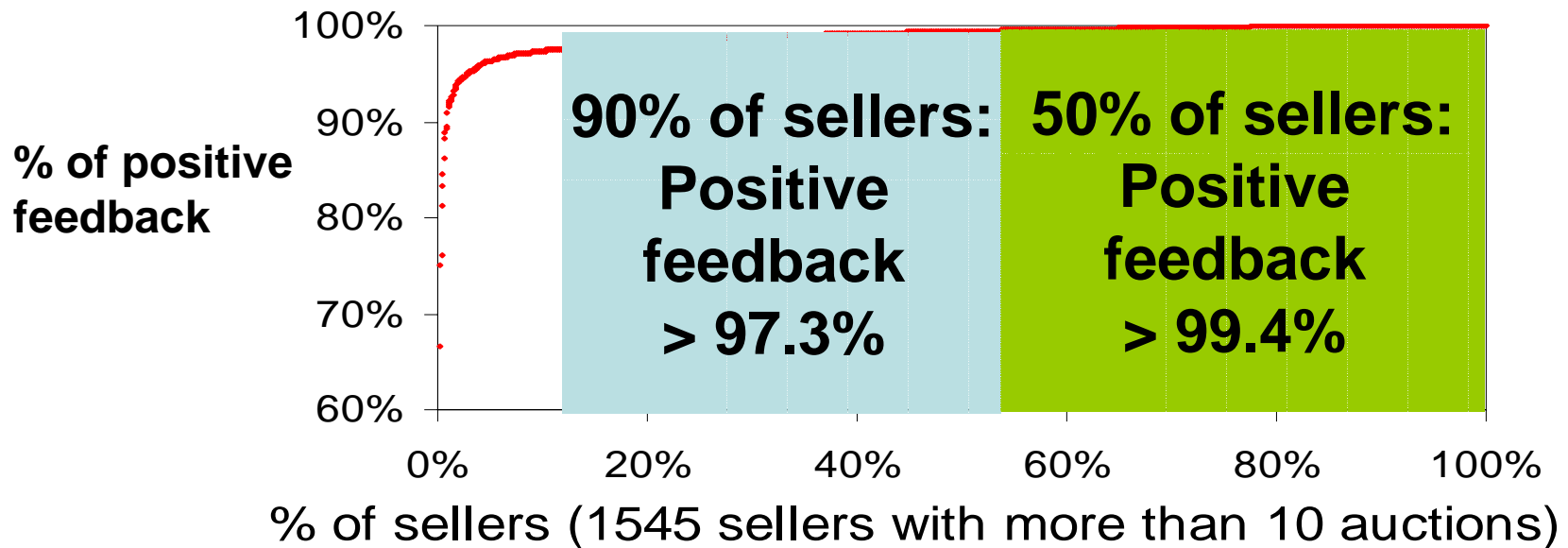
+ WORKS GREAT !! DREAT DEALLER!!

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- eBay's reputation system provides little help
  - Based on feedback: vulnerable to “poisoning” attack
  - Does not provide information on price

# Finding a Bargain is Tricky



- eBay's reputation system provides little help
  - Based on feedback: vulnerable to “poisoning” attack
  - Does not provide information on price
  - Does not differentiate among the majority of sellers

# Goals

- *Alice*—a buyer, *Bob*—a seller
- Develop a trustworthy mechanism that helps Alice:
  - Achieve her goal: what are the chances that Alice can find a bargain in Bob's auctions?
  - Warn her from fraudulent activities: are the prices in Bob's auctions artificially inflated?
  - Provide her assurance against poisoning attack: why should Alice trust the mechanism?

# Contributions

- A reputation system that helps buyers avoid sellers who seem to be inflating prices
  - Formulated the “seem to be inflating prices” as an anomaly detection problem
  - Business level anomaly detection: the basic events are auctions, bidding.
  - Behavioral system: based on how human behave/act rather than on people feedback.
- Only a first step, some goals still ahead



# Outline

- Motivation: find a bargain and avoid fraud
- Contributions: anomaly detection system to identify price inflating sellers:
  - The N model
  - The M model
  - The P model
- Case studies

