The University Library Information System Adaptability in an Intelligent Based University Environment

Vanco Cabukovski[1], Riste Temjanovski[2] and Roman Golubovski[1]

[1] Faculty of Natural Sciences and Mathematics, Ss Cyril and Methodius University, Skopje, Macedonia

[2] Faculty of Economics, "Goce Delcev" University, Stip, Macedonia

e-mail cabukv@hotmail.com, riste.temjanovski@gmail.com, roman.golubovski@t.mk

Abstract: Agent-based (intelligent) systems technology has generated lots of excitement in recent years because of its promise as a new paradigm for conceptualizing, designing and implementing software systems. Multi-agent systems are designed as a collection of interacting autonomous agents, each having their own capacities and goals that are situated to a common environment. An information system is very important part of the contemporary university. Adaptation as a new trend in the modern e-Learning concepts aimed to produce more effective learning curve by tailoring a course's curriculum to individuals' specific preferences. In this paper, presented is an AeLS (Adaptive e-Learning System) successfully implemented as an advancement from the previous agent-based eLS IABUIS (Integrated Intelligent Agent Based University Information System). The main point of interest would be an ULIS (University Library Information System) adaptability as a part of AeLS.

Keywords: Intelligent University Information System; Library Information System; Adaptive e-Learning System

1. INTRODUCTION

A model of an Integrated Intelligent (Agent-Based) Univesity Information System - IABUIS with an embedded multi-agent infrastructure has been developed at the Faculty of Natural Sciences and Mathematics with the University Ss. Cyril and Methodius. It is designed to control University's administration and education system. Many procedures related with educational and non-educational programs in a university environment are supported by the outcomes of this project. With the very first steps in development of this system one could be introduced in [12]. The IABUIS main structure was described in [7], [8] and [9]. It is an integrated intelligent e-university environment in a provision of multi-agent infrastructure, agent-based e-learning concepts, technology and digital content unification, digital library's standardization and information management integration. Some of these aspects are discussed in [1], [11], [16], [17].

Adaptation is the new trend in the modern e-Learning concepts (Adaptive e-Learning System - AeLS) aimed to produce more effective learning curve by tailoring a course's curriculum to individuals' specific preferences. These individual student preferences are evaluated by the AeLS in an automated manner, by following student's activities in the formal e-Learning system (lecturing material) and in complementary informal Content Management System (CMS) containing carefully gathered supplement material (multimedia supplements). An AeLS is able to keep track of usage and to accommodate content automatically for each of the users, for the best learning result, which in turn is supported by a student model built from student's goals, preferences, and knowledge. Per (Brusilovsky 1999), (Brusilovski, 2001) and (Brusilovsky & Peylo 2003) the student model is used to adapt the interaction mode of the e-Learning system according to the user's needs. The AeLS is based on adaptive selection of alternative supplements of course material. A methodology for development of additional low-budget digital content as an additional alternative fragments of course material for adaptive selection and composing of the course to individual users in accordance with their knowledge and behavior is given in [10].

In this paper, presented is an AeLS successfully implemented as an advancement from the previous agent-based eLS IABUIS (Integrated Intelligent Agent Based University Information System). The main point of interest would be an ULIS (University Library Information Sysetm) adaptability as a part of AeLS which attempts to propagate faster individual learning curves by employing agent-based system consisted of agent-based algorithms for adaptive interaction with the consumers (students), and adaptive content/course selection and delivery of appropriate material (supplements) intended for improved knowledge acquisition, thus better learning results - subject of official examination.

An AeLS ULIS adaptability is developed based on adaptive selection of alternative (fragments of) course material developed as low-budget content with a main goal alternatively to give the students additional material in order successfully to gain and implement the knowledge as well the automatically proposing the literature from the ULIS.

2. THE IABUIS MULTI-AGENT MODEL

The model of IABUIS includes four processes: student administrative information management, library information management, e-learning information management and university administrative information management process. In Fig. 1, the communication of these processes with the "external world" is given.
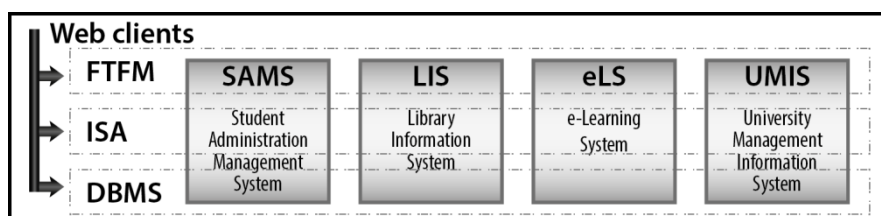

Figure 1. Communication of the IABUIS processes with the "external world"

Special web-based segments serve the connection with the IABUIS elements: the free text, files and multimedia management system (FTFM); the data base management system (DBMS) and the independent software applications (ISA).

