Chapter XI

A Methodology for Modeling Expert Knowledge for Development of Agent-Based Systems

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ABSTRACT

For intelligent agents to become truly useful in real-world applications, it is necessary to identify, document, and integrate into them the human knowledge used to solve real-world problems. This article describes a methodology for modeling expert problem-solving knowledge that supports ontology import and development, teaching-based agent development, and agent-based problem solving. It provides practical guidance to subject matter experts on expressing how they solve problems using the task reduction paradigm. It identifies the concepts and features to be represented in an ontology; identifies tasks to be represented in a knowledge base; guides rule learning/refinement; supports natural language generation; and is easy to use. The methodology is applicable to a wide variety of domains and has been successfully used in the military domain. This research is part of a larger effort to develop an advanced approach to expert knowledge acquisition based on apprenticeship multi-strategy learning in a mixed-initiative framework.

INTRODUCTION

In order for multi-agent systems (MAS) to be truly useful in real-world applications and environments, it is necessary to identify, document, and integrate into the MAS the human knowledge people use to solve their real-world problems. This process has been found to be difficult and is a key part of the knowledge acquisition bottleneck.

This chapter presents a general methodology for collecting, modeling, and representing expert problem-solving knowledge for a given domain
A Methodology for Modeling Expert Knowledge

Other works (Mustafa, 1994; Schreiber et al., 2000; Tecuci, 1998) have included elements that describe the importance of knowledge acquisition, explain how knowledge engineers support the process, suggest ways knowledge can be represented, and provide examples. MAS-specific works (Hernandez, Gray, & Reilly, 2003; Maes, Tuyls, & Manderick, 2001) emphasize the importance of and describe methods for organizing or modeling MAS architecture. Neither of these groups of work, however, has concentrated on modeling expert problem-solving knowledge or providing specific methodologies for accomplishing it. This chapter documents a methodology for modeling expert problem-solving knowledge in support of agent development that can be used directly by an expert, knowledge engineers, or system designers for the design and implementation of MAS or individual agents.

BACKGROUND

A typical first step in the development of agent-based systems is modeling expert problem-solving processes and reasoning. Reasoning is the formulation of conclusions, judgments, or inferences from facts or premises. With respect to agent development, knowledge modeling is the conceptualization and representation of problem-solving knowledge in a knowledge base. It is potentially the most difficult aspect of developing knowledge-based systems. Knowledge conceptualization and representation are particularly difficult because the form in which experts express their knowledge is significantly different from how it should be represented in the knowledge base. Moreover, experts typically fail to specify the knowledge that is common sense or implicit in human communication but which needs to be explicitly represented in the knowledge base. After knowledge is conceptualized and represented, the representation must be verified for correctness and usefulness. This modeling