

Guest Editorial

Special issue on negotiation and scheduling mechanisms for multiagent systems

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Automated negotiation among software agents is becoming increasingly important because automated interactions among agents can occur in many different contexts. For instance, designing agents that can negotiate deals on behalf of human traders is essential for developing the next generation of e-commerce and e-trading systems. More recently, bargaining and negotiation mechanisms have been applied as economic models to resource management in a Grid computing platform. Additionally, recent studies seem to focus on completely open and highly uncertain environments in which agent systems are applied to the real world. In engineering practical negotiation agents, issues such as reliability and robustness are essential in addition to the more traditional notion of rationality (in the sense of being utility optimizing). Furthermore, scheduling in multiagent systems is essential in team formation for task allocation and cooperation. With agents assuming different roles, scheduling among agents is needed for forming teams to effectively accomplish simultaneous joint tasks in dynamic environments.

This special issue brings together a collection of papers addressing issues of designing both negotiation mechanisms and scheduling mechanisms for multiagent systems into the same forum. It presents recent research achievements and studies on understanding, analyzing, as well as developing (societies of) agents for negotiation, conflict resolution, and e-commerce systems. In this special issue, six papers were accepted as full papers. Some of the issues addressed in these six papers include:

- formulating and devising a (Markov Chain) decision making heuristic to guide negotiation agents operating in a dynamic environment in reaching early consensus in a bargaining process.
- designing a retractable contract net protocol for distributed scheduling of agents with potentially conflicting interests.
- designing a decentralized multi-attribute negotiation model based on alternating-offer protocol among self-interested agents.
- developing a multi-issue negotiation protocol among nonlinear utility agents to work on highly complex utility spaces.

- developing a mechanism that enables agents to flexibly choose team duration and members based on fuzzy rules.
- designing a multilateral negotiation protocol with the consideration of inter-dependencies among multiple issues to help cooperative agents in finding optimal solutions during negotiation.

MCDM negotiation strategy: The paper by An and Sim et al. adopts a Markov Chain Decision Making (MCDM) heuristic for guiding negotiation agents operating in a dynamic environment in reaching early consensus in a bargaining process. In their negotiation model, the strategies of agents take into consideration the time-dependent negotiation decision function and dynamic outside options. Even though only one pair of agents can ultimately reach an agreement, during negotiation, an agent can potentially engage multiple trading parties simultaneously. In such a dynamic and complex negotiation environment, agents (i) can either withdraw from or join an e-market at any time, and (ii) need to decide when to reach a consensus with some other agent. The distinguishing feature of their work is devising a decision making mechanism for a negotiation agent to determine whether to (i) accept the best proposal from the pool of its current trading options, or (ii) proceed to the next negotiation round. To this end, the authors developed a Markov Chain stochastic modeling technique as part of an agent's negotiation strategy using a heuristic for deciding when to complete negotiation. Adopting an MCDM strategy, an agent takes into account the dynamics and resulting uncertainties of the negotiation process using stochastic modeling of the negotiation process.

RECONNET: The paper by Tsang et al. designed a negotiation protocol for distributed scheduling in multiagent systems. Whereas the contract net is a well-known protocol for task allocation in multiagent systems, the authors devised a RECONNET (REtractable CONtract NET) protocol for bolstering workforce scheduling in BT's business operations in which there are multiple service providers serving multiple service buyers, and buyers and sellers may have conflicting interests. Furthermore, each provider (respectively, buyer) attempts to optimize its own utility. Formulating the BT workforce scheduling problem as a multi-objective optimization problem, RECONNET is used to optimize parameters such as maximizing completion rates and service quality, and minimizing traveling distances. RECONNET extends the contract net protocol by bolstering hill-climbing by the buyers and service providers in the schedule search space.

Alternating-offer based multi-issue negotiation: The paper by Lai et al. proposes a negotiation model that allows agents to reach "win-win" agreements in multi-attribute negotiations based on an alternating-offer protocol without any mediator. Multi-attribute negotiation is an important and valuable mechanism because in reality conflict resolutions for negotiating parties often involve mediation and arbitration of multiple issues. But a multi-attribute negotiation is much more complicated than a single-attribute negotiation. This paper extends the existing related works (e.g., [Bac and Raff 1996] [Klein et al. 2003]) by considering quasi-concave utility functions, continuously-valued issues, incomplete information and Pareto optimality. Experimental analyses in their work showed that agents can reach near Pareto optimal agreements in quite general situations following the model where agents may have complex preferences on the attributes and incomplete information.

Auction-based multi-issue negotiation: The paper by Ito et al. proposes a multi-issue negotiation protocol by employing techniques of adjusting sampling and auction-based maximization of social welfare among non-linear utility agents. In the protocol, agents adjust their sampled points firstly by using a search technique. Following that, agents submit bids. Since a huge utility space is assumed in the protocol, if these bids are based on contract points, there could be too many bids. Thus, in the model, agents make bids based on a set of constraints among values of multiple issues. This bid expression can drastically reduce the computational cost. In their work, a mediator is used to find a combination of

bids that can maximize social welfare. Experimental results showed that: (1) their protocol can handle highly complex utility spaces; and (2) agents involved in the negotiation do not need to explicitly know their utility spaces.

Flexible scheduling for agent team formation: The paper by Bai and Zhang proposes a mechanism that enables self-interested agents to flexibly choose team durations and members. To realize such a mechanism, factors such as agents' historical performance, task requirements, and resource constraints, must be considered. However, considering these factors is very difficult in dynamic environments. Thus, in their paper, fuzzy rules are employed to evaluate factors related to team forming. Using these fuzzy rules, agents can dynamically select collaboration durations and objectives according to the result of fuzzy evaluations, as well as the manner of collaboration. Experimental results demonstrated that their flexible team forming mechanism can perform well compared with one-shot and long-term team forming mechanisms.

Cooperation-based multilateral multi-issue negotiation: In their paper, Hemaissia et al. present a negotiation protocol to solve a distributed allocation problem for crisis management by considering complex preferences and multiple interdependent issues among agents. Crisis management involves evacuation, search and rescue, and recovery from the crisis by minimizing its effects, limiting the impact on the community and environment. In their protocol, multi-issue negotiation is achieved by taking into account complex inter-dependencies among multiple issues with the use of complex preference modelling supported by a multi-criteria decision aid methodology and tool. In addition, "sharp recommendations", made on the basis of a time dependent penalty, are also used in the negotiation protocol to help in accelerating the search of a consensus between the cooperative agents and in finding an optimal solution. A case study seems to suggest that their protocol has sub-game perfect equilibria and these equilibria converge to the usual optimal solution.

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