Chapter I
Overview of Agent Modelling

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ABSTRACT

The field of agents is presented, taking in mind what means to be a rational entity, how it operates, can be specified, and formally described. After giving a glimpse of the current state of the field, we use the BDI model, supported by folk psychology, to discuss new challenges concerning the mentality and the behaviour of an agent. This is done with the help of our own research around new mental states and properties of the agency. Defining the character and personality of an entity can be rather interesting to attack real applications where complexity is a strong ingredient.

INTRODUCTION

The increased importance of current agent technology to fight complexity (composite applications, interoperability of heterogeneous, and heavy agency networks) induces the reflection about the agency theory behind, the techniques and tools, the frameworks, the problem domains and associated tasks, the new challenges, and the requested experimentation to find new alleys. Today, belief-desire-intention (BDI) models may be combined with partially observable markov decision problems (POMDP), where the first ones are responsible for generating behaviours and the second ones adopted during the analysis phase, to support hybrid applications.

Among a variety of real applications with agents, learning environments (and intelligent tutoring systems, i.e., ITS) is an interesting field to innovate new ideas about models because agents need to be able to access one or multiple heterogeneous and distributed information sources; proactively searching for, mediating, and maintaining relevant information or services on behalf of its human users, or other agents, at anytime and anywhere. As a matter-of-fact, such environments are a kind of institution where we find social and organizational aspects of agency that require multiple agents with different personalities, and of course with authority and power skills. The choice of appropriate mental states, apart from the need for new ones (e.g., will), is mandatory for designing those proactive agents,
that is, those able to make direct interventions or be governed by norms. Also, the models may cover a palette with more sophisticated decision machinery to support, for example, team work and collaborative actions (Luck, McBurney, Shehory, & Wolmott, 2005).

Methodologies and tools are necessary for agent software engineering when hybrids are common, and the idea of mixing techniques becomes a way out to find efficient solutions to our difficulties. However, the key question now is about the type of (individual and multitudes) features an agent needs when it is immersed in a society. Each individual action may contribute to collective intervention, where cooperation is rather important to face the autonomy of networked data, and information and knowledge sources have the potential payoff of leveraging them by the appropriate use of diverse agents. These methodologies may cover the relationship between the modeler and the model, and help to build different descriptions (trade-off between complexity and abstraction). New tools to aid sensitivity analysis, calibration, and validation are helpful for understanding the behaviour of the models. In certain situations, the exploration of collections of models is an interesting option to feel some features of the problem domain and to make clear the selection of the most suitable model.

Currently, there are four competing approaches, BDI, distributed constraint optimization (DCOP), distributed partially observable markov decision problems (POMDP), and auctions and game theoretic (Tambe, Bowring, Jung, Kaminka, Maheswaran, Marecki, et al., 2005). The use of hybrids is quite common, for example, integrating BDI and POMDP, where BDI is chosen on account of monitoring and creating explanations and POMDP uses stochastic models for generating agent behaviours. In Tambe’s proposal to get a team plan, POMDP is used in analysis mode and BDI is used to generate agent behaviours. In point of fact, when practical multiagent applications scale-up to 100s or 1000s of agents, robots, or other entities, it becomes increasingly critical to provide analysis tools for such systems. For example, in domains as disaster rescue, such analysis will be important in order to specify how many agents (and of what type) are necessary to allocate to various roles in the team. These role allocations can have a drastic impact on the performance of the team and for larger teams; it will be difficult for human developers to even specify good allocation of roles within such teams. Integrating BDI and POMDP is a good choice for generating policies, role-taking and role-execution actions, and the goals are quite clear. The final aspect of team-oriented programming is assignment of agents to plans: assign the roles in the organization hierarchy to plans; assign agents to roles; and face the markov team decision problem for quantitative analysis of role allocation and reallocation.

More than 126 Conferences in 2005 and AAMAS05, with 29 workshops, is an impressive record that asserts an image of great power for Agents as a scientific and technological field (this figure decreased in 2006 and 2007). Critics put forward there is a lack of innovative ideas: filming individual agents in action and better techniques to capture the agent internal processes as they unfold inside the agent minds (motion-visualization technology) are two examples of missing items in the area of computer intrusion by enemy agents. However, when comparing Agents to other areas in AI, we observe differences in power and activity. For example, in IJCAI07: Agents (10,4%) vs. Reasoning(16,5%), the top one; in ECAI06: Agents (22,1%) vs. Knowledge Representation (34,1%); in IJCAI05: Agents (5,1%) vs. Machine Learning (22,2%); in ECAI04: Agents (9,4%) vs. Machine Learning (17,1%); in AAAI04: Agents (13,8%) vs. KR&R (17,3%); in IJCAI03: Agents (16,2%) vs. Reasoning (20,4%); or, in IJCAI01: MAS (13,7%) vs. KR&R (15,7%). Observing the hot themes of AAMAS’s, we get: Learning is the most important topic, followed by Embodied, Emotional, and Believable Agents; Argumentation and Dialog;