The FTFM management system is consisting of portals, www pages, questionnaires, forms, output reports, images, servers (like e-mail and ftp), etc. The DBMS is consisting of databases, advanced indexing and retrieval database engines (ORACLE and MySQL). The third segment (ISA) contains different software applications developed for special purposes, like accounting, warehousing, books and education material circulation, e-learning management systems, etc.

The Student Administration Management System (SAMS) keeps track of the students educational records. The Library Information System (LIS) is developed in ORACLE. It is UNICODE based and it is supporting the MARC format and the dialects UNIMARC and MARC21. This module would be described in a next section. The e-Learning System (eLS) is based on ORACLE iLearning and SAKAI management systems providing complete infrastructure to manage, deliver, and track learning in both online and classroom based environments. The University Management Information System (UMIS) is designed to enhance the efficiency of the administrative and managerial aspects of the institution.

3. THE UNIVERSITY LIBRARY INFORMATION SYSTEM (ULIS)

Globalization is a very real phenomenon that is transforming information services and the library systems into e-library, digital library and semantic digital library according to the evolution of information technology. The library information systems in present day have rapidly evolved into the digital library aiming to realize integration and interoperability of information resources under distributed computing environment based on the Internet and computer networks. Since the main business objects of the library are knowledge resources, the library information systems are heavily influenced by means of the evolution of information. On the proliferation of electronic resources such as audio, images, videos and texts, electronic library (e-Library) has been appeared to manage electronic resources effectively [13].

The University Library Information System (ULIS) which is part of IABUIS is standardized library information system, intended to catalogue, update, search, borrow book and non-book materials (artwork, audio recordings, video recordings, cartography, educational materials, etc.) in academic, school, popular and public libraries, archives, museums, film archives, etc. This complex information system, can also perform automation of daily operations as well as documents archives of ministries, government offices and public enterprises who need a modern and powerful UNICODE based (multilingual) library system compatible with the standard MARC [1] and its dialects UNIMARC, MARC21 and others. ULIS is based on ORACLE database engine, fully protected and secure system with the possibility of networking and web access to the data.

Despite the full compatibility with other library systems based on the MARC standard - an internationally accepted standard for bibliographic / catalog processing of library material, ULIS offers and the following:

---

[1] https://www.loc.gov/marc/ [17.03.2016]

- Multilanguage based on UNICODE standard text-editor;
- Automation of procurement of new library materials (requests for procurement, seeking approval, approval of procurement, order procurement acceptance, financial records);
- Automated Cataloging (monographs, serials, non-book materials, articles, books, educational materials), signing, enumeration and recording, inventory and book of records, indexing, annotation, the main catalog card, analytical catalog card UDC catalogs ABCDE catalogs, bibliographies;
- Automation of the circulation of library materials (lending, return, reservation loss, withdrawal of damaged samples, interlibrary loans, financial records);
- Automatic control and review the state of the library;
- Automatic generating of periodic reports and statistical surveys;
- Basic and advanced searching supported by the Z39.50 / ISO 23950 ;
- Classification by UDC, DEWEY and other world classification schemes;
- Full web access to library materials.
- Import / Export of UNIMARC records in ISO 2709.
- Import / Export of records in MARC and other internationally accepted standards.

The web and its associated technical standards continue to dominate, although within a framework of much more use of mobile devices, data protection take primarily place in system's platform. ULIS covers such limited access to the data protecting their integrity in all domains and sources to access. In the next time, ULIS will be moving towards cloud computing technology and taking advantages of cloud based services especially in building digital libraries, social networking and communication. The use of cloud based library management systems has increased drastically since the rise of cloud technology started [14], [15].

4. THE ULIS ADAPTABILITY AND THE AGENTS COOPERATION

The eLS had successfully been upgraded from a classic e-Learning System to an Adaptive eLS (AeLS) by employing the multi-agent environment of the IABUIS aiming to improve the educational process.

The system presented is based on adaptive selection of alternative supplements of course material. This AeLS is successfully implemented at the Faculty of Natural Sciences and Mathematics with the University Ss. Cyril and Methodius, as an advancement from the previous agent-based eLS IABUIS. The general idea behind this concept is to provide the students with supplemental material in support to steeper learning curves, submitted to the AeLS via the CMS, and approved by the lecturers. The CMS is constantly monitoring through SAMS the overall progress of all students with their semestral courses and updates the supplements ranking list accordingly. Students are also evaluated periodically through test examination and ranked accordingly. Adaptation is then implemented with an algorithm which basically suggests higher ranked supplements set to lower ranking students, and more relaxed content to higher ranking students.

