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E-Learning: A Milestone in the Research of Data Mining

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Abstract--***Data Mining and Data Warehousing are two most important techniques for pattern discovery and centralized data management in today's technology. E-Learning is one of the most significant applications of data mining. The main objective is to provide a proposal for a functional model and service architecture. The standards and system architecture are analyzed here. This paper gives importance to the integration of Web Services on the e-Learning application domain, because Web Service is the most advanced choice for distance education now. The process of e-Learning can be possible more effectively with the help of Web usage mining. More advanced tools are developed for online customer's behaviour to increase sales, and profit, but no such tools are developed to understand learner's behaviour in e-Learning. In this paper, some data mining techniques are discussed that could be used to enhance web-based learning environments.***

1. INTRODUCTION

Generally the organizational data are stored in files and databases. The processing of large amount of data is difficult, for which the data mining techniques are very useful. Data mining is the process of extracting information in terms of patterns or rules (e.g. association rules, sequential patterns, classification trees) from large databases. So, it is also referred as data or knowledge discovery. For example, by mining demographic data of students' enrolments, the university could improve the qualitative features (e.g. information regarding the past students) of database.

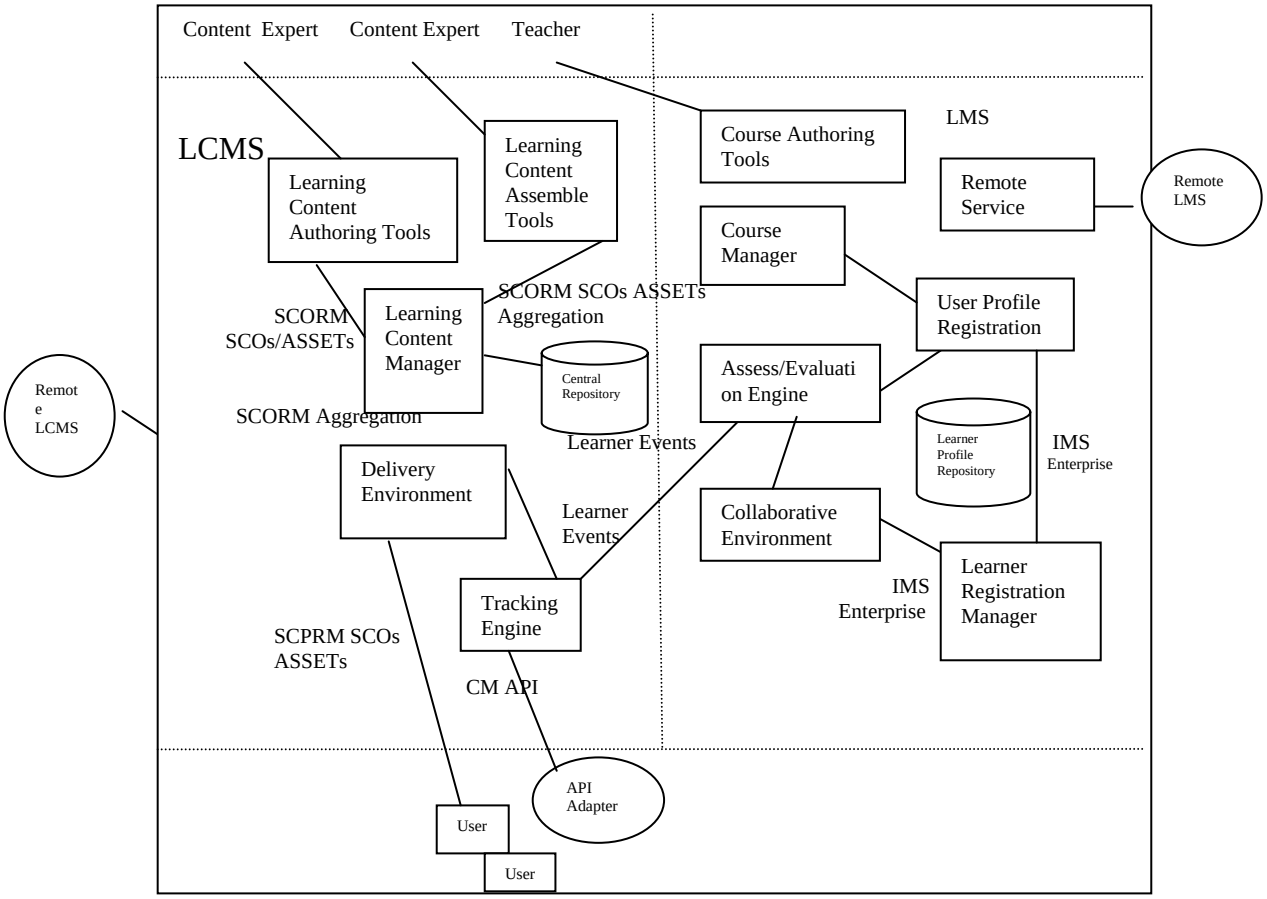
Any organization does not deal with a single database, but deals with various types of databases means multiple databases. But, there is the need for quick processing, and integrating of these databases which can be possible by data warehouse. Centralized data management and retrieval is often defined as data warehousing. This centralization helps the user for maximizing access and analyzing data. The data warehouse supports varieties of analyses, including elaborate queries on large amounts of data that may require extensive searching. When databases are set up for queries on daily transactions, they are called "operational data stores" rather than data warehouse. So, a data warehouse is a repository of an organization's electronically stored data [3]. The components of data warehouse are : retrieval, analysis, extract, transform and load data, and managing data dictionary. Data mining, data warehousing, and Online Analytical Processing (OLAP) together form the functionality of decision making or Decision Support System (DSS). The various areas Eof application of data mining and data warehousing are e-commerce, e-governance, online shopping, digital library, online reading, e-learning or e-education, etc. Among these, e-learning now-a-days is a significant application of data mining.

