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Agent-based Decision Support System for Technology Recommendation

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Abstract

This paper presents an idea of a multi-agent decision support system. Agent-based technology allows for decentralized problem solving and creating complex decision support systems, mixing various processing techniques, such as simulation, reasoning and machine learning and allows for distributed knowledge. Our main contribution is an agent-based architecture for decision support systems which is an agent-based implementation of a labeled deductive system. Such approach allows to decompose an inference algorithm into separate modules and distribute knowledge base into parts. The system is tested on a domain of material choice support for casting.

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Keywords: agent-based expert system, inference and machine learning integration, logic of plausible reasoning

1 Introduction

Multi-agent systems are efficient architectures for decentralized problem solving [1]. Decision support systems may be very complex. Therefore such architectures are applied in such systems development [5, 6, 7, 8, 9]. An agent-based technology allows to mix various processing techniques, such as simulation, reasoning and machine learning and allows to distribute processing.

Our main contribution is an agent-based architecture for decision support systems. Our approach has a theoretical background: our system is an agent-based implementation of a labeled deductive system in which agents are used to decompose the system simultaneously in two orthogonal dimensions: knowledge distribution and processing. The first one allows to create a system, in which a knowledge base is divided into parts. In this way a decision support service may be provided without sharing the knowledge. The second dimensions allows to decompose an inference algorithm into separate modules.

This work is a continuation of [3, 4] in which we presented LPR Intelligent Information System (LIIS) with a centralized architecture. We have chosen the same knowledge representation

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and reasoning formalism: the Logic of Plausible Reasoning (LPR) [2] and applied an agent-based architecture. As a result, our implementation combines many knowledge manipulation techniques during reasoning in a decentralized way. It also allows to integrate the machine learning techniques in the reasoning algorithm. Execution of the learning algorithm is defined as a complex inference rule executed in an inference chain if the reasoning process is not able to continue classical reasoning. Training data consists of facts stored already in the knowledge base. The new knowledge may be used in the same inference chain to derive a decision.

In the following sections related research is discussed, the agent-based model of the system is presented. Next, LPR basics and the software are described. Results of experiments in a domain of technology recommendation for casting conclude the work.

2 Related research

The main point of using decision support systems (DSS)[7] is to provide a user with the possibility to consult with an automated system while making decisions. The DSS, as a rule, includes a set of procedures, starting from data determination and processing, and finishing by generation and evaluation of alternatives. Thus, a typical DSS can be logically divided and represented by three main modules or levels: the first one, responsible for data fusion and pre-processing, the second, dedicated to a necessary calculations (modeling, data mining, etc.) and the third, which executes simulation and manages a humancomputer interaction. Agent-based decision support system (ADSS) architecture presented in the cited paper was developed in accordance with the typical structure of a DSS. The system consists of three levels, the first is aimed for meta-data creation, the second is responsible for hidden knowledge discovering, and the third level provides a real-time decision. It is applied to support environmental health impact decisions.

In paper [6] a framework for building decision support systems using an agent-based technology is proposed to support organizations characterized by physically distributed, enterprise-wide, heterogeneous information systems. Intelligent agents have offered big potential in supporting well-defined tasks such as information filtering, data mining and data conversion. This paper proposes a taxonomy of agent characteristics that can be used to help to identify agents providing different types of decision tasks. Development of agent-based DSS is proposed as being a process of putting together a coordinated workflow of collaborating agents that is able to support a problem-solving process. Developing an agent-based DSS requires a new approach. Two-tier approach is proposed to designing an agent-based DSS. The first tier is in essence an assignment model that consists of searching, identifying and selecting the agent(s) that are most appropriate to accomplish required tasks. The second aims at devising a coordination and collaboration strategy for all the involved agents to work together (the last two phases of the lifecycle). This phase consists of finding decision support requirements and devising a detailed breakdown of all decision processes. Processes are sets of partially ordered steps intended to reach a particular goal. Process steps are the most primitive, atomic processes.

The aim of [9] is to prepare an expert system based on intelligent softbots and prepare and propose a portfolio of Information Systems (IS) that has the maximum alignment with the strategy plan. Attaining such an issue, an expert system, which emerges through the implementation of a credible methodology, is proposed. The fuzziness of such an expert system is embedded in its data supply agent which prepares necessary information through an environmental survey.

In paper [5] a multi-agent architecture is proposed for an electric arc furnace steel making processes. Adaptive neuro-fuzzy inference system is used to generate agents knowledge bases. Contract net protocol is used as negotiation protocol in the proposed multi-agent system. The