NEGOTIATION

MultiAgent Negotiation

2009

Master Course

22/12/09

Introduction to the Problem

- Communicate (offers & counter-offers)
- Compute (based on *prior* knowledge & negotiation history)
- Repeat / Quit

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Desired characteristics of a Negotiation Model

- Support representation of negotiation context
- Be prescriptive
- Incur moderate computational cost
- Model the dynamics of negotiation
- Support learning from feedback in negotiation

The Bazaar Model (Zheng & Sycara, 98)

- Uses sequential decision making framework
- Players ***have*** knowledge about the environment and other players
- History of negotiation is also taken into account
- At each stage in the negotiation and for each non-terminal history, each player has a subjective probability distribution that represents the player's knowledge at this stage

The Bazaar Model (ii)

In response to the most recent action taken by others, player will:

1. Update his subjective evaluation of the environment and other players, using Bayesian rules (posterior probability calculation)

2. Select the action that *maximizes* his expected payoff, given the information available at the current stage

A Simple Example

Suppose that the buyer has two hypotheses about supplier's reservation price:

H_1= 100€

H_2=130€

Suppose the buyer has no other knowledge about the supplier. Then, $P(H_1)=0.5$ and $P(H_2)=0.5$

Suppose the buyer also has domain knowledge that "*The suppliers will typically ask a price above their reservation price by 17%"* So, $P(e/H_1)=0.95$ and $P(e/H_2)=0.75$, where *e* denotes the event that the supplier asks 117€

An Example

Now, suppose that the supplier does ask 117€

Then the buyer uses Bayes rule to calculate:

$$P(H1/e) = 55.9 \text{ and } P(H2/e) = 44.1$$

Suppose the buyer adopts a simple strategy "*Propose a price that is 10% less than the estimated reservation price of the supplier*".

Prior to receiving the supplier's offer the buyer would have offered 115€ (the mean of the RP of supplier's distribution).

After receiving the offer and updating his beliefs, the buyer now offers 113,25.€

Experimental Design

- A buyer, and a supplier
- RP private information
- The agents try to estimate the other player's RP
- Range of possible actions is integer within [0,100]
- Each player's utility is linear in the final price
- Each agent proposes strictly monotonically.
- Each agent has different initial subjective believed functions

Experimental Design

Three conditions:

- Neither one learns
- Both learn
- Buyer learns, supplier does not (game is symmetric)
- For each condition, we ran 500 randomly generated negotiation scenarios

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Average Performance of Three Experimental Configurations in Bazaar

- ***A non-learning agent makes decisions based solely on his own reservation price***
- ***A learning agents makes decisions based on both the agent's own and the opponent's reservation price***

Zeng D. and Sycara, K. "Bayesian Learning in Negotiation", *International Journal of Human Computer Systems*, Vol 48, pp.125-141, 1998.

Configuration	Joint Utility	Buyer's Utility	Supplier's Utility	# of Proposals Exchanged
Both Learn	0.22	0.49	0.51	24
Neither Learn	0.18	0.49	0.51	34
Only Buyer Learns	0.15	0.59	0.41	28

