CS344M
Autonomous Multiagent Systems

Patrick MacAlpine

Department of Computer Science
The University of Texas at Austin
Good Afternoon, Colleagues

Are there any questions?
Logistics

- Next week’s readings in flux
Logistics

- Next week’s readings in flux

- Final projects due in 2 weeks!
Bidding for Multiple Items

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- What’s the value of the flash?
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- What’s the value of the flash?
  - Auctions are simultaneous
  - Auctions are independent (no combinatorial bids)
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• What’s the value of the flash?
  – Auctions are simultaneous
  – Auctions are independent (no combinatorial bids)

• $ \in [10, 50]$ — **Depends on the price of the camera**
# Bidding for Multiple Items

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- Let current camera price = $80
## Bidding for Multiple Items

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  \[ \text{score}(G_f^*) = \]
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- Let current camera price = $80
  - $score(G_f^*) = \max\{100 - 80, 10 - 0\} = 20$
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Let current camera price = $80

- $score(G_f^*) = \max\{100 - 80, 10 - 0\} = 20$
- $score(G_{no-f}^*) = \max\{50 - 80, 0 - 0\} = 0$
- So value(flash) = 20 - 0 = $20$
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  - So $value(flash) = 20 - 0 = $20$

- Already bought camera ⇒ price = $0
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- Let current camera price = $80
  - $\text{score}(G_f^*) = \max\{100 - 80, 10 - 0\} = 20$
  - $\text{score}(G_{no-f}^*) = \max\{50 - 80, 0 - 0\} = 0$
  - So $\text{value}(\text{flash}) = 20 - 0 = $20$

- Already bought camera $\Rightarrow$ price = $0$$\Rightarrow$
  $\text{value}(\text{flash}) = 100 - 50 = $50$
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- Let current camera price = $20, flash = $10
  - $\text{value}(\text{flash})$ would be
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- Let current camera price = $20, flash = $10
  - value(flash) would be $80 - $30 = $50
  - value(camera) would be
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- Let current camera price = $20, flash = $10
  - value(flash) would be $80 - $30 = $50
  - value(camera) would be $90 - $0 = $90

- But what if prices jump at the end?
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- Let current camera price = $20, flash = $10
  - value(flash) would be $80 - $30 = $50
  - value(camera) would be $90 - $0 = $90
- But what if prices jump at the end?
  - Let average past camera price = $80, flash = $30
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• Let current camera price = $20, flash = $10
  – value(flash) would be $80 − $30 = $50
  – value(camera) would be $90 − $0 = $90

• But what if prices jump at the end?
  – Let average past camera price = $80, flash = $30
  – value(flash) = $20
  – value(camera) = $70
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- What’s the value of the flash?
  - Camera price = $70 $\Rightarrow$ value(flash) = $30
  - Camera price = $20 $\Rightarrow$ value(flash) = $50
  - Camera price = $40 $\Rightarrow$ value(flash) = $50
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- What’s the value of the flash?
  - Camera price = $70 \Rightarrow \text{value(flash)} = $30
  - Camera price = $20 \Rightarrow \text{value(flash)} = $50
  - Camera price = $40 \Rightarrow \text{value(flash)} = $50

- Expected value: resample camera price, take avg.

Patrick MacAlpine
Spectrum licenses

- Worth a lot
- But how much to whom?
Spectrum licenses

- Worth a lot
- But how much to whom?
- Used to be assigned
Spectrum licenses

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Spectrum licenses

- Worth a lot
- But how much to whom?
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- Switched to lotteries
  - too random
  - clear that lots of value given away
Spectrum licenses

- Worth a lot

- But how much to whom?

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  - took too long

- Switched to lotteries
  - too random
  - clear that lots of value given away

So decided to auction
Goals of mechanism

- Efficient allocation (assign to whom it’s worth the most)
- Promote deployment of new technologies
- Prevent monopoly (or close)
- Get some licenses to designated companies
- No political embarrassments
Goals of mechanism

• Efficient allocation (assign to whom it’s worth the most)
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Relevance an afterthought (but important in end)
Choices

- Which basic auction format?
Choices

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- Sequential or simultaneous auctions?
Choices

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- Combinatorial bids allowed?
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- How to encourage designated companies?
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- How to encourage designated companies?
- Up front payments or royalties?
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Choices

- Which basic auction format?
- Sequential or simultaneous auctions?
- Combinatorial bids allowed?
- How to encourage designated companies?
- Up front payments or royalties?
- Reserve prices?
- How much information public?
Problems from New Zealand and Australia

Second price, sealed bid
Problems from New Zealand and Australia

Second price, sealed bid

- High bidder’s willingness to pay is public
- No reserve prices
- No penalties for default, so many meaningless high bids
Problems from New Zealand and Australia

- Second price, sealed bid
  - High bidder’s willingness to pay is public
  - No reserve prices
  - No penalties for default, so many meaningless high bids

Any oversight in auction design can have harmful repercussions, as bidders can be counted on to seek ways to outfox the mechanism.
License interactions

