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Chapter VII

Extending Objects to Model Agents: A Collaborative Group Design Framework Using the Agent UML Extension

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Abstract

Incorporating the agent paradigm into geographic information science is one approach to modeling the complex interactions between natural and human systems. In the agent paradigm, systems are abstracted to a basic structural and functional form and programmed as agents that respond to changes in the environment, interact with other agents, have control over their behavior, achieve specific goals, and change their behavior using past experiences. As a result, the agent paradigm has created a growing need for standardized tools to support agent-based design, analysis, and documentation. Since the design, analysis, and documentation are dependent on input from many types of users and modelers, an emerging challenge is how to develop and document a consistent agent-based model. Based on the

similarities between agents and objects, this study examines the use of the Agent UML (AUML) extension to develop and document agent-based designs. A framework is proposed to use the AUML extension in a collaborative group process to support consensus agent designs.

Introduction

In recent times, there has been increasing interest within geographic information science to adopt the agent paradigm to model interactions between natural and human systems. A key justification for the adoption was that natural and human systems exhibited complex systems behavior at multiple scales (An, Linderman, Qi, Shortridge, & Liu, 2005; Parker, Manson, Janssen, Hoffmann, & Deadman, 2003). This meant that the local interactions and nonlinear dynamics features of the agent paradigm provided a more realistic characterization of system patterns and processes when compared with traditional equation modeling and experimental methods (Agar, 1999; Deadman, 1999). Agents are outcome-oriented computational entities that can operate independently and cooperate with other agents in dynamic and open environments (Luck, Ashri, & D'Inverno, 2004). Two recent reviews on agents in land-use and ecosystem applications called for focused research in agent-based model selection, validation and verification, and an expansion of its potential application areas (Bousquet & Le Page, 2004; Parker et al., 2003). However, this focused research agenda may lead to diffusion of efforts if common strategies for designing and documenting agent-based models are not easily available.

There are many approaches to design and document agent-based solutions. These approaches can be categorized as development process methods and diagramming notations (Luck et al., 2004). In the development process methods, well-defined steps are used to elicit the building blocks of the agent model. The diagramming notations are used to document and explore a system before implementation. A disadvantage of these approaches is that they are not standardized, although efforts towards achieving standardization are ongoing. Moreover, since agent-based modeling has its origins in artificial intelligence, human-human interactions to collectively design agents have not been given substantial consideration. For example, in environmental agent-based designs, a participatory approach is required in the problem-solving process (Downing, Moss, & Pahl-Wostl, 2001). In searching for standardized approaches to design and document agents, a promising avenue is to build layers of agent specifications on top of the already established suite of object-oriented development methods and diagramming notations (Luck et al., 2004).

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