Modeling Cooperative Decision Support Systems with Hybrid Agents

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ABSTRACT

In this paper, the authors propose to use Multi-Agents Systems (MAS) to model Cooperative Decision Support Systems (DSS). These systems support the collaboration of two kinds of agents: the human agent (the decision-maker or the user) and the artificial agent (machine) to solve jointly a problem and make a decision. In this way, the authors take advantage of the capacities of both the decision-maker and the machine. The novelty of the proposed approach is the modeling of Cooperative DSS using agent technology by coupling two MAS, the first is reactive and the latter is cognitive or deliberative. The resulting system is designed to support operators, as decision-makers during contingencies. Using the system, the operators should be able to: gather information about the incident location, access databases related to the incident, activate predictive modeling programs, support analyses, and monitor the progress of the situation and action execution. A simple scenario is given, to illustrate the feasibility of the proposal.

Keywords: Cooperative DSS, Decision Support System (DSS), Hybrid MAS, Intelligent Agents, Multi-Agent System (MAS)

INTRODUCTION

Agile enterprises have been seeking to develop various information technology systems to assist with the information management of their business processes where many of the coming new business processes contain embedded Distributed Artificial Intelligence (DAI). The DAI, which is commonly implemented in the form of intelligent agents, offers considerable potential for the development of information systems and in particular Decision Support Systems (DSS). Widely range applications domains, in which agent solution is suggested, are being applied or investigated (Cheung, 2005). This is because intelligent agents have a high degree of self-determination capabilities, and they can decide for themselves when, where, and under what condition their action should be performed.

The aim of this research is to develop an agent-based system to enhance enterprise (decision making) agility. We apply the multi-agent system paradigm to decision support in a global contingency management. Hence, we examine the potential integration of agent technology into a Cooperative Intelligent Decision Support System (CI-DSS) that we have developed (Adla et al., 2007). The software agents’ integration provides an automated, cost-effective means for making decisions. Integrated in DSS, agents offer the potential to automate a far wider part of the overall problem solving task than was
possible with classical DSS or Intelligent DSS (Kebair, 2006; Filip, 2008). The agents in the system autonomously plan and pursue their actions and sub-goals, to cooperate, coordinate, and negotiate with others, and to respond flexibly and intelligently to dynamic and unpredictable situations. They are organized in a hybrid couple of MAS: reactive and deliberative.

The reactive MAS support the production of the different possible action plans to solve the problem at hand. These actions plans are then validated and checked by an observer agent external to reactive MAS. The observer agent collaborates with the decision-maker to choose the best plan to be introduced as input of cognitive MAS. This system considers the action plan as input and supports the man-machine collaboration to solve the decision problem.

In the sequel, the paper is organized as follows. In the next sections, a review of the relevant research streams is provided: it is devoted to a presentation of a historical and current view of DSS research and in a following section, the history and current status of software agents is discussed. After dealing with the integration issue of agents in DSS and their detailed roles in such a system, we present our multi-agent framework for Cooperative Intelligent Decision Support Systems and the coordination mechanism in the third section. The use of this framework promises to raise some DSS to a new level of capability whereby “what-if” systems are transformed into real-time, proactive systems. We also present an example of a scenario to illustrate the feasibility of our idea in a later section. In the final section, the conclusion summarizes the contributions of this work and outlines potential research opportunities in the realm of software agents, and DSS.

RELATED WORK

Decision Support Systems (DSS)

A DSS is an adaptive and evolving information system meant to implement several of the functions of a human support team that would otherwise be needed to help the decision-maker to overcome his/her limits and constraints he/she may face when approaching decision problems that count in the organization (Schneeweiss, 2003). Decision support systems (DSS are designed to actively interact with an individual decision maker in order to assist him to make better decisions based on information obtained (Keen, 1978; Sprague, 1982).

Incorporating knowledge-based methodology in DSS, allow these systems to aid the decision-making process through a set of recommendations reflecting domain expertise. They are able to provide services to users and they try to satisfy the user’s requirements through interaction, cooperation, and negotiation. They also offer tremendous potential in support of well-defined tasks such as data conversion, information filtering, and data mining, as well as supporting ill-structured tasks in dynamic cooperation. Some other advantages proposed by Marakas (2003) give those of using intelligent components with DSS as opposed to plain DSS as increased timeliness in making decisions, improved consistency in decisions, improved explanations and justifications for specific recommendations, improved management of uncertainty, and formalization of organizational knowledge. The usage of intelligent DSS improves the ability decision makers to better perform their duties.

However, despite their impressive functionalities and whatever the intelligence it integrates, DSS of all of types must focus on supporting, not replacing, a human decision maker for important decision tasks, as many of the problem situations faced by managers are unstructured in nature and require the use of reasoning and human judgment. As articulated by Lévine and Pomerol (1995): “The DSS and the decision maker form a united problem solver”. Solving decision problems requires calling intuition and know-how of the decision-maker which becomes the preponderant element of the coupled man-machine. The system must be able to play collaborator’s role with the decision-maker, that is, to know his intentions and the context of the decision problem, to be able to give an action coordinated with one of the decision-maker.
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