# Auctioning 101

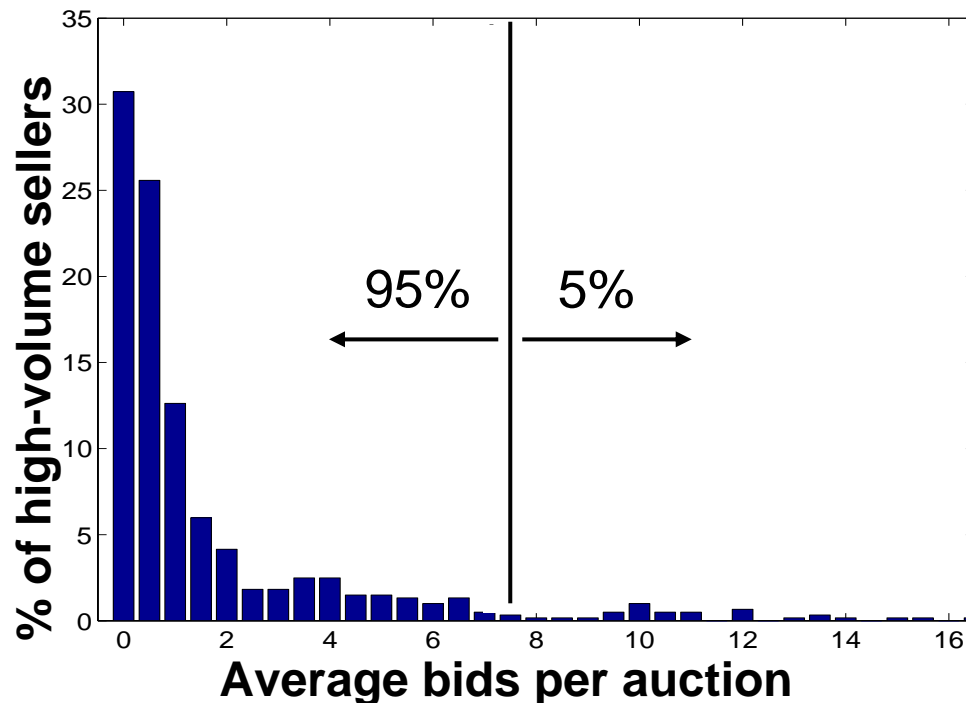
- Pseudonymous sellers and bidders
- Auctions end after a predefined time (e.g., 7 days)
- Highest bid wins
- Seller sets minimum starting bid
- Shilling: a group of bidders that place fake bids to inflate the final price

# Methodology

- Collect data from eBay
  - three weeks of data in the category: *Laptop Parts & Accessories*
  - 127,815 auctions, 12,331 sellers,
  - 604 high-volume sellers: posted more than 14 auctions controls 60% of the market
- Use statistical model to predict seller behavior
  - 95% of the sellers are “normal”
  - 5% are abnormal, or suspicious

