Spectrum Auction Final Project

CSCI 1440 TAs

October 29, 2025

GSVM Model (Prior Year's Labs)

- 9 goods:
  A through F are national goods; G through I are regional goods
- 4 bidders:
  1 national bidder, and 3 regional bidders (3 regions)
  - The national bidder is eligible to bid on all national goods
  - The regional bidders are eligible to bid on 4 out of 6 national goods, plus one regional good (their region)
  - The national bidder can win up to 6 goods
  - Regional bidders can only win up to 3 goods

GSVM Model (cont'd)

	Goods								
	National						Regional		
	A	B	C	D	E	F	G	H	I
National Bidder	15	15	30	30	15	15			
Regional Bidder 1	20	20	40	40			20		
Regional Bidder 2			40	40	20	20		20	
Regional Bidder 3	20	20			20	20			20

- Individual good's valuations are drawn uniformly between 0 and the number in this table
- Global complements: Each additional good increases the value of the bundle by 20%, as follows: if your agent wins $g_1, g_2, \ldots, g_n$, then

$$v(\{g_1, g_2, \ldots, g_n\}) = [1 + 0.2(n-1)] \left(\sum_{i=1}^{n} v(g_i) \right)$$

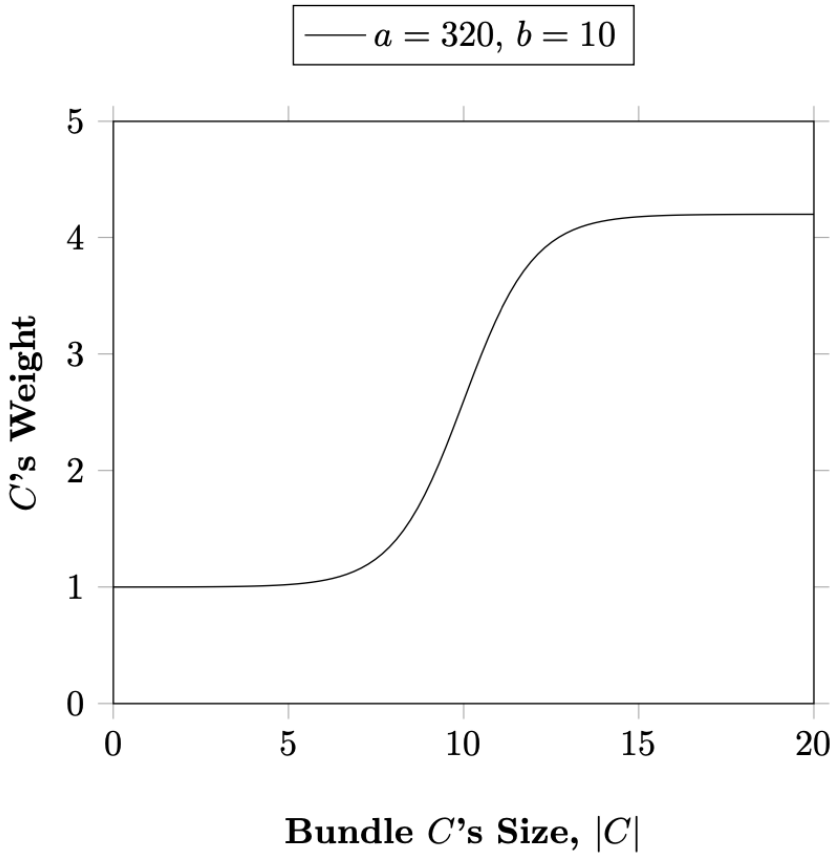
LSVM Model (Final Project)

A	B	C	D	E	F
G	H	I	J	K	L
M	N	O	P	Q	R

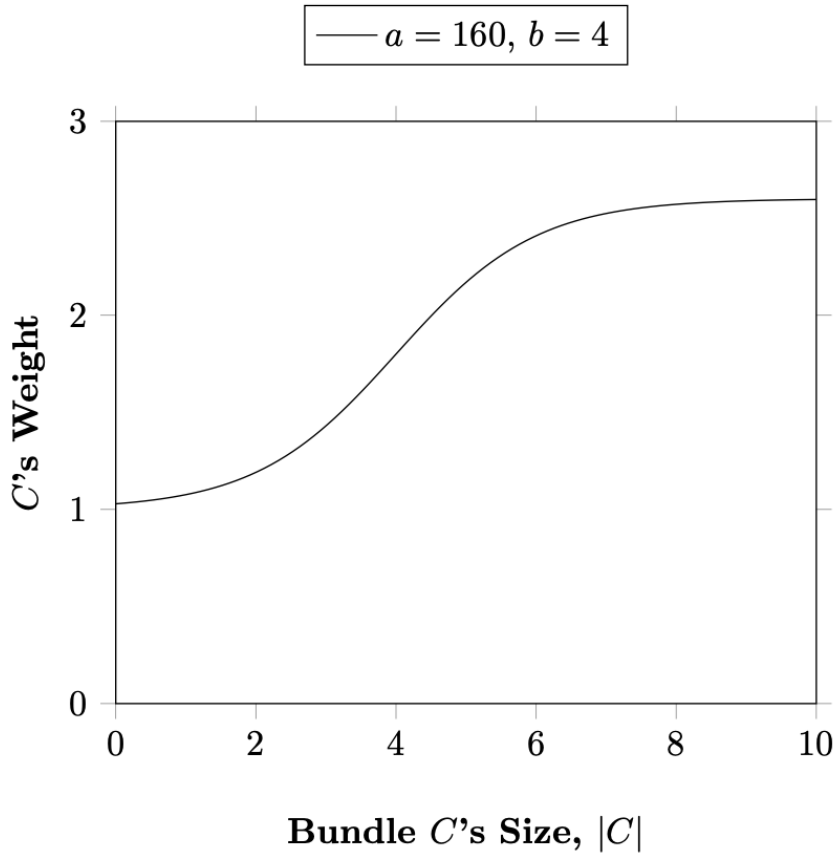
- A local version of the model
- National bidders still have value for each good
- Regional bidders now only value goods in their proximity
- Using this idea of proximity, winning goods that are "connected" accrue an exponential bonus:

