Autonomous Multiagent Systems

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Week 11, Thursday (11/7)

Any Questions?

- Irrelevant alternatives
- Arrow
- Concave TODs
- negotiating decommitment

Arrow's Theorem

Universality. The voting method should provide a complete ranking of all alternatives from any set of individual preference ballots.

Pareto optimality. If everyone prefers X to Y, then the outcome should rank X above Y.

Criterion of independence of irrelevant alternatives. If one set of preference ballots would lead to an an overall ranking of alternative X above alternative Y and if some preference ballots are changed without changing the relative rank of X and Y, then the method should still rank X above Y.

Citizen Sovereignty. Every possible ranking of alternatives can be achieved from some set of individual preference ballots.

Non-dictatorship. There should not be one specific voter whose preference ballot is always adopted.

Gibbard-Satterthwaite

- 3+ candidates $\Longrightarrow$ only **dictatorial system** eliminates need for tactical voting
  - One person appointed
- No point thinking of a “perfect” voting system
- Assumption: no restrictions on preferences

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Student-led Discussion

- Suggest and evaluate voting mechanisms

Bargaining

small market, both can come out favorably

- Two people bargaining, each with a preference over outcomes O

- Let o^* be the selected outcome

- Example: “split the dollar”
  - One person makes offer o
  - Other rejects with probaility $p(o)$ — based on offer
  - If rejects, both get nothing

Nash Bargaining Solution

Unique solution that satisfies:

Invariance: only preference *orders* matter
Anonymity: no discrimination
Pareto efficiency: if one does better, other does worse
Independence of irrelevant alternatives: removing outcomes doesn't change things

$$\boxed{\textbf{Maximize } u_1(o) * u_2(o)}$$

General Equilibrium

Consumers: utilities, endowments
Producers: production possibility sets
Variables: prices on goods
Equilibrium: allocation (prices) such that consumers maximize preferences, producers maximize profits

- Assumption: agent doesn't affect prices
  - Only true if market is infinitely large
  - Else, strategic bidding (like bargaining) possible
- Assumption: no externalities
  - Utilities or production sets depend on others'
  - Braess' paradox

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Contract Nets

Task allocation among agents

- OCSM-contracts: original, cluster, swap, multiagent
  - Hill-climbing leads to optimum
  - Without any type, may be no sequence to optimum
- Backing out of contracts
  - Contingency (future events)
  - Leveled commitment (price)
  - What are some of the tradeoffs?

Q: What about negotiating decommitment?

Lying in Contract Nets

Subadditive Task Oriented Domain • The cost of the union of tasks is less than or equal to the sum of the costs of the separate sets

• for finite $X, Y \in T, c(X \cup Y) \leq c(X) + c(Y))$.

Concave Task Oriented Domain • We have 2 tasks X and Y, where X is a subset of Y Another set of task Z is introduced

• $c(X \cup Z) - c(X) \geq c(Y \cup Z) - c(Y)$.

Modular TOD •

$c(X \cup Y) = c(X) + c(Y) - c(X \cap Y)$.

Coalitions

- Formation
- Optimization within
- Payoff division

Summary

For many agents: voting, general equilibrium, auctions

For fewer agents: auctions, contract nets, bargaining

Possible in all: coalitions

All self-interested, rational agents

Next Week's Readings – Auctions

- FCC Spectrum Auctions
- The Trading Agent Competition
- Comparison of eBay and Amazon mechanisms (optional)