# Step 1: Average Number of Bids

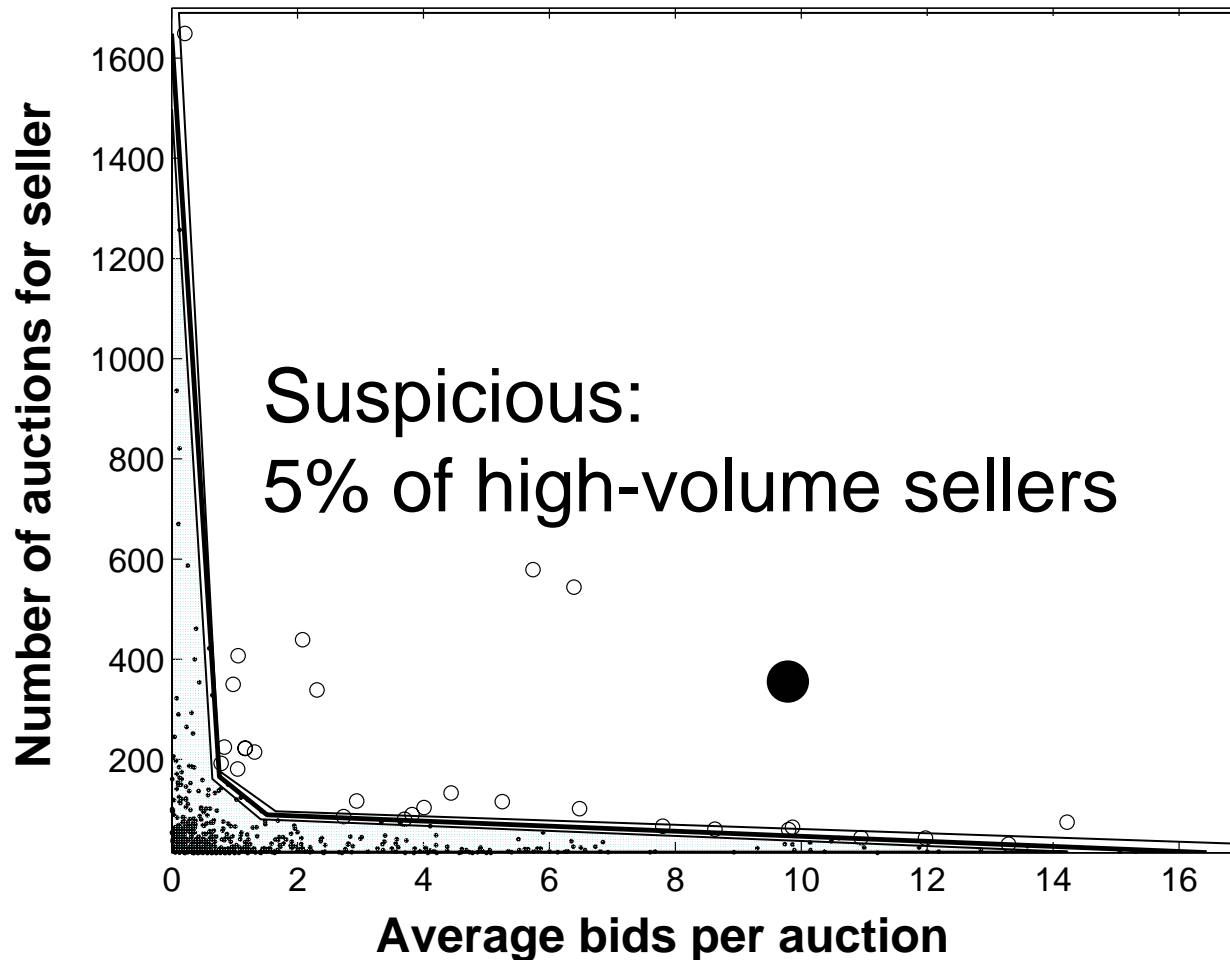
- What is an indication that prices are high?
  - high number of bids
- Goal: identify sellers with abnormally high number of bids