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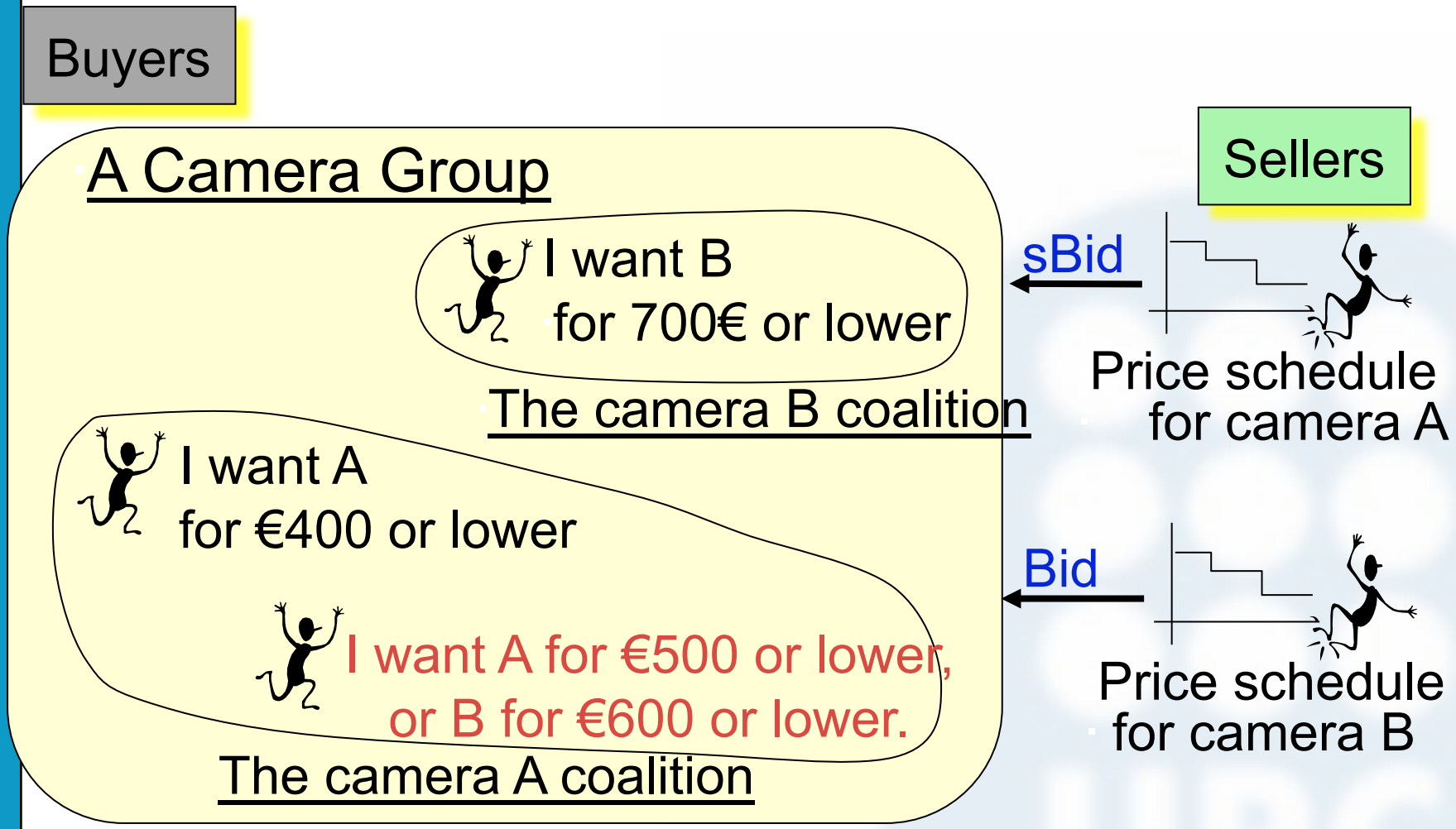
Outline of the GroupBuyAuction scheme



Coalitions

- A buyers' coalition is a group of buyers that want to buy the same item

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- Buyers in a coalition may pay different prices for the same item depending on their reservation prices

- Desired goals for the coalition are:
  - Increase the number of buyers who can purchase items
  - Increase group utility and individual buyers utility
  - Divide the total utility among buyers in a fair and stable way.

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Approach to Coalition Formation

Principle 1:

- Maximize the utility of the most valuable coalition, then maximize the utility of the second valuable one, and continue recursively.

Principle 2:

- Distribute the surplus of each coalition within the coalition in a stable way.

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Buyers' Utility

b_k: a buyer,
g_i: an item,
r_{ki}: the reservation price of a buyer b_k for g_i,
Ci : a buyer coalition to purchase g_i.

$v_i(k) = r_{ki} - p_k$

The utility of buyer b_k gained from buying g_i at the price p_k,

$v_i(Ci)$ = Sum of $v_i(k)$ where b_k in Ci

The utility of a buyer coalition gained from buying g_i.

Coalition Configuration Algorithm

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(2) Then maximize the utility
of the second valuable coalition,
and continue recursively...

Buyers

A Camera Group

I want B
for 700€ or lower

The camera B coalition

I want A
for 400€ or lower

I want A for 500€ or lower,
or B for 600€ or lower.