E-Learning is sometimes known as electronic learning or e-learning in which there is no face-to-face interaction between the teacher and the students. Rather than it is web-based learning. It uses the Web or Internet technology and delivers digital contents, provides learner-oriented environment for teachers and students [4]. So, the environment is not teacher-centric. It may include all types of Technology Enhanced Learning (TEL), where technology is used to support the learning process [5]. For example, in companies, e-Learning is used to deliver training courses to employees and in universities, e-Learning is used for enrolment of students in different courses, provides teaching without any face-to-face interaction, or on-campus facilities, but through internet that is online. As a whole, e-Learning includes Distance Learning (DL), Computer Based Teaching (CBT), Computer Aided Instruction (CAI), and Life Long Learning (LLL) principle. So, we see that, e-Learning consists of various types of databases, storing information for user access. To implement e-Learning, data mining can help to construct e-textbook, e-reading, digital libraries, etc. Further scope of e-Learning is blended e-Learning which is a combination of face-to-face interaction and online learning. It incorporates online lectures, tutorials, performance and decision support systems, simulations and games, and more [5].

2. ARCHITECTURE OF E-LEARNING

2.1. Functional model

The functional model of an e-Learning system creates an interface between the components and the objects of the e-Learning system. It is shown in "Fig. 1".



"Figure 1. Functional model of e-Learning"

The architecture of e-Learning till now does not give any clear picture of the e-Learning components. The e-Learning architecture contains two models: the component model and the information model. These two models are to be combined and an interface must be defined to achieve interoperability. This architecture of e-Learning provides a functional model of the components of e-Learning for the standardization of e-Learning process. The Advanced Distributed Learning (ADL)'s Sharable Content Object Reference Model (SCORM) functional model defines the exchange of data within an Learning Management System (LMS) or an Learning Content Management System (LCMS)to track learner's progress. But the functionality is not defined by SCORM.

A multi-user environment in which the learning developer can create, store, reuse, manage, and deliver digital learning content from a central repository is known as LCMS. Here the processes surrounding the learning are managed by LMS. LCMS allows the users to create and reuse small units of digital instructional content. The integrated use of metadata structures and learning object import and export formats also allows learning objects to be created and shared by multiple tools and repositories.LCMS incorporates specifications of metadata, content packaging, and content communication. The components of LCMS are shown in "Fig 1".

