Combinatorial Auction (in practice)

Tuesday, October 4, 2022 10:57 AM

→ set A of agents

→ set M of items $m = |M|$.

Assume

v_i(i gets nothing) $= 0$

v_i(i gets S) $= v_i(S)$.

eg. spectrum: item = (freq band, location/area).

$m \sim 500/1000$

Airport landing slots item = (airport, time).

★ VCG Mechanism: DSIC, SW. maximizing

$v_i : 2^m \to \mathbb{R}_+$ $m \sim 100$ X

Issue 1: representation of v_i

↳ $\boxed{\text{ask about } v_i(S) \text{ per-need-basis}}$.

Issue 2: SW maximizing allocation.

↳ if v_i's are substitutes. $v_i(A \cup B) \leq v_i(A) + v_i(B)$ } → easy.

↳ if v_i's are complements $v_i(A \cup B) \geq v_i(A) + v_i(B)$ } → NP-hard.

X X

Approximate, Indirect.

★ Sell items separately:

$1, \dots, m$ m separate values.

$v_{i1}, \dots, v_{im}$

Q1: Simultaneous / $\boxed{\text{sequential}}$.

2 - similar items, 3-bidders each want at most 1 of item.

↳ which auction to participate in?

March 2000, Switzerland.

3-seq SIA.

Blocks: 26 MHz 26 MHz $\boxed{\text{56 MHz. / 55M!}}$

Rev: 121 M 132 M

unexpected gap.

Take away 1: Simultaneous SIA.

Q2: $\boxed{\text{Sealed bid}}$ / English auction. (ebay).

- participate in which auction if wants only one item?

coordination issues - If part of multiple then how ~~how~~ to bid in order to win one item?

1990 New Zealand.

Blocks: Several block of similar size (250M!)

Auction Rev: 36M!

Highest bid: \$100,020 → \$7M

Second-H. bid: \$ 6 \$5K

↳ First price. Didn't help.

Take away 2: English auction.

☆ Simultaneous Ascending Auction. (SAA)

- each item sold seperately
- English / Ascending-price auction for each.

2-items 3-bidders (each wants only one)

pay ~5

Rounds	$V_1 = 10$	$V_2 = 8$	$V_3 = 5$
1	(0.1, 0.1)	(0.5, 0.5)	(1, 1)
2	(2, 0.1)	(0.5, 2)	(1, 1)
3.	(2, 0.1)	(0.5, 2)	(3, 1)
	⋮		
	(3, 2)	(4.1, 4.0)	(4, 4.9)
	(5, 2)	(4.1, 4.0)	(4, 4.9)
	(5, 2)	(4.1, 5.1)	(4, 4.9)

VCG outcome.

"Pros"

→ Resolves coordination issues
→ Agents need not know their values upfront.
→ "works well"
  - Similar blocks go for similar price
  - ... at similar price sell.

→ "works well"

- Similar blocks go for similar price
- No outside transaction / at similar price sell.
- Price discovery: correlation betn mid-auction (winner, price) & final (winner, price)
- Exceeds projected Rev.

* "Cons"

- Demand Reduction.

$V_1(A) = V_1(B) = 10$ $V_1(AB) = 20$

$V_2(A) = V_2(B) = V_2(AB) = 8.$

SAA (truthful): First bidder wins both & pays $8+8 = 16$ $U_1 = 20 - 16 = 4$

SAA (untruthful): First bidder goes only for B → pay minimal ε. Then second bidder will go for A.

$U_1 = 10 - \varepsilon >> 4.$

* Exposure problem.

$V_1(A) = V_1(B) = 0$ $\boxed{V_1(AB) = 100}$

$V_2(A) = V_2(B) = V_2(AB) = 75.$

SAA (truthful): Either 1 wins both at price of 75 each

$U_1 = 100 - 150 < 0.$

OR 1 drops out at price of (50, 50)

OR 1 drops out at price of (50, 50)

then 2 wins both & pays 100!

$$U_2 = 75 - 100 < 0.$$

★ Sol^n: package bidding.

(1) Fixed packages.

A, B, C, D, AB, CD.

what if a bidder wants AC?

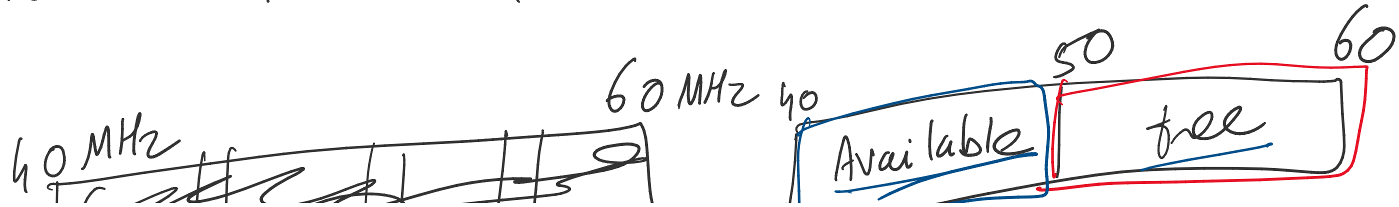
(2) - First run SAA : Round I

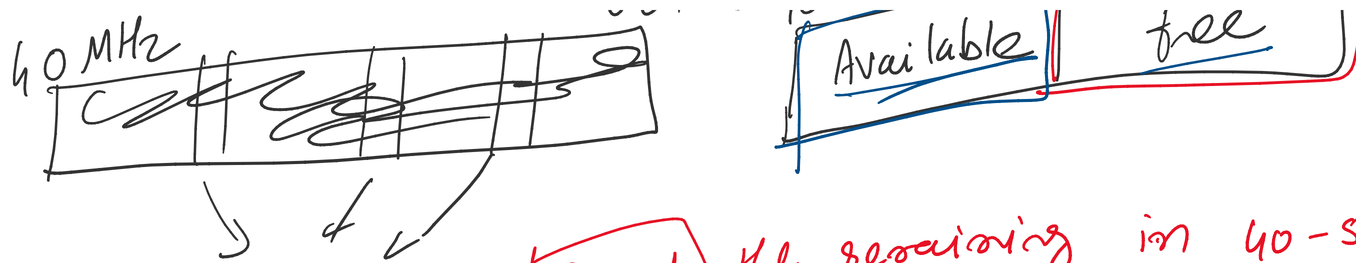
- Limited package bidding : Round 2.

(3) Now.

Both package & single bids. } 2022.

★ Reverse Auction (~ 2014)





$\boxed{\text{Buy out}}$ & $\boxed{\text{Repack}}$ the remaining in 40-50 MHz band.

- Intuitively buy from low-welfare agents sell to high-welfare agents.

- Repack is moderately NP-hard problem. Graph-coloring.

⇒ Direct Mechanism:
bidder i specifies (b_i, r_i)
b_i ↳ bid. r_i ↳ freq range

⇒ We say $W \subseteq A$ is a feasible set
$\boxed{\text{if } A \setminus W \text{ can be repacked in the available range.}}$ → NP-hard.

① $W = A$ // W is feasible because $A \setminus W = \emptyset$, so nothing to repack.

$W \setminus \{i\}$ is feasible

① $W = N$ // W is feasible ... to repack.

② while $\exists i \in W$ s.t. $W \setminus \{i\}$ is feasible

⊛ Remove one such i from W.

③ Return W.

⊛ depends on $\underbrace{\text{bid, storage, bid / capita}}$

↓

give score to agents

↓

pick highest score agent to drop from W.

If score increases w/ increase in bid then the allocation rule is Monotone

$\Downarrow$ by Myerson's payment.

DSIC Mechanism.