Applying Agent-Based Technology to University Knowledge Management

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Abstract

A university knowledge management system is composed by three components: the educational management, the research management, and the institutional management. The high complexity of the whole university knowledge management system, that is also a distributed system, can be handled by using a multi-agent system. Through communication and cooperation the agents are solving different problems specific to knowledge management in a real or virtual university. The agents are associated to the humans involved in all processes (e.g. educational, research, institutional) that are running in a university, such as professors, assistants, students, researchers, technical staff, management staff, administrative staff etc. The paper presents an university knowledge management system based on agents technology. Two case studies are described in detail, one for the university research management, and the other for the educational management. The implementation of the agent-based system was done in ZEUS, a toolkit for multi-agent systems development.

Keywords: University knowledge management, Multi-agent systems

1 Introduction

Knowledge management (KM) became an important research area in the last decade, with applications in most of the domains (e.g. industrial, governmental, medical, economical, educational) [1], [7], [9]. It deals with knowledge and collaboration management in a specific organization. The purpose of KM is the management of activities related to knowledge creation, preservation, distribution and also, the management of the collaboration between people [8]. A strategic domain that uses and provides knowledge is the educational domain [3], [4]. In this paper, we focus on the higher education domain, and we propose an agent-based model for the university knowledge management system. Other agent-based solutions that can be adopted for the management of some university activities are presented in [2] and [6].

The university knowledge management system, that is a distributed system, can be modeled as a multi-agent system, associating agents to all humans involved in the
processes that run in the university (educational, research, institutional etc). Thus, we
have personal agents for professors, assistants, students, researchers, technical staff,
management staff, administrative staff. The paper presents an university knowledge
management system based on agents technology. The implementation of the agent-based
system was done in ZEUS, a toolkit for multi-agent systems development. Two case
studies are described in detail, one for the university research management, and the other
for the educational management.

2 University knowledge management

Knowledge management provides a systematic and holistic approach for the
improvement of knowledge handling at all levels of an organization in order to fulfill the
organization’s business goal. In the particular case of a university, knowledge
management refers to the three main activities: teaching, research, and university
(institutional) management. Figure 1 presents the organizational structure of a university.
The basic organizational units of a university are the department and the faculty.

![Diagram of University Structure]

*Figure 1. The organizational structure of a university*

Usually, a university is composed by a number of faculties, and some independent
departments (e.g. administrative, distance learning, pedagogical training, research), and
has students and employees (teaching / research staff, technical / administrative staff etc).
A faculty is composed by a number of departments, and a number of specializations for
students (undergraduate, postgraduate, master, PhD), has students enrolled in different
study programmes, and has a secretariat and a management team. Each department has
teaching, research and technical staff, plus a secretariat, and a head of department, and is
directly involved in the teaching and research activities. Each administrative department
(e.g. accounting, personnel) has administrative staff (e.g. accountants, personnel staff),
and is directly involved only in the institutional processes.

The management of a university is provided by a university management team that is
composed by a rector, a number of vice-rectors, and a scientific secretary. Each faculty
has a faculty management team composed by a dean, a number of vice-deans and a
scientific secretary.
Figure 2 shows the modular structure of the University KM system.

The teaching knowledge management module is dealing with all the didactical activities done in the university (e.g. teaching courses, training in laboratories, student’s examinations, and so on) for different forms of study programmes. Related to the didactical activities there are some auxiliary tasks such as admission exams (in July and September), student’s enrollment (in September), university courses and laboratories scheduling (at the beginning of each semester). The teaching knowledge sources are specific to each study programme. Examples of teaching knowledge sources and products are hard copy and electronic courses and laboratories materials, manuals, textbooks, software tools, computer networks.

The research knowledge management module is dealing with all the research activities done in the academic departments or in the independent research departments (research centers, research laboratories). The research activities are done under national and international research projects. Examples of knowledge sources and products are research papers, research reports, Master and PhD theses, computer software, inventions (e.g. new devices).

The institutional knowledge management module is dealing with all the activities done for the good functioning of the university so that its main goal is reached, i.e. a high quality educational system based on training and research, according to the current needs on the national and international employment markets. Some institutional activities are the management of all faculties and departments (i.e. including students, and all university personnel), university budget planning, management of projects for the university development (e.g. university infrastructure development projects). Examples of institutional knowledge sources and products are the university charta, university management quality guide, different university management guides and methodologies, laws and norms.
3 An agent-based system for university knowledge management

Starting from the considerations made in section 2, we have designed the generic architecture of a multi-agent system for university knowledge management, UnivKM, that is shown in Figure 3.