LMS requires the interchange of user profile and user registration information with other systems. The location of the course and the learner action are provided by the

LCMS. The components and information needed are shown in "fig 1". So, there is an integration of LMS and LCMS.

Secondly, the SCORM is developed by US Department of Defense's ADL. This is an "application profile" consisting of a set of specifications and standards. The three main components of SCORM are:

1. Runtime Environment: The runtime environment is an API defines the interface between learning object and LMS or LCMS to track learner's progress;
2. Meta-Data: A set of data elements for describing learning contents so that it can easily searched for, identified, and accessed[7];
3. Content Packaging: Content Packaging is the delivery and exchange of structured content i.e. Learning objects and courses between different LMS and LCMSs;

As a course is divided into lessons, and sometimes the lessons are divided into topics The SCORM specification defines two hierarchical levels:

1. Content aggregation: A group of learning resources to build complex structures, contents aggregations may be nested and may contain lower-level blocks of contents which form a content aggregation;
2. Resources: Two main types of learning resources are there: SCO and ASSET;

The level at which learner interacts with the learning content and also the LMS tracks the results is known as SCO. Basically, the SCO is a learning object.

A piece of content in form of graphic, movie, sound, or other media item is referred as an ASSET. Most ASSETS are launched by SCOs as part of of their internal content (e.g. graphics appearing on an HTML page).

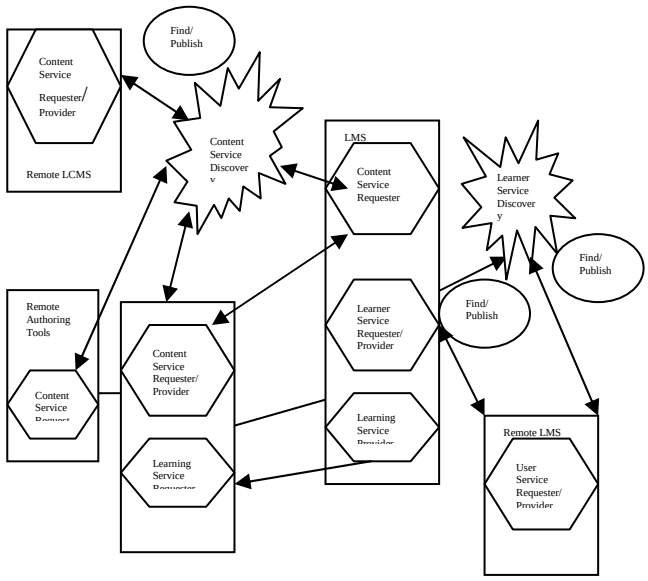
2.2. Standards in e-learning

Standards in e-Learning provides standardized data structures and communication protocols for e-Learning objects and cross-system workflows [1]. The standards are of the following types:

1. Metadata: Metadata refers to the labeling of learning contents and catalogs to support indexing, storage, discovery (searching), retrieval of learning objects by multiple repositories of data mining and data warehousing techniques. The data used here is known as metadata;
2. Content Packaging: Content Packaging allows the transfer of course content from one learning system to another learning system. The most important content packaging system now-a-days is, ADL's SCORM [7]. The details of the contents are stored in multiple databases which can be processed and received by data mining and data warehousing techniques;
3. Learner Profile: Learner Profile includes personal data, learning plans, learning history, prerequisites, degrees and certifications, assessment of knowledge and participation status in current learning;
4. Learner Registration: Learner Registration specifies the availability of courses for the learner, also, information about other participants of the course; and
5. Content Communication: It provides an interface between learner data and previous activity after content is launched. The communication is developed by ADL's SCORM Object Reference Model.

2.3. Service architecture

The Web Service architecture of e-Learning is shown in "Fig. 2".



"Figure 2. Service architecture of e-Learning"

From the study it is revealed that, Web Services are very much feasible to implement e-Learning systems for the following three reasons:

1. The exchange of information between e-Learning systems like LOM, IMS content packaging all have standard XML binding;

2. Web services architecture is platform and language independent. It promotes interoperability and extensibility among various applications in e-learning set to Acrobat 4.0 compatibility;
3. Web Services provide a confined programming model for the development and usage of private Internet as well as public Intranet services. “Fig. 2” shows the Web Service architecture of e-Learning.