$$v_i(S) = \sum_{C \in P} \left(1 + \frac{a}{100\left(1 + e^{b-|C|}\right)}\right) \sum_{k \in C} v_i(k)$$

Connected Bundle Valuation Weight



(a) National Bidder's Bundle Valuations.



(b) Regional Bidders' Bundle Valuations.

Simultaneous Multi-round Auction (SMRA)

- Simultaneous ascending auctions
- Bids are submitted synchronously, in rounds.
- All auctions end simultaneously, when there is no further bidding—in any of them!
- Bids do not stand from one round to the next. Losing bids are effectively withdrawn.
- Only the current price stands, as the winner's bid.
- A **valid** bid is then at least the current price plus the price increment. Only valid bids are entered into the auction.
- Current prices are broadcast to all, but only tentative winners are told the identity of the tentative winners.

Auction Pricing Rule

- The price in each auction is determined using a mechanism much like eBay's.
- The winning bidder is one of the highest bidders, and the price is the second highest.
- Edge cases: If there is only one bidder, the price is updated to current price plus the price increment, if the good changes hands; otherwise, the price does not change.

Auction Pricing: Example

Current Winner	Current Price*	Bid A	Bid B	New Winner	New Price
-	0	-	-	-	0
-	0	ϵ	-	A	ϵ
-	0	$c \geq \epsilon$	-	A	ϵ
-	0	$3+\epsilon$	$2+\epsilon$	A	$2+\epsilon$
A	p	-	-	A	p
A	p	$p+3\epsilon$	-	A	p
A	p	-	$p+3\epsilon$	B	$p+\epsilon$
A	p	$p+2\epsilon$	$p+2\epsilon$	A or B	$p+2\epsilon$
A	p	$p+3\epsilon$	$p+2\epsilon$	A	$p+2\epsilon$
A	p	$p+2\epsilon$	$p+3\epsilon$	B	$p+2\epsilon$

*The minimum valid bid is the current price plus ϵ. Even the current winner cannot place a bid that is not above this minimum. Once bidders beat this minimum, however, they need not bid in increments of ϵ: e.g, if the current price is 10 and the price increment is 2, any bid of 12 or greater is valid: e.g., 12, 12.3, 12.7, 20, ...

Revealed Preference Activity Rule

- Like all activity rules in combinatorial auctions, the revealed preference rule is intended to ensure that the bidders' behavior is consistent with *some* (possibly unknown) quasi-linear utility function.
- In words, if, in an earlier round, when prices were $\mathbf{p}^s$, a bidder chose package S, then later, when prices are $\mathbf{p}^t$, the bidder cannot choose a package T that contradicts the **revealed preference** at time s.
- Operationally, a bidder is only allowed to switch their preferred demand set from S to T if, since the time when S was preferred, the price of T increased by less than the price of S. Mathematically, for price vectors and bundle choices $\mathbf{p}^t, \mathbf{p}^s, \mathbf{x}^t, \mathbf{x}^s$, at rounds t and s:

$$(\mathbf{p}^t - \mathbf{p}^s) \cdot (\mathbf{x}^t - \mathbf{x}^s) \leq 0$$

- This activity rule discourages bidders from re-entering an ascending market for a good after previously exiting it. In particular, this rule discourages bidders from sitting out the very first round, as this will render all future bids invalid.

Strategic Considerations (There are many!)

- This is a combinatorial auction. Your agent needs to find an efficient way to identify goods of interest, and their values.
- Beyond just their values, your agent also needs to come up with a bidding strategy. Will your agent make use of the valuation distributions to try to predict the bids of opposing agents, and ultimately the final auction prices?
- These are second-price auctions, so it is possible to overbid successfully. On the other hand, the exposure problem is real!
- Is it better for your agent to signal its interests to the other agents early in the auction, to stake out its territory? Or should it lay low at first, to see how others behave, and then try to capitalize on cheap prices later on?