The camera A coalition

Bid

Price schedule
for camera A

Bid

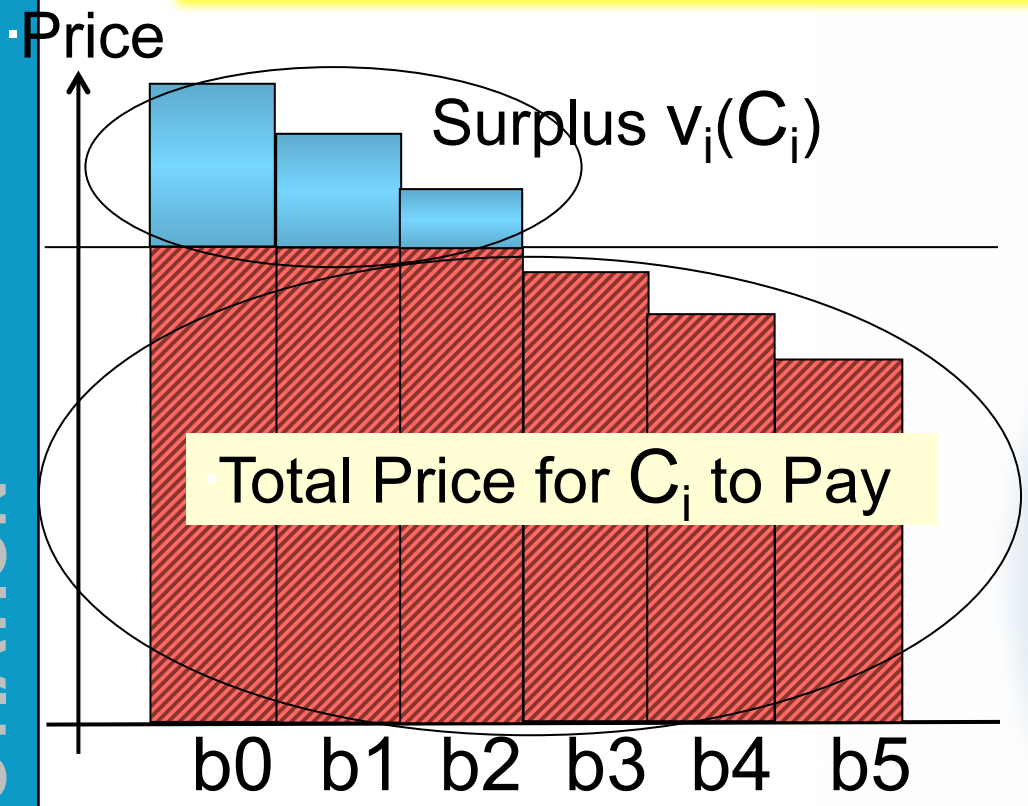
Price schedule
for camera B

Sellers

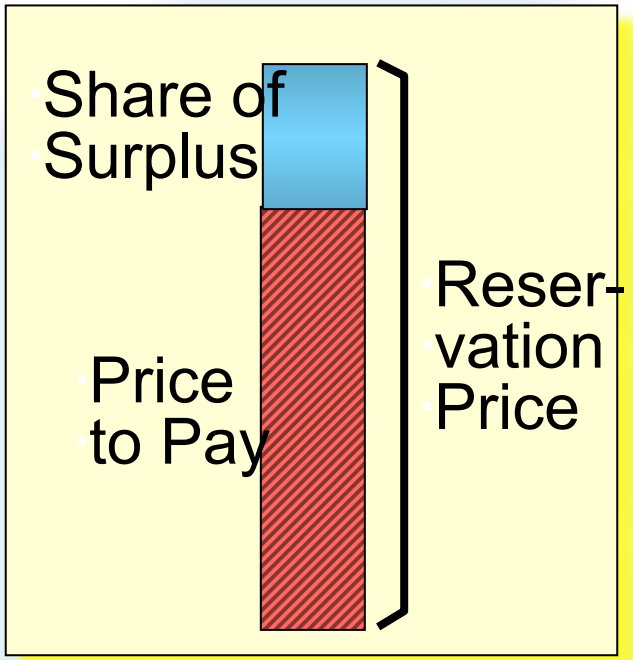
(1) Maximize the utility
of the most valuable coalition.

Surplus Sharing Rule in a Coalition

- Distribute the surplus of each coalition within the coalition.



Coalition C_i = {b0, b1, …, b5}



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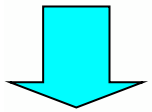
Stability of the Surplus Sharing Rule

Proposition

For any coalition C_i , the surplus distribution is in the *core* of coalitional game with transferable payoff $< C_i, v_i >$



No subset of buyers in a coalition can obtain utility that exceeds the sum of the current utility of the members in the subset.