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Expert System based Online Assessment System

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ABSTRACT
Open and Distance Leaning (ODL) is a rapidly increasing area of education system in the world today. Since the number of students in this system is growing year by year, the traditional paper based system to assess the student's knowledge is going difficult and also it is a time consuming and costlier process. This paper introduces an architectural framework of a web based Expert System for Online Assessment (ESOA) of student. Since various types of learner's are available in the ODL system, ESOA will consider all the factors and constraints while conducting the assessment process. The proposed system will be designed using JESS (Java Expert System Shell). The proposed system can be deployed in J2EE (Java 2 Enterprise Edition) environment using MVC (Model View Controller) paradigm. The system will integrate an external relational database to store question dataset and academic/performance history of the students. The rule base of the system is designed in the form of XML file. The proposed system will be designed for assessment purpose of students, where the questions for each student will be different according to their academic history and earlier performances and then give assessment result. Besides, the system is designed in such a way that it can handle online examination and evaluation process also if necessary. There is a unique technical contribution in this proposed expert system, which is dynamic knowledge management, i.e. administrative users will be able to change the facts and rules of the ESOA with the help of interactive web-interfaces.

Keywords
web based expert system, JESS, online assessment, J2EE, MVC, JSP, Java, JavaBean.

1. INTRODUCTION
The topic of online assessment and measurement is timely and important in terms of discussing continuous improvement in quality of learning, as various institutions grapple with how best to implement the assessment processes for online learning (Drummond, 2003; Mason, 1998; Sun, 2002). Every assessment, regardless of its purpose, rests on three pillars: a model of how students represent knowledge and develop competence in the subject domain, tasks or situations that allow one to observe students' performance, and an interpretation method for drawing inferences from the performance evidence thus obtained. (National Research Council, 2001, p. 2) [1].

The paper "Evaluation of Online Assessment: The Role of Feedback in Learner-Centered e-Learning", presents the evaluation of an online test based on a case study of an e-Commerce course offered by the Computation Department, University of Manchester Institute of Science and Technology (UMIST). The main aim of the online test is to provide 'rich' feedback to students, which is one of the requirements of the learner-centered learning paradigm. The online test, in the form of multiple choice questions, provides feedback through automatic grading, providing correct answers and referring the students to the learning content which explains the correct answers. [2]

In the research paper "A Bloom's Online Assessment Test (BOAT) to assess student learning outcome in a distance engineering education course", the author proposes an assessment test called Bloom's Online Assessment Test (BOAT) for a distance education course on the basis of Cognitive learning based on Blooms Taxonomy. By using Bloom's Online Assessment Test (BOAT) proposed in the paper, educators can assess students on multiple learning outcomes that are aligned to different objectives of their course as they seemed fit. [3]

The paper "Intelligent Online Assessment Methodology" presents the system architecture for applying intelligent methodologies to online assessment that adapts to the examinee's ability level. [4]

In the paper "Knowledge-Based Adaptive Assessment in a Web-Based Intelligent Educational System", the authors present an adaptive and intelligent web based educational system that uses AI techniques for personalized assessment of the learners. [5]

This paper proposes a web based expert system for online assessment of student which will consider various factors. Expert systems (ES) emerged as a branch of artificial intelligence (AI), from the effort of AI researchers to develop computer programs that could reason as humans [6]. An Expert System allows the transfer of specialist knowledge from human expert to computer programs [7]. Expert systems are generally of three categories: (1) rule-based, (2) inductive, and (3) hybrid. ESOA will be a rule-based expert system which gathers two sets of factual data: (a) student academic history and his/her earlier performances, (b) a set of questions depending on (a). Today's web-based online assessment techniques are not a very convincing way of assessment as they contain the following deficiencies: (a) no consideration of student academic background/performances, (b) no

categorization of toughness of questions, (c) traditional way of result processing.

To overcome the above deficiencies, we propose an expert system based online assessment system called Expert System for Online Assessment (ESOA). ESOA will act as the role of a teacher while assessing a student's knowledge about a particular topic/subject. Here the questions will be categorized into different level of toughness; the academic history of students will be categorized depending on some defined properties/characteristics. Also there will be rules for generating the question sets for students depending on their categories and for processing assessment results. Also there is a unique technical contribution, which is dynamic knowledge management, i.e. administrative users will be able to change the facts and rules of the ESOA with the help of interactive web-interfaces.

