Good Afternoon, Colleagues

Are there any questions?
Logistics

- Final tournament: Friday, May 13th, 2pm, ACES 2.402
Logistics

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- All readings up
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- All readings up
- Progress reports coming back
  - Hand them in with your final reports
Logistics

- Final tournament: Friday, May 13th, 2pm, ACES 2.402
- All readings up
- Progress reports coming back
  - Hand them in with your final reports
- Final projects due in 2 weeks!
Your Progress Reports

- Overall quite good! (writing and content)
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- Best ones motivate the problem before giving solutions
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- Say not only what’s done, but what’s yet to do
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Your Progress Reports

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- Enough detail so that Mazda or I could reimplement
Style

- More about your approach, less about the process
Style

• More about your approach, less about the process
  – Not “What I did on summer vacation”
Style

• More about your approach, less about the process
  – Not “What I did on summer vacation”
  – Not just “we decided.”
  – How? Why? What alternatives?
Style

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  – How? Why? What alternatives?

• Slides on resources page
Class Discussion

Michael Chrien on Bidding Strategies
Michael Chrien on Bidding Strategies

Vickrey strategy clear?
## Bidding for Multiple Items

<table>
<thead>
<tr>
<th></th>
<th>Utility</th>
</tr>
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<tbody>
<tr>
<td>camera alone</td>
<td>$50</td>
</tr>
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<td>flash alone</td>
<td>10</td>
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  - Auctions are simultaneous
  - Auctions are independent (no combinatorial bids)
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  - Auctions are simultaneous
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- $\in [10, 50]$ — **Depends on the price of the camera**
Spectrum licenses

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

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Spectrum licenses

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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
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Revenue an afterthought (but important in end)
Choices

• Which basic auction format?
Choices

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- Sequential or simultaneous auctions?
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- How to encourage designated companies?
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- Reserve prices?
- How much information public?
Problems from New Zealand and Australia

Second price, sealed bid
Problems from New Zealand and Australia

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- 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

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- No reserve prices
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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
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- Substitutability: several licenses in the same region
License interactions

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License interactions

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- Secondary market might allow for some corrections
  - Likely to be thin
  - High transaction costs
Limits of Theory
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- 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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- Doesn’t scale to complexity of spectrum auctions
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Used laboratory experiments too
Open vs. Sealed Bid

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

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  - Leads to higher bids
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  – Risk aversion leads to higher bids in sealed bid auctions
  – Sealed bid auctions deter collusion
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  - Circumvented!
Simultaneous vs. Sequential

- Sequential prevents backup strategies for aggregation
- Sequential also allows for budget stretching
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Went with activity rules
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

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• Also some problems
  – Strategic Demand Reduction
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- Incremental design changes
  - New problems always arise
  - Bidders indeed find ways to circumvent mechanisms
Results

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• Lessons to be learned via agent-based experiments
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
Model

- Agent goals
  - desire 0, 1, or 2 licences per market
  - desired markets have unique values
  - subject to budget constraint

Assumption: no inter-market value dependencies

- Utility is profit: $\Sigma_l(value - cost)$

- modeled 5 most important bidders
  - others served mainly to raise prices
  - modeled as several small bidders
  - lower valuations (75% → pessimistic)
Bidding Strategies

- Considering self only
  - Knapsack
  - Best self-only approach

- Strategic bidding (consider others)
  - Threats
  - Budget stretching
  - Strategic Demand Reduction (SDR)

Explicit communication not allowed
Randomized SDR

- Figure out allocations dynamically
  - round 1: bid for everything you want
  - first big bidder winning bid owns licence
  - satisfaction = owned value / desired value

- Random ⇒ uneven allocation
  - get small share ⇒ incentive to cheat
  - fair: own satisfaction close to average
  - if unlucky, take licences until fair

- Small bidders take licences from owners
  - remember licence’s owner
  - allocate while small bidders active
# RSDR vs. Knapsack

<table>
<thead>
<tr>
<th>Method</th>
<th>Agent</th>
<th>Profit ($M)</th>
<th>Ratio</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knapsack</td>
<td>0</td>
<td>980 ($\pm 170$)</td>
<td>1.00</td>
<td>.82</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>650 ($\pm 85$)</td>
<td>1.00</td>
<td>.82</td>
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<tr>
<td></td>
<td>2</td>
<td>830 ($\pm 91$)</td>
<td>1.00</td>
<td>.84</td>
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<td></td>
<td>3</td>
<td>170 ($\pm 20$)</td>
<td>1.00</td>
<td>.84</td>
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<td></td>
<td>4</td>
<td>550 ($\pm 96$)</td>
<td>1.00</td>
<td>.86</td>
</tr>
<tr>
<td>RSDR</td>
<td>0</td>
<td>1240 ($\pm 210$)</td>
<td>1.26</td>
<td>.76</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>820 ($\pm 83$)</td>
<td>1.25</td>
<td>.77</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1300 ($\pm 290$)</td>
<td>1.58</td>
<td>.74</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>300 ($\pm 44$)</td>
<td>1.78</td>
<td>.79</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>930 ($\pm 240$)</td>
<td>1.68</td>
<td>.76</td>
</tr>
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44% more profit; avg. ratio 1.51
Robustness

• What if someone cheats?
  – cheat: defect back to knapsack
  – others stay out of its way ⇒ big win

• Solution: Punishing RSDR (PRSDR)
  – cheater takes your licence ⇒ take it back
  – take it back first while still have money
  – aggressively punitive: skips optimizers

Simplification: pointing out cheaters by hand
## Robustness

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<tr>
<td>Knapsack</td>
<td>1.00</td>
<td>.84</td>
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<tr>
<td>RSDR</td>
<td>1.51</td>
<td>.76</td>
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<tr>
<td>RSDR Cheater</td>
<td>1.63</td>
<td>.76</td>
</tr>
<tr>
<td>RSDR Victim</td>
<td>1.22</td>
<td>.79</td>
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<tr>
<td>PRSDR Cheater</td>
<td>1.02</td>
<td>.83</td>
</tr>
<tr>
<td>PRSDR Enforcer</td>
<td>1.17</td>
<td>.81</td>
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Extensions

- **Change small bidder valuations**
  - test robustness
  - RSDR is optimal for preserving profit

- **Multiple cheaters**
  - current punishment too aggressive
  - collapse back to knapsack instead
### Extentions

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<th>Local Ratio</th>
<th>Cost</th>
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<tr>
<td>Multiple Cheater</td>
<td>1.03</td>
<td>1.03</td>
<td>.84</td>
</tr>
<tr>
<td>Multiple Enforcer</td>
<td>1.01</td>
<td>1.01</td>
<td>.83</td>
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<tr>
<td>50% Knapsack</td>
<td>1.70</td>
<td>1.00</td>
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<td>75% Knapsack</td>
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<td>.84</td>
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<td>75% RSDR</td>
<td>1.51</td>
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<td>.76</td>
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<tr>
<td>85% Knapsack</td>
<td>0.68</td>
<td>1.00</td>
<td>.89</td>
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<tr>
<td>85% RSDR</td>
<td>0.81</td>
<td>1.25</td>
<td>.87</td>
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Future Work

More complex value functions
  ● inter-market dependencies

Automatic cheater detection
  ● partial cheating vs. detection arms race

Generalization to other auctions
  ● more robust to tie-breaking procedure variations
  ● Recall Roth-Ockenfels:
    – late bidding on Ebay = randomized strategy