CSE 976: Scribe notes of the discussion of Wednesday, April 17, 2002.
"Distributed Rational Decision Making"
By Tuomas W. Sandholm

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I presented the first part of this paper, which included:

- Introduction.
- Evaluation Criteria
- First three protocols:
    1. Voting.
    2. Auction.
    3. Bargaining.

Tibor presented the remaining part of the paper, namely:

- Last three protocols:
    1. General Equilibrium Market Mechanisms.
    2. Contract Nets.
    3. Coalition Formation.
- Conclusions.

Tibor's Presentation:
Tibor began his presentation by first giving an outline of his presentation and then began the fourth protocol, General Equilibrium Markets.

General Equilibrium Markets:
In this protocol we saw the following:

1. Properties of General Equilibrium: General Equilibrium theory provides a distributed method for efficiently allocating goods and resources among agents based on market price. It demands that the markets be clear, consumers maximize their preferences and producers maximize their profits. It has the properties of Pareto efficiency, coalitional stability, existence and uniqueness under gross substitutes.
2. Distributed search for a general equilibrium: Price Tatonnement algorithm, a steepest descent method, is the most popular algorithm that searches for a general equilibrium. For this method to guarantee to converge to a general equilibrium the consumers must save more money satisfying their preferences than the producers make in their profits.
3. Speculative strategies in equilibrium markets: Since there are finite number of agents, an agent will speculate how his lying will affect other agents and drive the market prices to maximize his utility function. There are two cases of speculation here: Speculating Consumer and Speculating Producer. There is a risk for the speculator that even thought equilibrium exists for his speculated prices; the market algorithm may not find it. Strategic solution concepts from game theory can be used to design market protocols, such as, dominant strategy and requirement of maintenance of equilibrium at every step of the game (this may require a third party to oversee this requirement).

Contract Nets:
The problems with General Equilibrium Markets were:

- Global prices
- Single centralized mediator.

The above problems warranted a more distributed negotiation protocol and this resulted in the contract net protocol of Chapter 2 of MAS. This section discusses some of the recent improvements to it, namely:

- Task allocation negotiation: The agents are allowed to trade tasks amongst themselves; have more control, which may be better suited to make decisions in their local environments and can take on the role of both a contractor and contractee. These changes can lead to local optima, but may fail to find global optimum. To workaround this problem the following methods are used:
    - Cluster contracts: a set of tasks is atomically contracted.
    - Swap contracts: a pair of agents swaps a pair of tasks.
    - Multiagent contracts: more than two agents are involved in atomic exchange.

  Here again we have the problem of an agent lying by *hiding tasks*, declaring *phantom tasks* and announcing *decoy tasks*.
- Contingency and leveled commitment contracts: Contingency contracts can be made in situation where the original goal has changed due to dynamic environment. The disadvantages with them is that they get cumbersome as the number of relevant events to monitor from the future increases; often it is impossible to enumerate all possible future events in advance and very difficult to verify the unraveling of the events. While leveled commitment contracts provide for unilateral decommitting at any point in time by specifying decommitment penalties for each agent. The disadvantage with them is that the contract breacher's gain may be smaller than the victim's loss and there may be insincere or reluctant decommiting.

Coalition forming:
Coalition forming includes three activities:

1. Coalition structure generation: Agents are able to coordinate their activities within each coalition but not between coalitions. That is the set of agents are partitioned into exhaustive and disjoint coalitions.
2. Optimization within a coalition: Optimization is done for maximizing the monetary gains. For this, the tasks and resources of the agents in the coalition are pooled together for solving the joint problem.
3. Payoff division: The agents divide the value of the generated solution amongst themselves. The value of the solution may be negative because the cost of generating that solution may be more than the returns. The paper discusses two ways of dividing the payoffs:
    1. Core.
    2. Shapley value.

Conclusions:
Multiagent systems consisting of self-interesting agents are becoming ever-present. The interaction protocols for such systems have to be designed in such a manner that each agent is motivated to follow the strategies it was designed to follow.
A deep understanding and hybridization of technological and economic methods are needed in order to avoid manipulation and have better coordinated systems.

Questions and comments:

- Cory: Would be so much easier if the protocols could be secure and disallow cheating. It looks very complex to implement any of these protocols. Has anybody actually build any such system?
  Tibor: The paper mentions one such system called WALRAS, which uses the General Equilibrium Market Mechanisms.
- Dan: If an agent trades a task to another, what forces the agent to do the work for the other agent?
  Tibor: When the agents trade tasks, they also trade the responsibilities of those tasks.
  Dan: Why aren't there agents that freely perform work, each according to their abilities.
- Rob: General Equilibrium demands that markets be clear and each producer maximizes its profit. But it appears that these two demands conflict if the cost of clearing the market decreases the producers' profit.
  What is the search space in which we find the General Equilibrium? Is it profits or market products?
  In the strategic behavior by multiple agents in General Equilibrium Markets is the protocol enforcing dominant strategy? If it does enforce it then, this seems to be restrictive and the markets would be very fragile or very contradictory to utility. If it is not enforced then some agent could take advantage of other agent's dominant strategy.
- Shabbir: In the contract nets protocol, how are the agents penalized for decommiting?
  Tibor: Penalized in such a way so as to decrease the utility function of the agent.
- Xu Lin: It seems that the author of the paper tells the agents how to lie.
  Implementing these protocols is going to be very hard and complex. Is the goal of the multiagent systems to find more efficient ways to solve problems or search for goals?
  Tibor: These protocols may be useful for e-commerce.
  Instructor: Is it safe to use these protocols?
- Amy: These protocols seem to be really hard and complex to implement. Did not like paper.