- Complementarities: good to be able to offer roaming capabilities
License interactions

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- Substitutability: several licenses in the same region
License interactions

• Complementarities: good to be able to offer roaming capabilities

• Substitutability: several licenses in the same region

• Need to be flexible to allow bidders to create aggregations
License interactions

- Complementarities: good to be able to offer roaming capabilities
- Substitutability: several licenses in the same region
- Need to be flexible to allow bidders to create aggregations
- Secondary market might allow for some corrections
  - Likely to be thin
  - High transaction costs
Limits of Theory
Limits of Theory

- Identify variables, but not relative magnitudes
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  - When there are conflicting effects, can’t tell which will dominate
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- Ignores transaction costs of implementing policies
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- May depend on unknown information
  - e.g. bidder valuations
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- Doesn’t scale to complexity of spectrum auctions
Limits of Theory

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- Doesn’t scale to complexity of spectrum auctions

Used laboratory experiments too
Open vs. Sealed Bid

- Open increases information, reducing winner’s curse
Open vs. Sealed Bid

• Open increases information, reducing winner’s curse
  – Leads to higher bids
Open vs. Sealed Bid

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• But...  
  – Risk aversion leads to higher bids in sealed bid auctions
  – Sealed bid auctions deter colusion
Open vs. Sealed Bid

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- Decided former outweighed latter

- Went with announcing bids, but not the bidders
Open vs. Sealed Bid

• Open increases information, reducing winner’s curse
  – Leads to higher bids

• But . . .
  – Risk aversion leads to higher bids in sealed bid auctions
  – Sealed bid auctions deter collusion

• Decided former outweighed latter

• Went with announcing bids, but not the bidders
  – Circumvented!
Simultaneous vs. Sequential

- Sequential prevents backup strategies for aggregation
- Sequential also allows for budget stretching
Simultaneous vs. Sequential

- Sequential prevents backup strategies for aggregation
- Sequential also allows for budget stretching
- Simultaneous needs a stopping rule
  - Closing one by one is effectively sequential
  - Keeping all open until all close encourages sniping
Simultaneous vs. Sequential

- Sequential prevents backup strategies for aggregation
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- Simultaneous needs a stopping rule
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- Stopping rule should:
  - End auction quickly
  - Close licenses almost simultaneously
  - be simple and understandable
Simultaneous vs. Sequential

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Went with activity rules

Patrick MacAlpine
Combinatorial Bids

- Nationwide bidding could decrease efficiency and revenue
Combinatorial Bids

- Nationwide bidding could decrease efficiency and revenue

- Full combinatorial bidding too complex
  - Winner determination problem
  - Active research area
Aiding Designated Bidders

- Give them a discount
Aiding Designated Bidders

- Give them a discount
- Circumvented!
Royalties vs. Up-front Payments

- Royalties decrease risk, increase bids
Royalties vs. Up-front Payments

- Royalties decrease risk, increase bids
- But royalties discourage post-auction innovation
Royalties vs. Up-front Payments

- Royalties decrease risk, increase bids
- But royalties discourage post-auction innovation
- Decided against
Reserve Prices

- Not necessary in such a competitive market
- Did include withdrawal penalties
Results

• Big successes
  – Lots of bidders
  – Lots of revenue
Results

• Big successes
  – Lots of bidders
  – Lots of revenue

• Also some problems
  – Strategic Demand Reduction
Results

• Big successes
  - Lots of bidders
  - Lots of revenue

• Also some problems
  - Strategic Demand Reduction

• Incremental design changes
  - New problems always arise
  - Bidders indeed find ways to circumvent mechanisms
Results

- Big successes
  - Lots of bidders
  - Lots of revenue

- Also some problems
  - Strategic Demand Reduction

- Incremental design changes
  - New problems always arise
  - Bidders indeed find ways to circumvent mechanisms

- Lessons to be learned via agent-based experiments
Discussion

- How could you fix the aspects that were circumvented?
Discussion

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• Could you design a better auction mechanism?
Discussion

- How could you fix the aspects that were circumvented?
- Could you design a better auction mechanism?
- Best bidding strategies?
Discussion

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- Use of agents in FCC spectrum auction?
Discussion

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• Need to know entire agent preference...
Discussion

• How could you fix the aspects that were circumvented?
• Could you design a better auction mechanism?
• Best bidding strategies?
• Use of agents in FCC spectrum auction?
• Need to know entire agent preference...
• Multiple item bidding in RoboCup?
FCC Spectrum Auction #35

- 422 licences in 195 markets (cities)
  - 80 bidders spent $8 billion
  - ran Dec 12 - Jan 26 2001
  - licence is a 10 or 15 mhz spectrum chunk

- Run in rounds
  - bid on each licence you want each round
  - simultaneous; break ties by arrival time
  - current winner and all bids are known

- Allowable bids: 1 to 9 bid increments
  - 1 bid incr is 10% – 20% of current price

- Other complex rules