A Generic Internal State Paradigm for the Language Faculty of Agents for Task Delegation

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ABSTRACT

Language ability is an inevitable aspect of delegation in agents to provide for collaborative natural language interaction (CNLI) during task delegation. To cater to users of different languages, the CNLI is required to be multilingual. When multilingual CNLI has to be provided in a manner characteristic of agents, it leads to realizing two types of autonomies viz. behavior autonomy - to provide CNLI in every language and management autonomy for managing the multiple language competencies. Thereby, the language ability of an agent evolves into a language faculty which encompasses behavior and behavior management autonomies. The existing paradigms for the internal state of agents are only behavior-oriented and cannot accommodate the behavior and behavior management autonomies. In this paper, a new paradigm for the internal state of the language faculty of agents consisting of the belief, task and behavior (BTB) abstractions has been proposed, defined and illustrated.

Keywords: language faculty, BTB agent, multilingual agent, behavior autonomy, language ability management autonomy

INTRODUCTION

A software agent is one which acts on behalf of someone to carry out a particular task which has been delegated to it (Bradshaw, 1997). Delegation of a task to an agent is possible only if the agent possesses the expertise to perform the particular task in a manner required by the user. That is, the agent should be able to blend the task expertise with the knowledge of the user (Bradshaw, 1997). While delegating a task to an agent, the people have to interact with the agent for which the agents have to provide for a natural form of interaction (Norman, 1997). Thereby, to work on delegation the agent needs the following expertise:
• Task – to perform the delegated task
• User-modeling – to model user preferences and perform the task in a customized manner
• Language – to provide interaction in natural language

The language aspect of delegation unfolds into the following language abilities to support delegation effectively:

• Collaborative natural language interaction (CNLI) (Jurafsky & Martin, 2000; McTear, 2002)
• Dynamic multilingualism

The former is required to interact with the user in a more comprehensive manner to assist the user to carry out the requested task. This includes the ability to collaborate with the user to explicate an incomplete, ambiguous or erroneous request, providing alternative suggestions proactively. Dynamic multilingualism is required to enable the agent to cater its services to users of various languages. This is achieved by supporting multiple languages and dynamically configuring to the required language to provide its service.

Since the language faculty is realized as a combination of two different autonomies, its internal state and its dynamism cannot be captured by the internal state definitions of existing agents (Brooks 1986; Muller & Pischel, 1994; Muller, Pischel & Thiel 1994; Rao & Georgeff, 1991; Wooldridge, 2000, 1999) as their focus is only towards action/behavior and does not encompass the management aspect. The definition of the internal state should help to accommodate both the management context and the behavior contexts. In addition, it should enable the agent to be internally aware that it supports multiple languages so that dynamic multilingualism and knowledge discovery across languages is possible. This has also not been taken care of in the existing approaches of achieving multilingualism in agents (Connell, 2000; Huang, Haft & Hsu, 2000; Pazienza, Stellato, Henriksen, Paggio & Zanzotto, 2005; Ritter, Meier, Yang & Waibel, 1999; Ren & Shi, 2000; Turunen & Hakulinen, 2000; Ws2). Hence, a new paradigm consisting of the Belief, Task and Behavior (BTB) abstractions has been proposed. Each of these abstractions has been defined, and the dynamism with respect to these abstractions is also described. This paradigm is a generic paradigm as it is applicable to any agent which has to support multiple facets of a particular task. This generality is illustrated by applying the paradigm to two examples of multi-faceted task agents.

Thus, the objectives of this chapter are:

• Deriving the language ability requirements of task delegation and defining their characteristics
• Hypothesizing the language ability management autonomy for managing multiple languages
• Conceptualizing the language ability of an agent as a Language Faculty which is attributed with language ability management autonomy and language behavior autonomy
• Developing a new internal state paradigm for the Language Faculty based on the BTB abstractions and defining their semantics and dynamism
• Generalizing and applying the paradigm for a multi-faceted task agent

The remainder of the chapter is organized as follows. The second section, Identification of Language Ability Requirements of Task Delegation, describes the process of deriving and characterizing the language ability requirements of task delegation. The third section, Hypothesis of Language Faculty with Language Ability Management Autonomy, provides the hypothesis of the language ability management autonomy as a combination of four autonomies and proceeds to defining the language faculty. The existing works in the internal state definitions of agents and multilingualism in agents is outlined in the fourth section, Existing Works. The limitations in these works help to elicit the need for the proposed paradigm. The fifth
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