Canonical problems are simplified representations of a class of real world problems. They allow researchers to compare algorithms in a standard setting which captures the most important challenges of the real world problems being modeled. In this dissertation we focus on negotiating collaboration in space and time, a problem with many important real world applications. Although technically a multi-issue negotiation, we show that the problem can not be represented in a satisfactory manner by the previous models. We propose the “children in the rectangular forest” (CRF) model as a possible canonical problem for negotiating spatio-temporal collaboration.

In the CRF problem, two embodied agents are negotiating the synchronization of their movement for a portion of the path from their respective sources to destinations. The negotiation setting is zero initial knowledge and the negotiation happens in the physical time. As equilibrium strategies are not practically possible, we are interested in strategies with bounded rationality, which achieve good performance in a wide range of practical negotiation scenarios. We design a number of negotiation protocols to allow agents exchange offers. The simple protocol can be enhanced by schemes in which the agents add additional information of the negotiation flow to aid the negotiation partner in the offer formation. Naturally, the performance of a strategy is dependent on the strategy of the opponent and the characteristics of the scenario. We develop a set of metrics of the negotiation scenario which formalizes our intuition of collaborative scenarios (where the agents’ interests are closely aligned) versus competitive scenarios (where the gain of the utility for one agent is paid off with a loss of utility for the other agent).

At last, we investigate some sophisticated strategies which allow agents to learn the opponents while negotiating. First, strategies can be augmented by collaborativeness analysis: we approximate the collaborativeness metric in the first several negotiation rounds, and use the result to cut short the negotiation. Second, we describe an approach for learning the model of the opponent through Bayesian learning. We assume that the agents do not disclose any of their information voluntarily; the learning needs to rely on the study of the offers exchanged during normal negotiation. Third, we investigate a setting where embodied agents are able to perform physical action (movement) while the negotiation is ongoing. We develop a method to represent and update the beliefs about utility function, current state and strategy of the the opponent agent using a particle filter.

By exploring a number of different negotiation protocols and several peer-to-peer negotiation based strategies, we demonstrate that the CRF problem captures the main challenges of the real world problems while allows us to simplify away some of the computationally demanding but semantically marginal features of real world problems.

Major: Computer Engineering

Educational Career:
Bachelor's of Automation, BS, 2003, Huazhong University of Science and Technology, China
Master's of Computer Engineering, MS, 2009, University of Central Florida

Committee in Charge:
Ladislau Boloni, Chair, EECS
Gary T. Leavens, EECS
Damla Turgut, EECS
Yue Zhao, Mathematics

Approved for distribution by Ladislau Boloni, Committee Chair, on January 20, 2009.
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