- 95% of high-volume sellers have less than 7 bids per auction

- Model is insensitive to supply: number of auctions posted by a seller

# Step 1: The N Model



# Outline

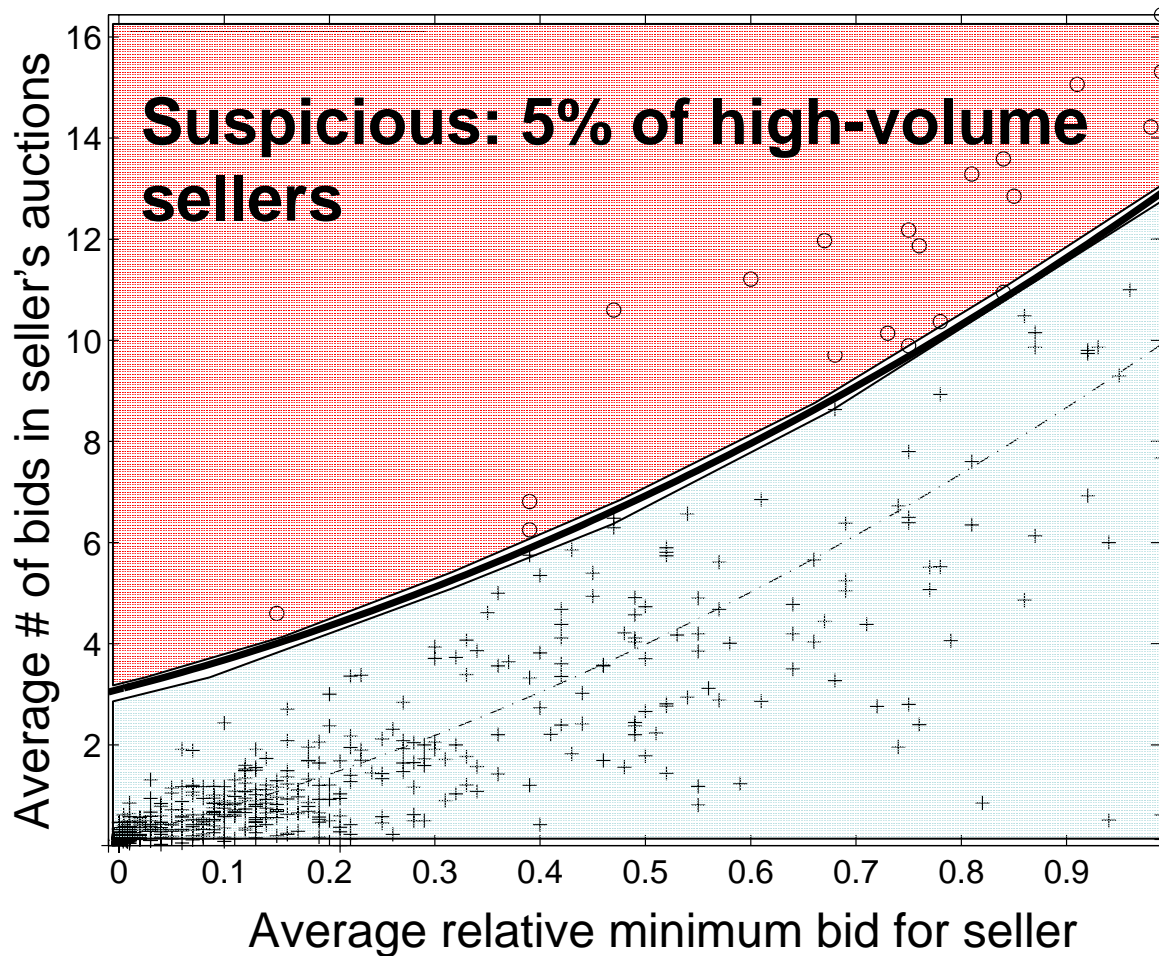
- Motivation: find a bargain and avoid fraud
- Contributions: anomaly detection system to identify price inflating sellers:
  - The N model: *a seller is suspicious if they post many auctions that attract many bids*
  - The M model
  - The P model
- Reputation example

## Step 2: Average Minimum Starting Bid

- Legitimate explanation for high number of bids: low minimum starting bid
- Goal: identify sellers with abnormally high number of bids **and** high minimum bid
- Problem: how do you know that the minimum bid is high?

$$\text{Relative minimum bid (RMB)} = \frac{\text{winning\_bid} - \text{minimum\_bid}}{\text{winning\_bid}}$$

## Step 2: The M Model



Correlation: low minimum starting bid implies many bids

M suspicious seller: starts with high minimum bid and attracts many bids

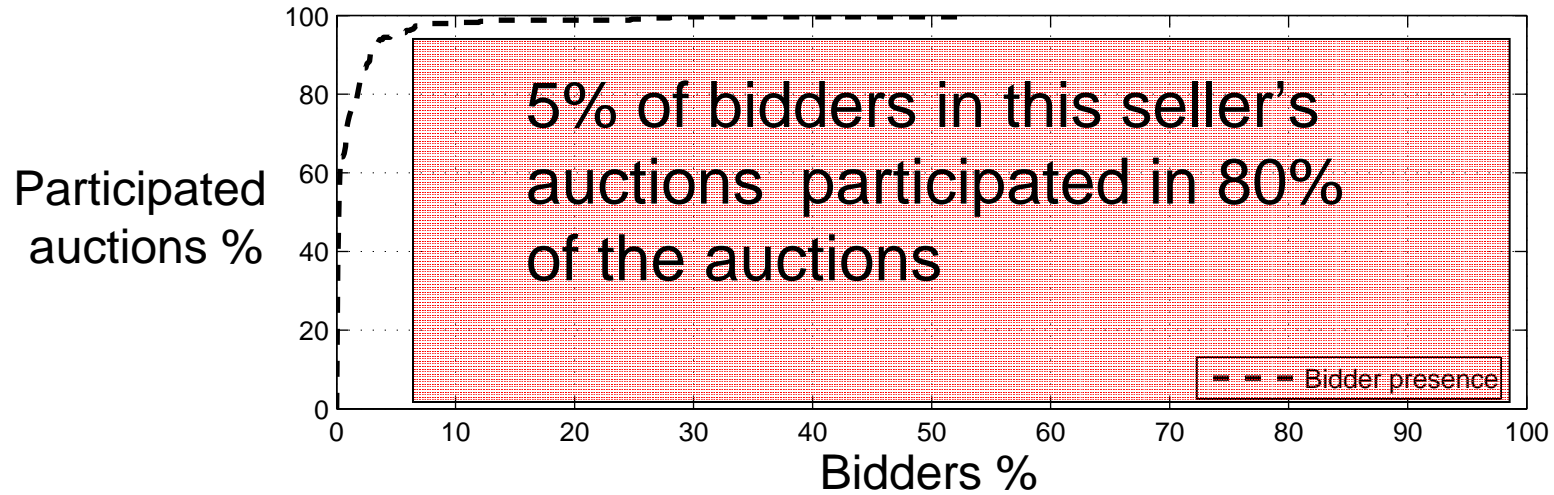
M+N suspicious seller: posts many auctions, attracts many bids, starts with high minimum bid