In addition to the 'informal' multimedia supplements, the AeLS implemented within the IABUIS had recently been integrated through its CMS with the ULIS - the library being the source of adequate and recommended text books and related scientific journals/articles. This new quality required structural and functional rearrangement of the multi-agent driving the follow-up of both - the individual students progress (based on SAMS data) as

well as the appropriateness of the suggested learning material by the AeLS (within the eLS). The logical integration of the CMS and the ULIS is organized through a complex DBMS based repository consisted of the relevant portions of the both, and suitable software is developed to interface them to the users and agents/applications.

By integrating ULIS with the IABUIS the AeLS is able to implement its proven agent strategies facilitating the required adaptation of the learning material, consisted of both the more formal text books and the less formal low-budget supplements.

The multi-agent environment (MMAS - MATHEIS Multi-Agent System) is based on a former eLS called MATHEIS (MATHematical Electronic Interactive System) - an educational system for learning mathematics and informatics for pupils and students [5], [6], [12]. This system had been successfully integrated into ORACLE iLearning management system at the Faculty of Natural Sciences and Mathematics in Skopje and extended into SAKAI e-learning environment. The MMAS component structure is given in Fig. 2.
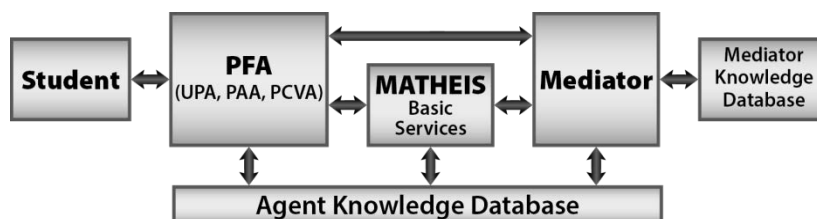

Figure 2. *The agent-based structure of MATHEIS*

The functional structure of MMAS is consisted of four conceptual subsystems: The User Agents Community; the Level Maintenance Subsystem; the Supervisory Subsystem and the Fuzzy Expert Subsystem. Detailed description of the structure of MMAS as well as relations between agents in MMAS is given in (Cabukovski 2010a).

The system is able to adaptively assist into filtering of the educational ULIS material according to the UPA (User Profile Agent) and student's activities in the communication with MATHEIS basic services recorded by the PAA (Personalized Activity Agent). The Personalized Content Viewing Agent (PCVA) is responsible for the adaptive interaction and adaptive content/course delivery – this enhances the usability of material and thus make the e-Learning system more effective, which improves the students' acquisition of knowledge and lead to better learning results.

The Mediator is responsible for the student learning model, database of the student's grades, degree levels, preferences, abilities, aptitudes, etc. This agent communicates with the Mediator knowledge database.

This adaptive aspect of the eLS (AeLS) is implemented by the PFA agent subsystem which follows the student's activities. It is responsible for the adaptive selection and display of the content (of both supplements and text books/articles) and adaptive interaction. The PFA is trained for each student to make the right content selection appropriate to the student's abilities and aptitudes.

The fundamental task of the PFA agent is to continuously evaluate both, the individual knowledge level of each student as (s)he advances through the course's curricula on one hand, as well as the "most appropriate" supplement material that had proved to be most

helpful for that particular student level, on the other hand. So basically, parallel ranking lists of students (by level) and ULIS supplements (by significance) are maintained and used for matching against each other, in direct support of the adaptation process itself.

The ULIS just like any other DBMS software archives every single action within its working domain in detailed log files containing: the action itself (upload, download, approved, etc.); the user who performed it (student, lecturer); the content (supplement, book, article) affected; timestamp of the action, etc. These detailed logs allow for the PFA to keep track of what content had been downloaded by which student within a certain course. PFA can also use the SAMS system to keep track of which students had passed certain exams and with what grades. By combining these DB entries with the ULIS logs the PFA can easily calculate a precise contribution of every single supplement to students' success of its corresponding course. Calculated contribution of all pieces of content belonging to same course allows the PFA to build and maintain a content's list ranking highest those that contribute most, i.e. downloads that helped most students to pass examination and/or with highest grades. The rank lists for all courses are updated on semestral basis - after the semestral exams. Adaptation is then implemented with an algorithm which basically suggests higher ranked supplements set to lower ranking students, and more relaxed content to higher ranking students.

The PFA agent follows all student's activities and among other things performs the adaptive selection of supplements to suggest to individual students for particular course. In order to be able to adapt supplements' curricula to the student, the PFA has to evaluate student's skill level periodically by test examination. The nature of the level estimation process logically requires a fuzzy approach, which is the job of the Fuzzy Expert System.

