Role of Acquaintance Models in Agent-Based Production Planning System

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Abstract. This paper comments the role of acquaintance models in agent-based engineering solutions. We present a specific methodology, a tri-base acquaintance model, as formal model of agents’ mutual awareness. The model contains three separate knowledge structures for representing agents’ permanent, semi-permanent and temporary knowledge, respectively, and mechanism for administering, maintenance and exploration of the knowledge. The paper explains how utilisation of an acquaintance model contributes to communication savings and to reduction of overall distributed problem solving complexity. Utilisation of the tri-base acquaintance model is illustrated on ProPlanT multi-agent system for project-oriented production planning. The system architecture exploits several different types of agents exploring the tri-base mechanism including the meta-agents who are used to adjust and tune the agents’ acquaintance models.

1 Introduction

The principle motivation behind grouping particular agents into a community and making them to collaborate is sharing responsibility, efforts, using abilities and knowledge of particular agents in order to meet a common goal. In principle there are three fundamental communication paradigms which organise collaboration within the agents’ community:

- **Broadcasting task announcements** - Whenever an agent needs help with satisfying its commitment it just blindly broadcasts a task requirement within the community (or a specific sub-community) and selects the most suitable proposal. The contract net protocol can be used as a technique for managing the negotiation process.

- **Central communication agent** - There is an agent within the agents’ community that is in charge of message passing co-ordination. It is supposed to be aware of agents capabilities, their physical addresses etc. An agent sends a message with a requirement to the central communication agent (facilitator) who contacts the best promising agent.

- **Acquaintance models** - Knowledge about collaborating agents are stored in agents’ acquaintance models that are located in agents’ *wrappers* - an
inseparable part of the agents’ architecture that is responsible for individual agent’s engagements in the multi-agent community. Every member of the community is to be aware (to certain extent) who may be the best one for satisfying its specific requirements.

Inter-agent communication based on manipulation of knowledge stored in agents’ acquaintance models minimises overall communication requirements while avoiding need of a central communication agent. If someone in the community dies or gets overloaded, the system is expected to reorganise itself in order to solve its tasks anyway. Putting too much power to a single agent - central communication agent - makes this approach too fragile and dependent on the central agent. With acquaintance models knowledge of the central communication agent is distributed across the community members. A number of case specific knowledge structures and maintenance algorithms for acquaintance models were implemented in the past.

1.1 Brief Acquaintance Models Review

Acquaintance models, as agents’ views of their collaborative environment, were widely used within the framework of the ARCHON project (Architecture for Co-operating Heterogeneous On-line Systems) [9]. ARCHON helps designers to correctly decompose and structure components of a MAS. In a wrapper of an agent (they call it ARCHON layer) three types of knowledge are stored: (i) planning and co-ordination knowledge, (ii) knowledge about the agent internal state, and (iii) knowledge about collaborating agents - in the form of acquaintance models. Both the agents’ problem solving knowledge and inference mechanism are stored in the Intelligent System Layer.

Coverage is a system for multi-agent systems verification [2]. The system is capable of detecting of anomalies that can exist in MAS (of ARCHON architecture) between their declarative knowledge - knowledge of the Intelligent System Layer and cooperation knowledge stored and manipulated within its ARCHON Layer. Though no particular mechanism for acquaintance knowledge representation was presented, specific algorithms for detecting inconsistencies within various types of agent’s knowledge have been analysed. The system is able to identify conflicts within the set of agent’s internal problem solving domain knowledge (dk anomaly), among agent’s co-operation knowledge (ck anomaly), between agent’s problem solving knowledge and appropriate social acquaintance knowledge (cd/dk anomaly) and among acquaintance knowledge of different agents (ck/ck anomaly). A methodology for detecting inconsistencies in agent’s acquaintance models offers checking security in the entire MAS.

Pleiades is an architecture of collaborative agents making organisational decision making over the collection of internet-based heterogeneous resources [6]. The community consists of task-specific agents (TA) and information-specific agents (IA). TA co-ordinate and schedule plans with respect to a context. They collaborate in order to resolve conflicts and integrate information. IAs gather information from databases and collaborate mutually in order to provide TAs with requested information. Correspondingly, TAs agents maintain problem solving knowledge how to perform a task as well acquaintance knowledge detailing capabilities of the other TAs and IAs.

A specific acquaintance model, called twin-base model, was proposed by Cao, Bien and Hartvigsen [1]. The novel idea behind this paradigm is based on correct