2. DESIGN & METHODOLOGY

The development of most expert systems (Web based or not) embodies a number of challenges that must be surmounted like: domain experts' detection and persuasion for collaboration, knowledge acquisition and knowledge representation, programming, validation, verification etc. Additionally, when it comes for Web based expert systems, the extra challenges that must be surmounted are related to design construction and maintain a fairly large and possibly complex Web site/application, which includes the expert system [8].

In the design & development of a Web based Expert system, the software engineering approach should be used. The proposed system will use JSP and Servlet technology along with JESS. The whole system is designed in MVC Paradigm.

2.1 MVC Paradigm:

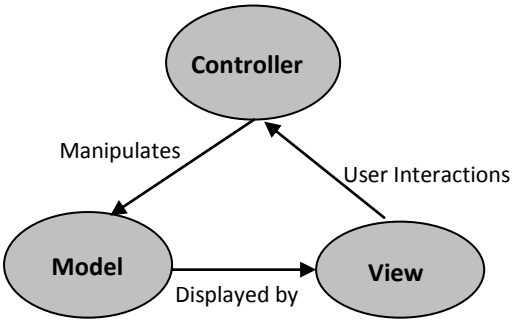
MVC is an architectural pattern used in software engineering. The pattern isolates "domain logic"(the application logic for the user) from input and presentation (GUI), permitting independent development, maintenance and testing of each.

The Model: The *M* in MVC refers to the data object model [9].

The View: The view is responsible for presentation issues. It handles how the client will see the application [9].

The Control: The control part of the paradigm deals with the business logic of the application. It handles how and when a client interacting with the view is able to access the model [9].

The Figure 1 shows how the three different logical functional blocks work together [9]:



2.2 J2EE Framework:

The J2EE platform specifies the logical application components within a system and defines the roles played in the development process. J2EE, introduced in 1998, defines a multi-tier architecture for enterprise information systems (EIS).

By defining the way in which multi-tier applications should be developed, J2EE reduces the costs, in both time and money, of developing large-scale enterprise systems [9].

2.2.1 Application components:

Four application components are defined within the J2EE platform. They are as follows:

- Application clients (Standalone Java clients): Clients are generally stand-alone applications written in Java. They run within a virtual machine and can use the J2EE standard services to access components located within another tier. [9]
- Applets (Java code which executes within a browser): Applets are similar to application clients, but execute within a Web browser. Initially applets garnered extensive attention, as they were seen as a means of making Web pages more dynamic. [9]
- Web components (JSPs, Servlets): Web components are server-side components, generally used to provide the presentation layer to be returned to a client. Two types of Web components exist: Java Server Pages (JSPs) and Java servlets. [9]
- Server components (EJBs, J2EE API implementations): Server components come in the form of Enterprise JavaBeans (EJBs). EJBs execute within a container that manages the runtime behavior of the EJB. EJBs are usually where the business logic for an enterprise system resides. [9]

J2EE's architecture maps onto the MVC nicely. Typically, entity beans are used to provide the model logic, while a mix of entity beans and session beans are used to provide the control logic, and Web components are used to implement both control and presentation logic. In practice, however, the separation of the three types of logic is not as distinct, and additional patterns are often needed to support the development cycle. [9]

2.3 JESS

JESS stands for Java Expert System Shell. It is a rule engine and scripting environment written by Ernest Friedman-Hill in Java language at Sandia National Laboratories, Livermore, Canada. JESS is not an open source product but it is free for academic/research use worldwide. It is written in Java and supports Java APIs.

A program written in JESS may consist of rules, facts and objects. The inference engine decides which rules should be executed and when. A rule based expert system written in JESS is a data-driven program where the facts, and objects if desired, are the data that stimulate execution via the inference engine. [10]

JESS provides support for the modular development and execution of knowledge bases with the defmodule construct. JESS modules allow a set of constructs to be grouped together such that explicit control can be maintained over restricting the access of the constructs by other modules. [10]

Besides helping us to manage large numbers of rules, modules also provide a control mechanism: the rules in a module will fire only when that module has the focus, and only one module can be in focus at a time. [10]

2.3.1 JESS Facts and Rules

For a rule-based expert system, facts and rules are mandatory to make decisions/inferences/results. In ESOA, facts and rules are generated dynamically according to the students' parameters and subject/paper about which the assessment will be conducted.

