A Computationally Friendly Combinatorial Auction: Why Ask Wochnick When You Can Watch The Clock Tick?

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What is a Combinatorial Auction?

- 1980 Steve Rassenti created a new auction form
  - Airline landing slots
  - New message space
  - Smart market design
    - Optimization
    - They allow for tying bids together with logical constructs such as AND (combinations), OR (exclusive acceptances), and NOT TO EXCEED (budget limits) to name a few.
      - Requires combinatorial optimization

Why Combinatorial?

- Current research and application in auction design is allow individuals to submit complicated and flexible bids.
  - Reduces Uncertainty
  - Increases Participation
- Participants tailor their bids to consider the evolution of the interaction between their own complicated preferences and events that occur during the auction.

Costs of Using Combinatorial Auctions

- *Computation*
  - Solution Time
- *Complexity*
  - Cognitive and Participation Costs
    - Placing Bids
    - Interpreting Results (Transparency)
- *Incentives*
  - Strategic Bidding
    - Threshold

Price Information to Reduce Complexity

- Signals are based on multiple prices
  - Prices that signal rejection
  - Prices that signal acceptance
  - Ambiguous signals

Combinatorial Auctions with Price Information

- Trade-offs
  - *Computation*
    - Still an issue
  - *Complexity*
    - Prices help guide decisions
    - Prices are not perfectly transparent
  - *Incentives*
    - Experiments suggest that threshold is not a problem

Clock Auction

- Clock Auctions
  - Eliminate Jump Bidding
  - Simplicity
- Features
  - Price Posted
  - Demand Registered
  - Prices Increased based on Excess Demand
  - No IDs, etc.

Combinatorial Clock Auction

- Basic Design Features (1999)
  - Prices per object
  - Submit demand (packed, etc.)
    - Excess Demand$_i$ = Number of Participants bidding on resource
    - Increase Price until only 0 or 1 for each excess demand
      - Fill by doing full optimization
        - If 1 is reallocated → excess demand

Combinatorial Clock Auction

- Tradeoffs
  - *Computation*
    - No Computation required until end
    - Good Upper bound
    - Dominated bids calculation during rounds
  - *Complexity*
    - Price information guidance is unambiguous
  - *Incentives*
    - Information required to free ride is not readily available

Experiments with the Clock

- Environments
  - Threshold
  - Own effect

OPTIMAL ALLOCATION

A	B	C	D	E	F	G	H	I	J	$VALUE	BIDDER
O	O		O							90.00	1
		O						O		80.00	2
				O			O			80.00	3
					O	O				100.00	6
									O	50.00	5

2ND BEST ALLOCATION

A	B	C	D	E	F	G	H	I	J	$VALUE	BIDDER
O	O	O	O	O	O	O	O	O	O	275.00	6

A	B	C	D	E	F	G	H	I	J	$VALUE	BIDDER
O										1400	3
	O									4300	5
		O	O	O						73.59	4
					O					33.00	2
						O				26.00	3
							O			37.00	2
								O		50.00	1
									O	44.00	4

A	B	C	D	E	F	G	H	I	J	$VALUE	BIDDER
					O	O	O	O	O	153.00	5
O	O	O	O	O						114.00	1

Auction Treatments

- Mechanisms
  - SMR
  - Combo Auction (Plott)
  - Clock

Results

Case	Join	Own	Auction	% Allocation Efficiency
1	.81	Yes	Clock	100,100,100
			Plott	78, 79, 78
			SMR	59
1	.81	No	CC	100,100,100
			Plott	97, 79
			SMR	63
1	.70	Yes	CC	100,100,100,100
			Plott	100, 100
			SMR	70
2a	.80	Yes	CC	100,100,99,100,99,100
			Plott	99, 99, 99, 95, 94, 95, 95
			SMR	100, 99, 95, 95
2b	.94	Yes	CC	100,100,100
			Plott	91, 94, 94
			SMR	100
2b	.94	No	CC	100,100,100
			Plott	95, 95
			SMR	100
2b	.80	Yes	CC	100,100,100
			Plott	100, 91
			SMR	100

Extensions

- Multiple units per “item”
  - Capacity auctions
    - Eg. Sears Logistics
- OR/Eliminate past rounds
  - Dealing with budget constraints
- Exchange
  - Seller commitment and buy-back
- Speeding up the process
  - Moving the Clocks