

The design of intelligent workflow monitoring with agent technology[☆]

Minhong Wang^{*}, Huaiqing Wang, Dongming Xu¹

Department of Information Systems, City University of Hong Kong, Hong Kong, China

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Abstract

In recent years, workflow technology has been widely used in business process management. With the increased complexity, uncertainty and risks in business operations, workflow monitoring is gaining growing attention in business process controlling and supervision. However, monitoring functions provided in traditional workflow systems lack flexibility, and provide little support for managing complex and dynamical changes in business process. In this paper, we propose a novel workflow monitoring approach, in which various intelligent agents work together to perform flexible monitoring tasks in an autonomous and collaborative way. By using customized monitoring plan and proactive monitoring process, the workflow monitoring activities can be executed flexibly and efficiently. The application of intelligent agents for such flexible, adaptive and collaborative workflow monitoring is investigated through an intelligent monitoring system in securities trading.

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1. Introduction

Workflow management is a promising technology aiming at the automation of business processes to improve the speed and efficiency of an organization. In recent years, workflow management systems (WfMS) have been widely used in business process controlling and monitoring. With the increased complexity, uncertainty and risk in business operations, there is an increased demand on flexible and dynamic workflow management [4]. Workflow monitoring, an important function in workflow management systems, has gained growing attention in business process management. The historical data of workflow instance execution provide a valuable source for active monitoring of the current state or performance of workflow instances.

However, monitoring functions provided in traditional workflow systems lack choices and flexibility to deliver

relevant information to appropriate persons. In Workflow Reference Model provided by the Workflow Management Coalition, standard monitoring APIs are defined to enable the analysis of automated business processes through the analysis of the logged audit trail data [25]. However, such API supports monitoring solutions limited to a few built-in options and process-relevant events, and there are some problems such as information overloaded or information not delivered exactly to the user who need it [1].

In this paper, we propose a flexible workflow monitoring approach, in which a society of intelligent agents work autonomously and collaboratively to perform monitoring tasks. Agent technology with its properties of autonomy, reactivity, and pro-activity provides an extension and alternative to business process management. By the aid of intelligent agents, our system can execute customized monitoring tasks for different users based on their individual monitoring requests. Furthermore, with the proactive property of intelligent agents, the monitoring process can be adjusted based on the information generated during monitoring activities. By using customized monitoring plan and proactive monitoring process, the workflow monitoring activities can be executed flexibly and efficiently. The application of intelligent agents for such flexible and adaptive workflow monitoring is investigated through an intelligent monitoring system in securities trading.

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^{*} Corresponding author. Tel.: +852 2788 9962; fax: +852 2788 8535.

E-mail address: magwang@cityu.edu.hk (M. Wang).

¹ Present address: UQ Business School, University of Queensland, Australia.

The remainder of the paper is organized as follows. Section 2 briefly reviews the relevant literatures in workflow management, intelligent agents, and other related fields. Section 3 illustrates our intelligent monitoring approach that consists in customized monitoring plan and proactive monitoring process. Based on this approach, an example of intelligent monitoring system for securities trading is elaborated in Section 4. In this section, possible errors occurring in securities trading are discussed; a multi-agent framework for monitoring of securities trading is proposed, as well as the agent hierarchy with their communication and collaboration in monitoring activities. Finally, Section 5 concludes with some advantages and limitations of our agents supported workflow monitoring approach.

2. Background

2.1. Workflow management and workflow monitoring

A workflow management system (WfMS) is the software that automates the co-ordination and control of tasks during business process execution. The workflow approach helps to separate the business logic represented by business process from the underlying information systems that support the process. This separation allows business processes to be designed without requiring major changes to be made to the underlying computing infrastructure [12]. Nowadays, workflow management has become a promising technology aiming at the automation of business processes to improve the speed and efficiency of an organization. The success of workflow paradigm is based on its ability to support modeling, simulation, automated execution, and monitoring of processes in an environment that is distributed, heterogeneous, and only partially automated. While workflow technology has seen an explosion of interest and advances in recent years, numerous technical challenges have been addressed to provide flexible workflow management systems required by complex and dynamic application domains [4].

Workflow management systems enable the exact and timely analysis of automated business processes through the analysis of the logged audit trail data [1]. Active monitoring of the current state of workflow instances can serve numerous purposes, such as the generation of exception reports for overdue work items or early warning reports for potential workflow problems. Passive monitoring upon request can deliver status information about running workflow instances, e.g. for answering a customer inquiry about the status of an order. In Workflow Reference Model, a standardized set of interfaces and data interchange formats is provided to achieve interoperability between workflow products. As outlined in Fig. 1, standard monitoring APIs are supported via Interface 5, which specifies the elementary information a workflow management system should record about the execution of workflow instances [25]. Though the detail of this interface is for further study, it is feasible for

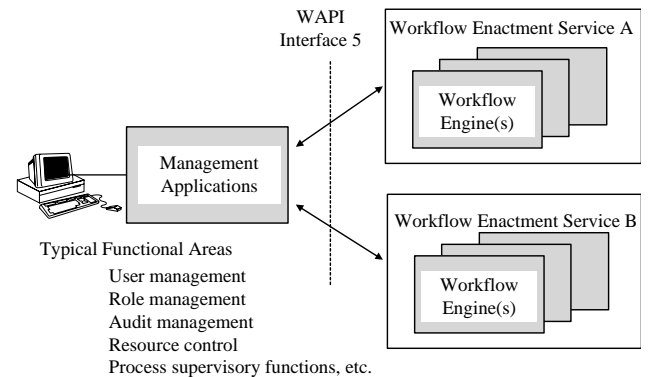


Fig. 1. Interface 5 in the workflow reference model.

the management application to take on some management functions, such as user management, role management, resource control, audit management, process supervision, and so on. The process supervision may contain opening/closing a process or activity instances query, setting optional filter criteria, fetching details of process instances or activity instances, changing the state of process or activity instances, termination of process instances, etc. However, such API supports monitoring solutions limited to a few built-in options and process-relevant events, and there are some problems such as information overloaded or information not delivered exactly to the user who needs it [1].

2.2. Intelligent agents in workflow management

In recent years, the concept of agent has become increasingly important in both artificial intelligence and computer science. The term of intelligent agent is used to denote a software-based computer system that enjoys the following properties: (a) autonomy (agents operate without the direct intervention of humans); (b) social ability (agents communicate with other agents); (c) reactivity (agents perceive their environment and respond in a timely fashion to changes that occur in it); (d) pro-activity (agents do not simply act in response to their environment, they are able to exhibit goal-directed behavior by taking the initiative) [23,24]. A generic agent has a set of goals (intentions), certain capabilities to perform actions, and some knowledge (or beliefs) about its environment. To achieve its goals, an agent needs to use its knowledge to reason about its environment (as well as behaviors of other agents), to generate plans and to execute these plans. A multi-agent system consists of a group of agents, interacting with one another to collectively achieve their goals. By drawing on other agents' knowledge and capabilities, agents can overcome their inherent bounds of intelligence.

Traditional workflow systems have certain limitations such as relying on central control, lack of reactivity, semantics, resource management and interoperation. Intelligent agent technology is among the ones that can benefit the workflow technology [9,12,26]. Agent-based workflow

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