5. CONCLUSION

An Integrated Intelligent (Agent-Based) University Information System (IABUIS) consisted of the default administrative modules (among which the student SAMS) as well as of the formal e-Learning System (eLS) is upgraded with an adaptation functionality in support to steeper student learning curves. The novel integrated system can be considered as an Adaptive e-Learning System (AeLS). And it utilizes the rich and comprehensive University Library Information System (ULIS).

ULIS is used as knowledgebase supporting the AeLS in providing tailored content (books, journals, proceedings, and related material) to the students. The core of the AeLS is an existing agent-based interactive context (MMAS) which defines additional roles to the Expert Agent to perform: ranking of the available supplements and librabry content within a certain course by determining their individual impact (and thus usefulness).

All the fuzzy processing and inference is performed by the PFA module and already shows positive results and acceptance by the student community. Further advancement is being worked on and expected as improvement in the adaptation algorithm, as well as in the fuzzy reasoning for the suggestions inference.

REFERENCES

[1] Bordini, RH, Dastani, M, & Dix, J 2005, *Multi-Agent Programming Languages. Platform and Applications*, Springer, Berlin.
[2] Brusilovsky, P 1999, "Adaptive hypermedia: from intelligent tutoring systems to web-

based education", *Künstliche Intelligenz*, No. 4, pp 19-25.

[3]   Brusilovsky, P 2001, "Adaptive hypermedia"*, User Modeling and User Adapted Interaction*, Vol. 11, No. 1/2, pp 87-110.

[4]   Brusilovsky, P, & Peylo, C 2003, "Adaptive and intelligent web-based educational systems", *International Journal of Artificial Intelligence in Education*, No. 13, pp 156-169.

[5]   Cabukovski, V, & Davcev, D 1998, "MATHEIS (MATHematical Electronic Interactive System): An Agent-Based Distance Educational System for Learning Mathematics", *Proceedings International Conference on the Teaching of Mathematics*, John Wiley & Sons, Inc. Publishers, pp 59-61.

[6]   Cabukovski, V 2006, "An Agent-Based Testing Subsystem in an E-Learning Environment"*, Proceedings of the 2006 IEEE/WIC/ACM international conference on Web Intelligence and Intelligent Agent Technology (WI-IATW'06)*, IEEE Computer Society, pp 622-625.

[7]   Cabukovski, V 2010a, "An Intelligent eLearning Environment as a Part of an Integrated University Information System"*, Proceedings of the 9th European Conference on eLearning, Academic Publishing Limited*, Vol. 1, pp 90-95.

[8]   Cabukovski, V 2010b, "Integrated Agent-Based University Information System", *Proceedings of The Second International Conference on Mobile, Hybrid, and On-Line Learning eL&mL 2010,* IEEE Computer Society, pp 36-40.

[9]   Cabukovski, V 2011, "IABUIS – An Intelligent Agent-Based University Information System", Lecture Notes in Information technology, Information Engineering Research Institute, USA, Vol. 3-4, pp 13-19.

[10]   Cabukovski, V, & Tusevski, V 2015, "An Additional Content Development Methodology in an Adaptive Agent Based e-Learning Environment", *Proceedings of the European Conference on e-Learning ICEL 2015*, ed C Watson, Academic Conferences and Publishing International Limited, pp 58-65.

[11]   Dahanayake, A & Gerhardt, W 2003, *Web-Enabled Systems Integration: Practices and Challenges*. Idea Group Publishing.

[12]   Davcev, D, & Cabukovski, V 1998, "Agent-based University Intranet and Information System as a Basis for Distance Education and Open Learning", *Proceedings of 1st UICEE Annual Conference on Engineering Education – Globalization of Engineering Education*, eds LePP Darvall & JZ Pudlowski, UNESCO International Centre for Engineering Education (UICEE), pp 253-257.

[13]   Hee-Kyung Moon, Ju-Ri Kim, Sung-Kook Han, Jin-Tak Choi, 2014 "A Reference Model of Smart Library", *Advanced Science and Technology Letters*, vol. 63, pp 81.

[14]   Kaushik, A & Kumar, A 2013, "Application of cloud computing in libraries", *International Journal of Information Dissemination and Technology*, 3(4), pp 270-273.

[15]   Sangeeta Dhamdhere, Ramdas Lihitkar 2013, "Information common and emerging cloud library technologies", *International Journal of Library and Information Science*, 5(10), pp 410-416.

[16]   Shute, V, & Towle, B 2003, "Adaptive e-learning"*, Educational Psychologist*, Vol. 38, No. 2, pp 105-114.

[17]   Woolridge, M 2002, *Introduction to Multiagent Systems*. John Wiley & Sons, Inc.