UnivKM multi-agent system is organized modular and hierarchically, and is composed by agent-based modules (i.e. multi-agent systems – MAS, of less complexity) corresponding to the university management team, to each faculty and to each department. The agents (i.e. personal agents) are corresponding to students, professors, assistants, researchers, technical staff, administrative staff, and management staff. Each MAS module (university management, faculty and department) has a manager agent of it (corresponding to rector, dean, head of department, chief accountant etc), and the agents...
that collaborates between them and with the manager agent for university specific activities. The system UnivKM can be viewed in different ways depending on the activities that are followed, teaching, research, and institutional. Thus, particular architectures, specific to different applications, can be generated.

4 Case studies
We have implemented the agent-based university knowledge management system for two applications of university research management, and educational management. The development of the UnivKM multi-agent system was done in Zeus, a Java-based toolkit for intelligent agents.

4.1 University research management
The first application consists in the analysis of the university research activity quantified in the production of articles published in ISI journals, and the participation in national and international research projects. All the required information are collected by agents from databases with data about the research activity done by the teaching and research staff of each academic department. Figure 4 presents the architecture of the multi-agent system UnivKM specific to this first application.

![Figure 4. Specific architecture of UnivKM multi-agent system for university research management application](image)
Each person involved in this application has a personal agent. The involved persons are the persons responsible with research at the university level, at each faculty level, and at each department level. In our case study we have considered the Faculty of Science and Letters from the University Petroleum-Gas of Ploiesti, and two departments from this faculty, Department of Mathematics and Department of Informatics.

The University_resp agent initializes the agents’ communication asking the Faculty_resp agent to provide the faculty research report for a certain academic year (selected from the interface). To achieve this goal, the Faculty_resp agent asks the needed information furthermore to the Mathematics and Informatics departments. The two research responsibles from these departments extract the information from a MySQL database, where all the needed data are stored from the academic year 1990-1991. Once extracted from the database, the information are presented in a special report to the department responsible, and furthermore to the faculty responsible, which centralize them, and send the final report to the university responsible for analysis of the university research activity. The ontology of the multi-agent system includes terms specific to this application (e.g. ISI_article, International_project, National_project, Informatics_research, Mathematics_research), that are used by the agents during communication. Figure 5 shows the interface of the system during a run for the academic year 2008-2009.

Figure 5. System interface during a run
Figure 6 presents a screenshot of the UnivKM multi-agent system run, with the DOS windows, corresponding to each task agent. Figure 7 presents the agents society for this application.

Figure 6. Screenshot of the UnivKM multi-agent system run

Figure 7. The agents society for UnivKM multi-agent system run
Figure 8 presents the Zeus task graph for the application.

4.2 Educational management
The second application consists in an agent-assisted students examination for online examinations that provides the test score by taking into account the number of the correct answers given by the student and the total duration of the test answering. As a case study we have considered an agent-based system that simulates an Object Oriented Programming test taken by a student and revised by the teacher. Figure 9 shows the specific architecture of UnivKM for the educational management application.
Once the student starts the application, he will be explained the test’ rules and the conditions in which the examination will take place. The 10 multiple choice questions test window appears after pressing a button. This event will trigger the timer which will be stopped only when the test is ready. The test finish is confirmed by pressing the Submit button. The responses will be sent to the TeacherAgent for revision and the test’ results are displayed in the Test Results window.

Figure 10 presents a screenshot of the system run.

![Screenshot of the UnivKM multi-agent system run for the educational management application](image)

*Figure 10. Screenshot of the UnivKM multi-agent system run for the educational management application*

Figure 11 and 12 show the user interface of the test system, and the Object Oriented Programming test.
Figure 11. User interface of the test system

Figure 12. The Object Oriented Programming test
5 Conclusion
The paper presented a generic architecture of an agent-based system for knowledge management in a university. Also, we have described two experimental systems developed for an application from the university research management (research activity analysis), and for an application from the educational management (online students examination). For simplicity, we have developed a specific ontology for each application. Another solution would be to use the general university management ontology presented in [5] and to add the application specific terms.

Intelligent agents can improve the benefits obtained in the implementation of an university agent-based knowledge management system, due to their characteristics of autonomy, flexibility, pro-activity and sociality [10], [11]. The collaboration and implicit, the communication involved in a knowledge management system can be modeled in a natural way in multi-agent knowledge management systems.

REFERENCES