

Goal and Responsibility Allocation in Sensible Agent-based Systems

Ryan McKay and K.S. Barber

The Laboratory for Intelligent Processes and Systems
The University of Texas at Austin
Austin, TX 78712
rmckay@lips.utexas.edu, barber@mail.utexas.edu

A Multi-Agent System(MAS) can be seen as a group of entities interacting to achieve individual or collective goals. Communication is a central issue in this interaction between agents. Protocols such as the Contract Net Protocol(CNP) (Smith, 1980) have been proposed to address the coordination level of communication in predefined organizational structures with predefined agent interaction mechanisms. The research presented here applies and extends this protocol to address issues in one particular MAS – Sensible Agents(SA) (Barber, 1996).

SAs carry out goals that have been allocated to them by another agent or by a user interacting with the system. Completion of a goal occurs in three phases: 1) planning – decomposing a goal into subgoals, 2) allocating the subgoals, and 3) executing the subgoals (which may themselves need to be further planned for). SAs are capable of dynamic agent organization based on dynamic adaptive autonomy where agents' roles in interactions can change.

SAs use the concept of an Autonomy Level(AL) to define their organizational roles with respect to goals. Autonomy level is a 4-tuple composed of values for the following autonomy constructs: responsibility, commitment, independence, and authority. A module in a SA assigns a distinct AL to each goal for which the agent bears some responsibility. Several typical autonomy levels are named: command-driven, consensus, locally autonomous, and master. The main difference between these ALs is the relationship between which agent owns the goal and which agent plans for the goal. A locally autonomous agent owns and plans its goal. A command-driven agent owns a goal, but has allocated responsibility for planning and subgoal allocation to a master agent. All agents in a Consensus Group(CG) share planning and allocation responsibility for some number of related goals owned by CG members.

Most ALs involve multiple agents, and so require an Autonomy Level Agreement(ALA) among them. In order to coordinate the agents' efforts of allocating goals to each other or allocating responsibility through an ALA, SAs need a communication protocol. The Goal and Responsibility Allocation Protocol and Language(GRAPL) based on the CNP (Smith, 1980) is proposed.

SAs immediately require GRAPL to extend CNP by the addition of two new ANNOUNCEMENT messages: GOAL ANNOUNCEMENT and ALA ANNOUNCEMENT. A SA uses the GOAL

ANNOUNCEMENT message to inform other agents about a goal it wants to allocate. We can use the ALA ANNOUNCEMENT in much the same manner, by treating ALAs as responsibility allocations.

GRAPL, as outlined here, addresses the important issues of goal and responsibility allocation in SAs using extensions to the straightforward and effective CNP (Smith, 1980). However, much work remains. Current efforts focus on moving GRAPL beyond the ANNOUNCE-BID-AWARD model to incorporate other methods of coordination such as negotiation, voting, and arbitration. These alternatives provide increased flexibility both in obtaining a contract and within an agreed upon contract. The protocol will be implemented in a standard intentional language such as KQML (Finin et al., 1993). A battery of experiments on SA's communication capabilities is scheduled for June 1998, using the Sensible Agent Testbed (currently under development). The results of those experiments will be analyzed with the goal of developing algorithms that SAs will use to determine the appropriate coordination technique for given situations.

Acknowledgments

This research was supported in part by the Texas Higher Education Coordinating Board (#003658-415).

References

- Barber, K. S. 1996. The Architecture for Sensible Agents. In Proceedings of the International Multidisciplinary Conference, Intelligent Systems: A Semiotic Perspective. Gaithersburg, MD.
- Finin, T., Weber, J., Wiederhold, G., Genesereth, M., Fritzon, R., McKay, D., McGuire, J., Pelavin, R., Shapiro, S., and Beck, C. (1993) "Draft Specification of the KQML Agent-Communication Language."
<http://www.cs.umbc.edu/kqml/kqmlspec.ps>, Current as of: 12-1-1997.
- Smith, R. 1980. The Contract Net Protocol: High-level Communication and Control in a Distributed Problem-Solver. IEEE Transactions on Computers 29(12): 1104-1113.