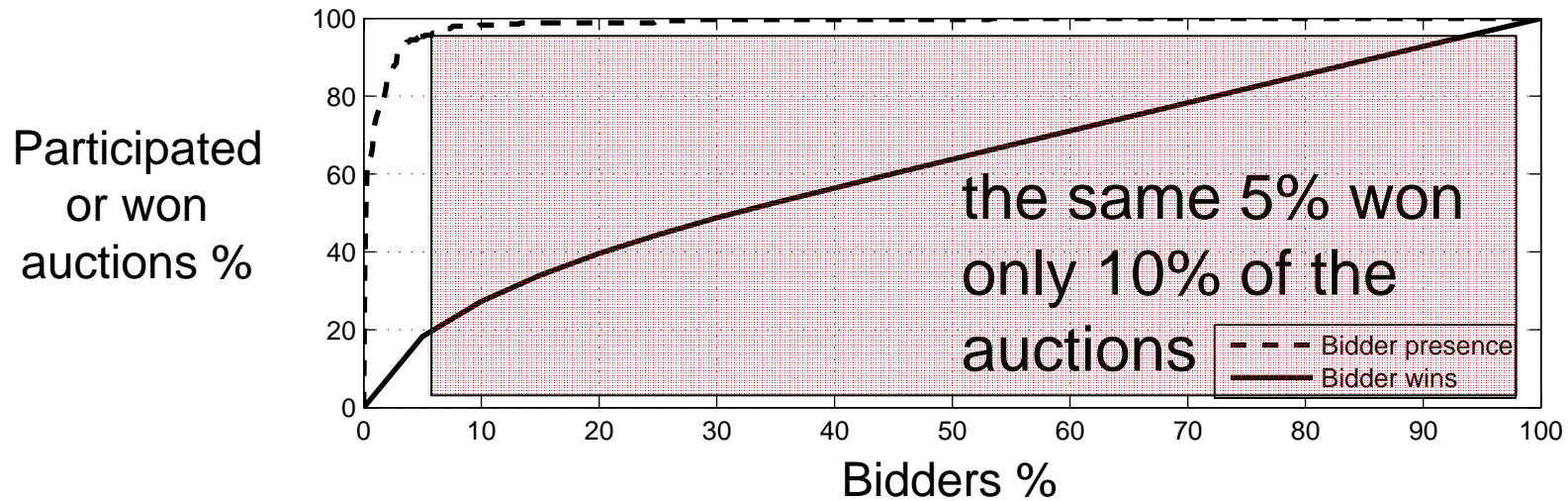
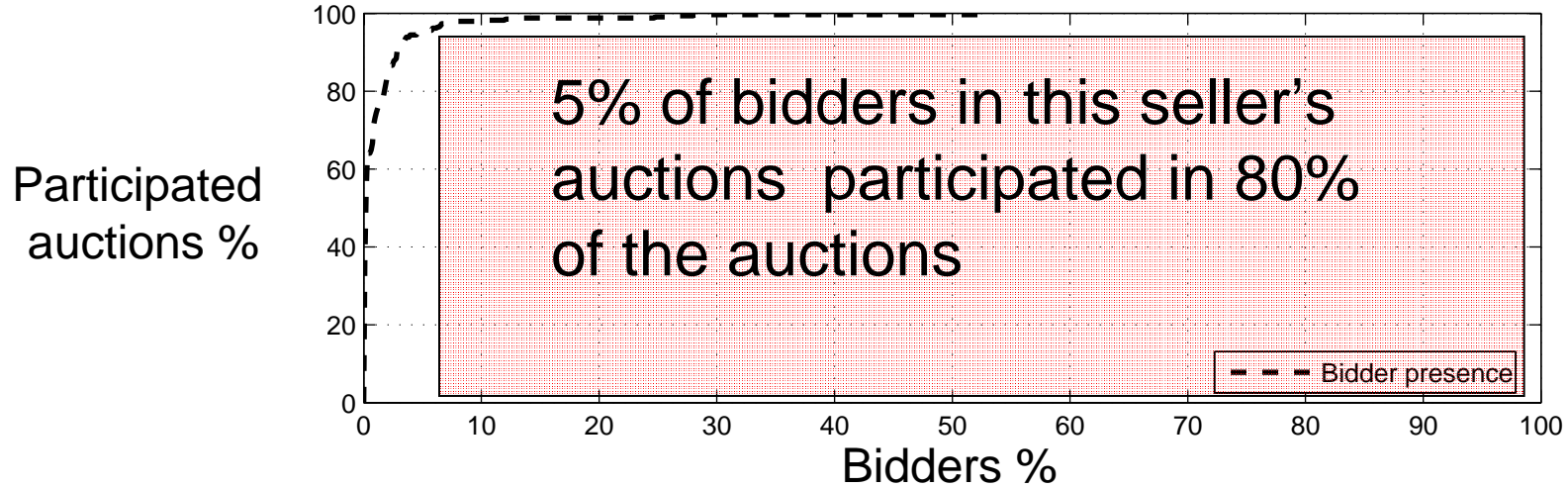
## Step 3: Bidders' Profile of a Seller

