A Stochastic Strategy for Multiagent Contracts and the Impact of Deliberation Overhead

Sunju Park and Edmund H. Durfee
Artificial Intelligence Laboratory
The University of Michigan
Ann Arbor, MI 48109-2110
{boxenju, durfee}@eecs.umich.edu

In multiagent systems consisting of self-interested agents, forming a contract often requires complex, strategic thinking (Rosenschein & Zlotkin 1994, Vidal & Durfee 1996). In this abstract, we describe a stochastic contracting strategy for a utility-maximizing agent and discuss the impact of deliberation overhead on its performance.

In a contracting situation, an agent often faces many factors and tradeoffs. To find the best payment to offer, for example, a contractor needs to think about the potential contractees' costs of doing the task, the payments offered by other contractors, and so on. Moreover, a higher payment is more likely to result in a successful contract but less profit.

We have developed a four-step stochastic contracting strategy (Park, Durfee & Birmingham 1996). The agent models the contracting process using Markov chains (MC), computes the transition probabilities between the MC states, computes the probabilities and payoffs of success and failure of a contract, and chooses an action that maximizes its expected utility. The MC model enables an agent to capture various factors that influence the utility value and uncertainties associate with them. In addition, Markov process theory provides a theoretically-sound method for computing the probabilities and payoffs. We have demonstrated that the stochastic strategy works better than a static strategy (that strives for a predefined profit margin) and a simple stochastic strategy (that models the contractees but ignores competing contractors).

In the previous experiments, however, we have assumed a stochastic contractor has negligible deliberation overhead, which will not be true in general. While a stochastic contractor is deliberating on an optimal payment, another contractor may be able to contract and finish more tasks. In the following, we examine the impact of deliberation overhead on the performance of the stochastic strategy.

To compare different deliberation overheads, we capture a distribution of deliberation times by varying the transition probabilities from the initial state to the announced state of the stochastic contractor (p) from 0 to 1. When p is 1, the stochastic agent's deliberation always takes a unit time (i.e., the same overhead as the simple-strategy contractor). When p approaches 0, its deliberation takes more time.

This research has been funded in part by Digital Libraries Initiative under CERA IRI-9411287.

Figure 1 depicts the profit per time unit of the two contractors. While the simple contractor's profit is pretty stable (since it always seeks a fixed profit), the stochastic contractor's profit per time decreases as the deliberation overhead increases. The crossover happens when the stochastic agent takes about 40% longer in deliberation than the simple agent. Therefore, when there is a steady stream of tasks to contract and the deliberation for an optimal payment takes a long time, the stochastic strategy may not be worthwhile.

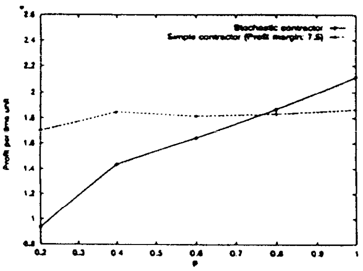

Figure 1: The performance per time unit

In addition to analyzing the performance of the stochastic strategy relative to its deliberation overhead, we can use the experimental result to develop an adaptive contracting strategy. Different MC models are needed for different contracting situations, and if the deliberation cost is zero, the agent will use the model which represents the contracting situation most accurately. Typically, however, the more accurate model is more expensive: it may have more Markov states or may require more complex computation to derive the transition probabilities. The meta-level question is then how to find the most appropriate MC model for the current contracting situation while considering the deliberation overhead, and the above set of experiments is a step toward developing such an adaptive contracting strategy for multiagent contracts.

References

Park, S., Durfee, E. H., & Birmingham, W. P. 1996. Advantages of Strategic Thinking in Multiagent Contracts. In Proceedings of the ICMAS, 259-266. Kyoto, Japan.

Rosenschein, J. S., & Zlotkin, G. 1994. Rules of Encounter. The MIT Press.

Vidal, J., & Durfee, E. H. 1996. The Impact of Nested Agent Models in an Information Economy. In Proceedings of the ICMAS, 377-384. Kyoto, Japan.