In JESS, facts can be stored in the working memory in three forms: (a) ordered facts (b) unordered facts and (c) shadow facts. Our proposed system will use shadow facts. Shadow facts are just unordered facts that serve as "bridges" to Java objects [11]. Shadow facts are useful as because using this Java objects can be put into the working memory of JESS.

The facts for our system will be of two types: (a) student academic/performance history (student facts), (b) questions tagged with different levels of toughness (question facts). All these facts will be stored into MySql databases.

will integrate MySql databases with JESS and generate some dynamic facts and load into the working memory of JESS. Here JavaBeans are used to implement the shadow facts.

A Jess rule is something like an "if... then" statement in a procedural language, but it is not used in a procedural way. While "if... then" statements are executed at a specific time and in a specific order, according to how the programmer writes them, Jess rules are executed whenever their if parts (their *left-hand-sides* or *LHSs*) are satisfied, given only that the rule engine is running. This makes Jess rules less deterministic than a typical procedural program. [11]

In our system, the rule data will be stored externally in XML files. Rules can be generated dynamically from XML files and loaded into the rule base of JESS.

2.4 Architecture of ESOA

The ESOA architecture includes mainly five components:

- Apache Web Server: listens for web page request
- Tomcat Servlet Engine: serves dynamically generated web page using JSP and Servlet technology
- MySql Database: stores the student information and the question bank of various courses.
- XML: files for external Rule Base
- JESS Engine: for online assessment

The working principle of ESOA can be explained as follows:

- When the online assessment for a particular subject/paper of a programme is needs to start, the administrator will log-in through web-browser.

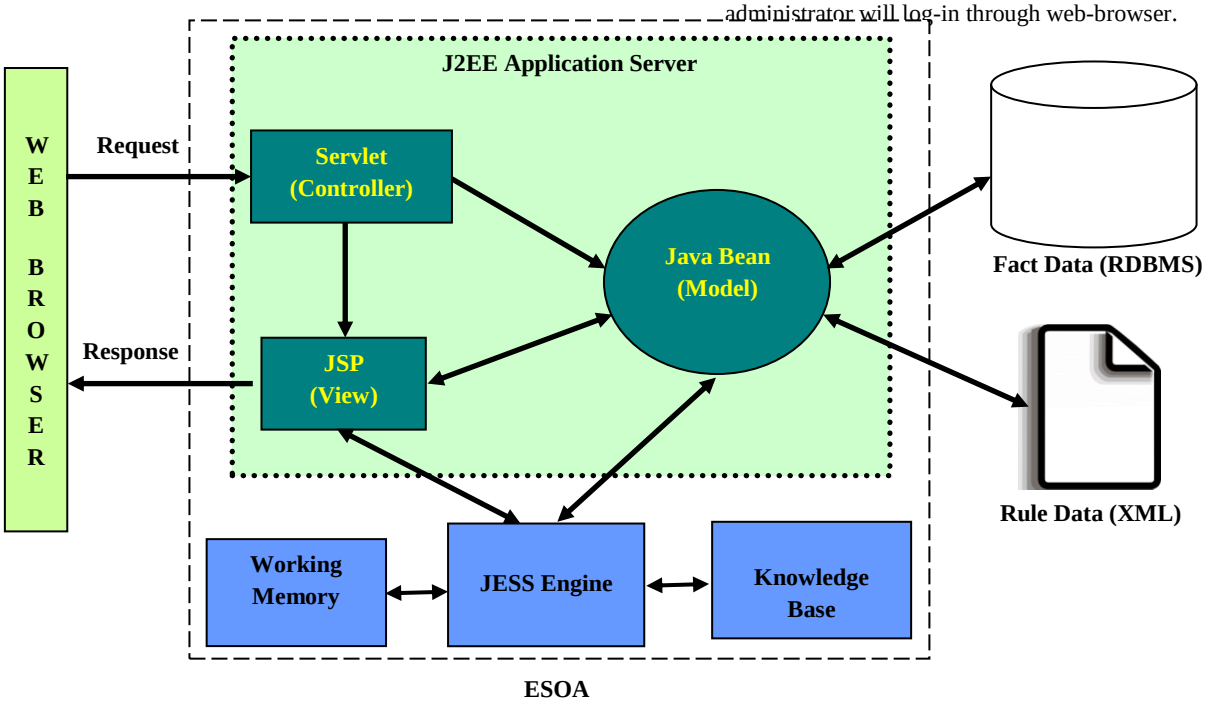


Figure 2: ESOA Architecture

The main reason for not storing the facts directly into the working memory of JESS is that if we do so, the facts will be static for the system. Using JSP and Servlet technology, we