- Fraudulent explanation for high number of bids: shilling
- Goal: identify group of bidders that repeatedly bid and lose in a seller's auctions
- Suspicious seller:
  - N: sellers with abnormally high number of bids **and**
  - M: high starting bid **and**
  - P: has a group of bidders that repeatedly bid and lose

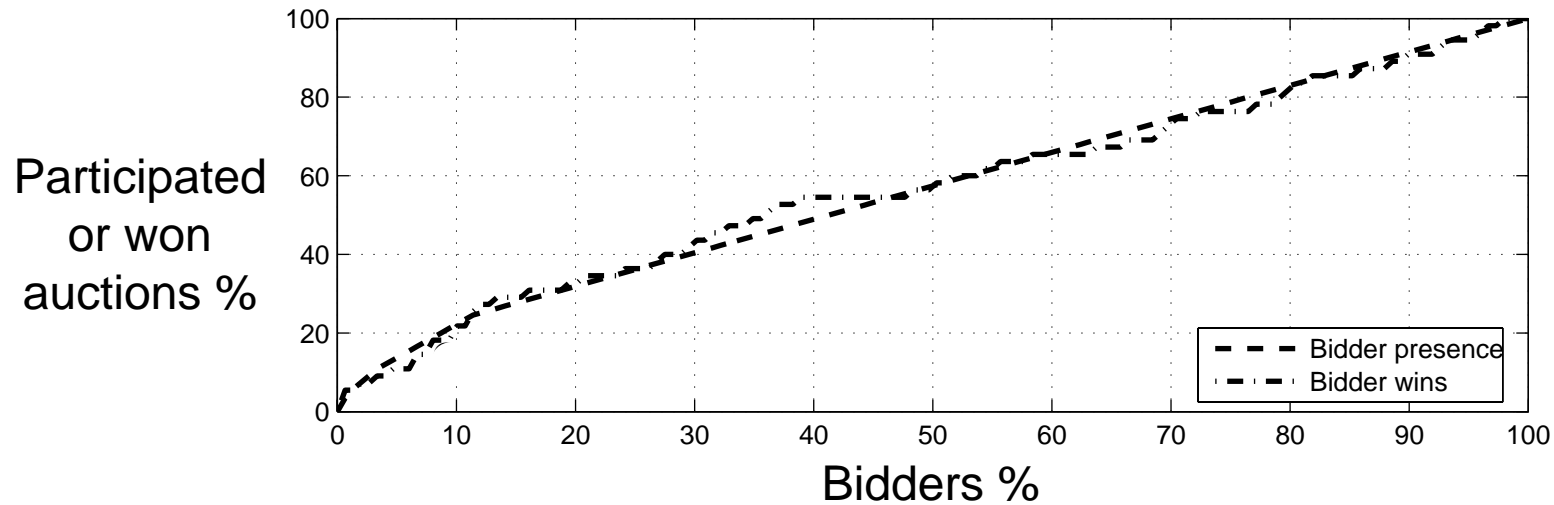
# Bidder Presence Curve



# Bidder Presence/Win Curves



# Bidder Presence/Win Curves (Normal case)

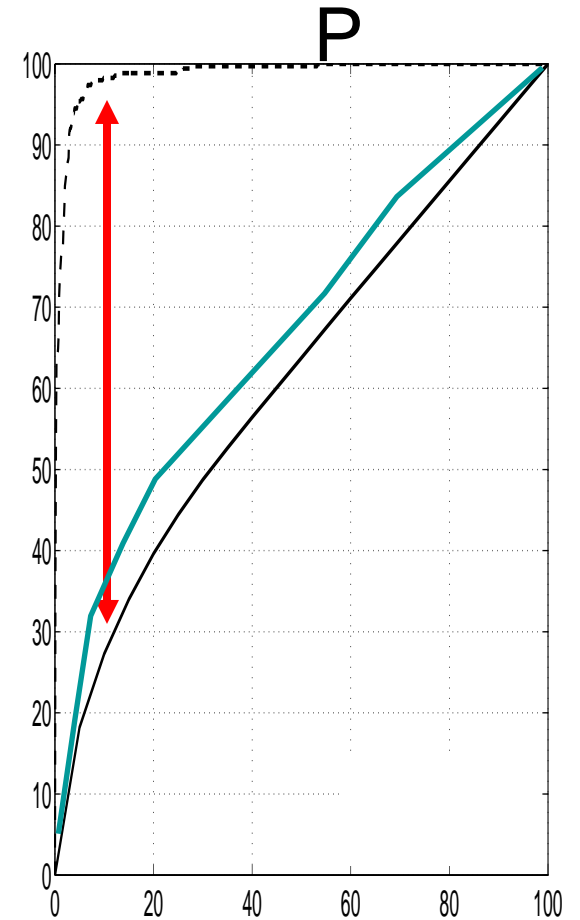
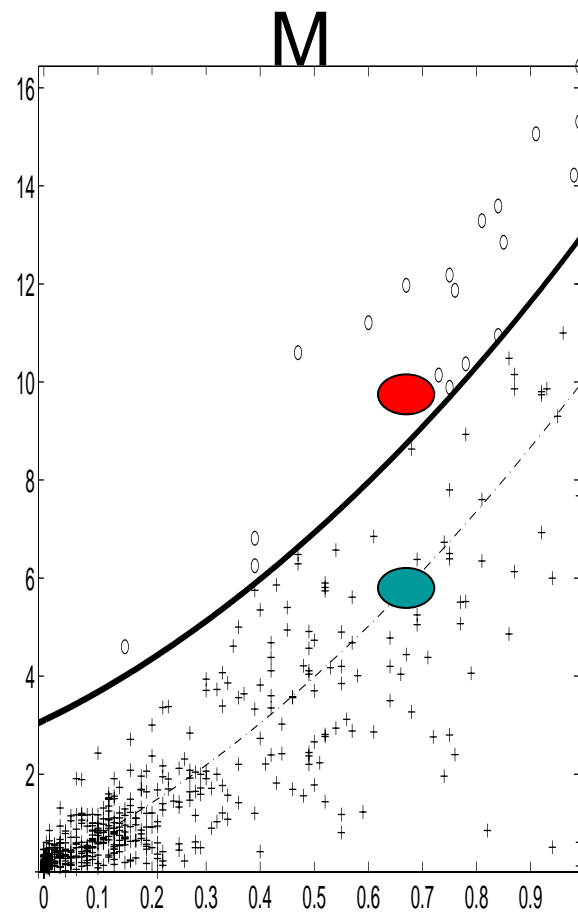
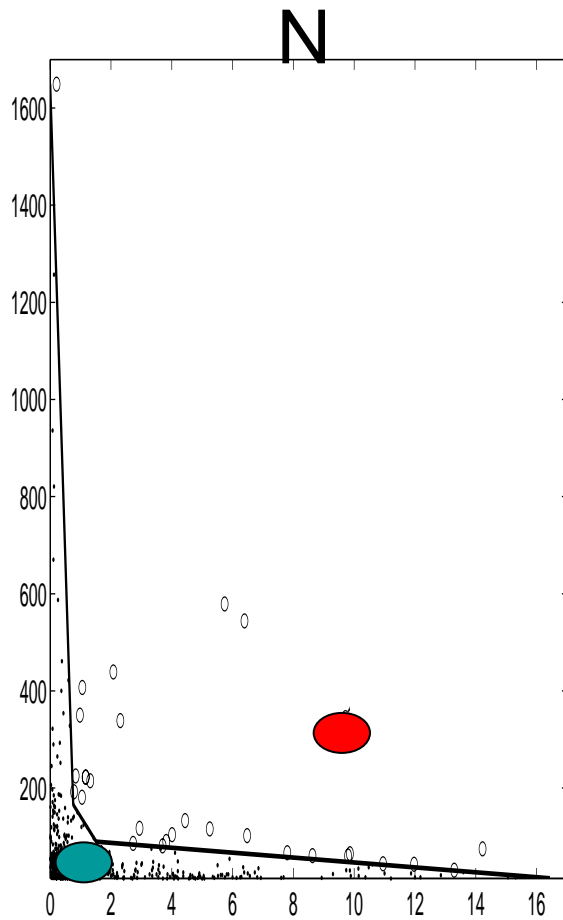