This architecture describes the basic concepts of distributed e-Learning system means the communication of messages through the interaction of web service agents, present in each system. Service Provider is the platform that hosts access to the service. It is the server in a client-service environment. Service Requester is the application that is looking for and invoking or initiating the interaction with a service. Discovery Agency is a searchable set of service descriptions where service providers publish their service descriptions. According to Xiaofei Liu, Abdulmotaleb EI Saddik and Nicolas D. Georganas [1], the discovery agency may be centralized or distributed. Information presented by XML regarding learning is wrapped with the Simple Object Access Protocol (SOAP) specification and is exchanged between requester and provider. A Web Services Description Language (WSDL) file containing the description of the message and information about end point is published by the provider to allow requester to generate the SOAP message and send it to the correct destination.

4. ADVANTAGES OF DATA MINING IN E-LEARNING

There are many web usage tools to perform data mining and data ware housing tasks. For, example, WebSIFT amd WebLogMiner are two data mining and data ware housing tools for pattern discovery from web logs [10][11]. But these tools are not introduced in e-Learning environment till now.. because in case, the educator does not have any knowledge in data mining, can’t use these tools to improve the efficiency of e-Learning. Web usage mining is a new system, dedicated for e-Learning is being developed to allow the educators for on-line assess activities [9]. It helps the educator to track the activities in the course web site and extract patterns and behaviours, improve or adapt the course content. For example, one could identify the paths frequently or regularly visited., the paths never visited, etc. By analyzing these common traversal paths of the course content web pages or frequent changes in individual traversal paths, the layout of the course can be recognized to be better fit the requirements of learners.

In e-Learning two types of data mining techniques are used: off-line web usage mining and integrated web usage mining.

Off-line Web Usage Mining: Off-line web usage mining is the discovery of patterns with a stand alone application. This pattern discovery process allows educators to assess the access behaviours, validation of the learning modules, evaluation of the learner’s activities, comparision between learners and their access pattern, etc [9]. The prototype of off-line web mining is a tool for the educators to apply association rules, sequential analysis, and clustering for the discovery of : relationships between the learning activities of learners, interesting patterns of on-line activities and to group similar access behaviour respectively. So, in off-line web usage mining, integrated educators can put questions and validate the learning models they use as well as the structure of the web site as it is persued by the learner. It is being seen that off-line web usage mining is a parametric approach, where the parameters are the educators, learners, etc.

Integrated Web Usage Mining: Contrasting to off-line web usage mining, integrated web usage mining is the process of discovering patterns integrated with e-Learning application. This encompasses adaptive web sites, personalization of activities. Also, suggestion of activities to learners according to their preferences along with their history of activities is done by automatic recommenders in integrated web usage mining. A recommender-based association rule mining is being developed recently that consists of ideas of discovering relevant association between learning activities and generating association rules that are applied in a current when the activities of the antecedent of a rule are verified then the activities in the consequent of rule are suggested to the learner as the recommended next step in the learning session [10]. So, integrated web usage mining is a non-parametric approach.

5. CONCLUSION AND FUTURE WORK

In this paper, a clear analysis of the content state of e-Learning standard is being defined. Also, a functional model of different learning objects is presented here. The exchange of system workflows is also being defined in this paper. E-learning standard provides interoperability between learning systems and tools from different vendors. A standard means of communication is established between different software applications. This communication is possible by the Web-Services technology.

The Web usage mining technique is described in this paper, which is a non-trivial process of extracting useful and previously unknown patterns from the use of Web. The data mining techniques to enhance e-education are described in this paper. Since e-Learning process is a continuously changeable process, the security services, the encryption of messages, and the common facts to describe services and services access points in e-Learning systems environments are in need of consideration. Though, some tools using data mining techniques to help e-Learning system are being developed, the research is still in progress, since the data record provided by the Web Servers are insufficient, so there is a need for more specialized logs from the application side to enrich the already logged information.

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