- The administrator will then request to start the pre-assessment processes with required/related inputs through web-browser.
- The servlet will handle the request and sends it to JSP which in-turn instantiates JavaBeans for retrieving question fact data from MySql and rules from XML files and then passes them to JESS Engine.
- JESS Engine then loads the question facts, rules into its working memory, rule base and informs the administrator.
- A student will have to log-in and request for the online assessment on the particular subject/paper of a programme through web-browser.
- The servlet again will handle the request and sends it to JSP which in-turn instantiates JavaBeans for retrieving student fact data and passes to JESS Engine.
- JESS Engine then loads the student facts into its working memory and rules into its rule base/knowledge base.
- The JESS Engine then generates questions for the student based on the student academic/performance history and instantiate JavaBean to store this question set with the student identification information into MySql database and frees memory, held by the generated question set, from the working memory.
- The JESS Engine then call JSP to view the question set to the student to answer and keep track of his/her answers.
- When the student completed his/her examination, JSP will instantiate JavaBean to load the question set given to the student and his/her respective answers from MySql database to working memory of the JESS Engine and tells the JESS Engine to processes the assessment result.
- The JESS Engine, after processing the assessment result, generates some feedbacks and instantiate JavaBean to store the student's performance/given feedbacks into the MySql database and send the result/feedbacks to JSP for the student to view.
- The JESS Engine then frees the memory held by the student academic/performance history from its working memory.

3. CONCLUSION

This paper presents the architectural framework for the design and development of an expert system for online assessment of students. The architecture is designed with the help of J2EE framework and using some open source technology like Apache Tomcat Web Server, Mysql database and JESS (which is free for academic/research use worldwide). The system is primary designed for assessment of students' knowledge online. Besides, the system can be used for conducting online examination and evaluation process also. The proposed system can be implemented in any academic stream like science, engineering, humanities, medical etc.

4. REFERENCES

[1] Online Assessment and Measurement Foundations and Challenges By Mary Hricko(Ke State University,USA), Scott L. Howell(Brigham Young University, USA):Information Science Publishing:Chapter I: Assessment is as Assessment Does-A Conceptual Framework for Understanding Online Assessment and Measurement: Jeanette M. Bartley, University of Technology, Jamaica.

[2] *NoorminshahIahad, Emmanouilkalaitzakis, Georgios A. Dafoulas, Linda A. Macaulay* "Evaluation of Online Assessment:The Role of Feedback in Learner-Centered e-Learning" Proceedings of the 37th Hawaii International Conference on System Sciences – 2004

[3] PrakashRanganathan, Kendall Nygard "A Bloom's Online Assessment Test (BOAT) to assess student learning outcome in adistance engineering education course" *2010 2nd International Conference on Computer Engineering and Technology*

[4] Uday Kumar M, Mamatha J, Sandesh Jain, Dhanander K Jain "Intelligent Online Assessment Methodology" 2011 7th International Conference on Next Generation Web Services Practices

[5] Ioannis Hatzilygeroudis, Constantinos Koutsojannis, Constantinos Papavlasopoulos "Knowledge-Based Adaptive Assessment in a Web-Based Intelligent Educational System" Proceedings of the Sixth International Conference on Advanced Learning Technologies (ICALT'06)

[6] K. Darlington, The Essence of Expert Systems, Prentice-Hall, Essex, England, 2000.

[7] Waterman, Donald, A guide to Expert Systems, Addison-Wesley Publishing Company, 1986.

[8] Ioannis M. Dokas, "Developing Web Sites For Web Based Expert Systems: A Web Engineering Approach", In the Proceedings of the Information Technologies in EnvironmentalEngineering (ITEE'2005), September 25-27 2005, Otto-von-Guericke-Universitat Magdeburg, Germany, pp. 202-217.

[9] James McGovern, Rahim Adatia, Yakov Fain, Jason Gordon, Ethan Henry, Walter Hurst, Ashish Jain, Mark Little, Vaidyanathan Nagarajan, Harshad Oak, Lee Anne Phillips, "Java 2 Enterprise Edition 1.4 Bible", Wiley Publishing Inc.

[10] Maarten Menken, "JESS Tutorial", Vrije Universiteit, Amsterdam, The Netherlands, December 24, 2002.

[11] "Working Memory", www.jessrules.com/doc/70/memory.html