10% of the bidders participated in 20% of the auctions and won 20% of the times

# Outline

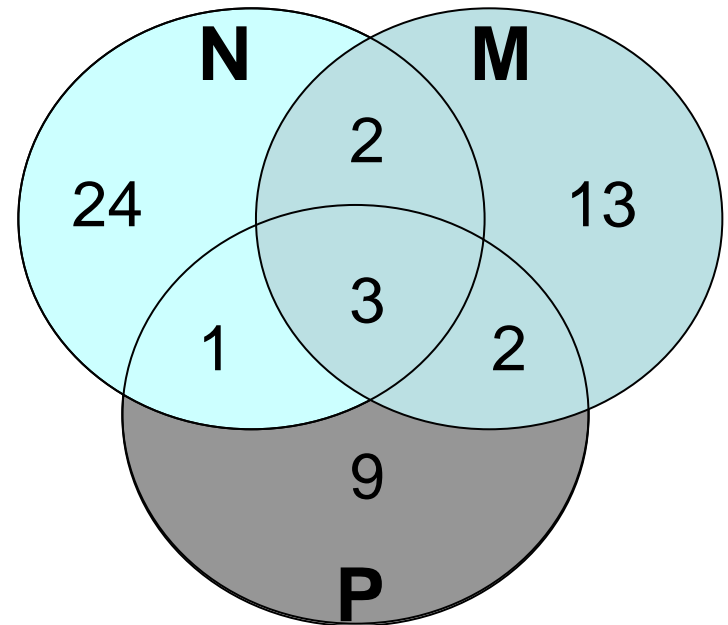
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- Contributions: anomaly detection system to identify price inflating sellers:
  - The N model: a seller is suspicious if they post many auctions that attract many bids
  - The M model: a seller is suspicious if they attract many bids and start with high minimum bid
  - The P model: a seller is suspicious if they have a group of bidders that repeatedly participate and lose
- Reputation example

# Reputation Example: Seller 10260



# Results Summary

- 54 sellers classified as abnormal with respect to at least one model
- 3 sellers classified as abnormal with respect to all three models
- No confirmed fraud



# Summary

- Trust: do we get what we expected?
- Reputation system as anomaly detection
  - Attempt to identify price inflation
  - Work at the business level
  - Consider poisoning attack (see paper)

Thank you.  
Questions?