Adaptive Upgradation of Personalized E-Learning Portal using Data Mining

Ravikiran R.K, K.R. Anil Kumar

Abstract: Implementation of data mining techniques in e-learning is a trending research area, due to the increasing popularity of e-learning systems. E-learning systems provide increased portability, convenience and better learning experience. In this research, we proposed two novel schemes for upgrading the e-learning portals based on the learner's data for improving the quality of e-learning. The first scheme is Learner History-based E-learning Portal Up-gradation (LHEPU). In this scheme, the web log history data of the learner is acquired. Using this data, various useful attributes are extracted. Using these attributes, the data mining techniques like pattern analysis, machine learning, frequency distribution, correlation analysis, sequential mining and machine learning techniques are applied. The results of these data mining techniques are used for the improvement of e-learning portal like topic recommendations, learner grade prediction, etc. The second scheme is Learner Assessment-based E-Learning Portal Up-gradation (LAEPU). This scheme is implemented in two phases, namely, the development phase and the deployment phase. In the development phase, the learner is made to attend a short pre-training program. Followed by the program, the learner must attend an assessment test. Based on the learner's performance in this test, the learners are clustered into different groups using clustering algorithm such as K-Means clustering or DBSCAN algorithms. The portal is designed to support each group of learners. In the deployment phase, a new learner is mapped to a particular group based on his/her performance in the pre-training program.

Keywords: Data Mining, E-Learning, Portal Up Gradation, Topic Recommendation, Clustering.

I. INTRODUCTION

Recently, with the advancements in the internet and tele-communication field, e-learning sector has become very popular among the learning aspirants. E-learninghas taken a revolution in the recent years due to its wide range of benefits. The main advantage of e-learning[1]–[4] is that its strategies can be adaptively changed based on the learner's history data. These data can be exploited to understand various prospects of the learners so that the e-learning environment can be enhanced. For understanding these huge amounts of data in an efficient manner, several data mining techniques[5] have been used recently. An intelligent report system was developed using data mining in [6]. Here, the behavior of the students were analysed and based on the results of the analysis the e-learning courses were modified.

In this way, the intelligent e-learning system was developed and implemented using data mining. The authors of [7] gave a brief review of various evaluation procedures that can be used for the valuation of e-learning environment. A framework for the assessment of student performance using machine learning techniques was presented in [8]. Here, the result of the student in the final exam was predicted in prior to the exam based on their performance in the e-learning environment. This prediction aided the students and the teachers to focus on improving their performance to achieve better results. Various machine learning algorithms like decision tree, naïve bayes, random forest classifier, etc., were employed here for prediction. A novel recommender system for e-learning was proposed in [9]. Based on a short and a random quiz, this scheme understands the topics of interests and recommends them for the learners. This scheme was used for improving the e-learning environment by recommending and providing materials from other web pages as well. Hence, in our research we propose two novel techniques for enhancing the e-learning experience by adaptive up-gradation of personalized e-learning portal using data mining. The overall contributions of this paper are twofold:

a) A novel scheme called Learner History-based E-learning Portal Up-gradation (LHEPU) for portal upgradation using learner's history data.

b) A novel scheme called Learner Assessment-based E-Learning Portal Up-gradation (LAEPU) for portal up-gradation using the performance of the learners in a pre-training program.

II. LITERATURE SURVEY

The application of data mining techniques for decision making in e-learning was presented in [10]. Here, the learning path followed by the students while undergoing an e-learning program was analyzed using data mining. The time spent by the students in each module of the course and for each assessment tests were recorded and evaluated. This information were used for enhancement of the e-learning platform. Also, mining of these data helped in decision making related to the methods of teaching, methods of designing portal tests, for improving the course materials and for feedback collection.

Castro et al.[5]presented a survey on various data mining techniques that can be applied to solve the e-learning problems. In this work, different group of literatures were reviewed based on the type of data mining models being used.

These models included techniques like neural networks, clustering, genetic algorithms, fuzzy systems, etc.

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This paper also analyzed different types of e-learning scenarios in which data mining can be applied like classification of learners based on their learning skills, flexibility of the system based on the needs on the learners, identification of abnormal behavior, etc.

In this paper, the application of machine learning techniques in e-learning was also presented.

Ueno et al. [11] proposed a technique for the detection of outliers in e-learning platform using data mining. In this paper, Bayesian model was utilized for the identification of outliers based on the data related to response time. The main advantage of this work was that it was developed using a small sample of data. Using this technique, it was possible to compute the predictive distribution of the e-learning data. This framework utilized the history database for creating the Bayesian model. The framework was designed such that, if any outlier was detected, then the student's learning progress is isolated and investigated by the instructor.

Aher[12] proposed a scheme for recommendation of appropriate course for the learners based on data mining technique. Based on the previous history of the courses undertaken by the learners, the courses that are likely to be taken next are predicted and recommended to the learners. The proposed recommendation algorithm was build using expectation maximization technique and apriori algorithm. The hybrid of these two algorithms was used for the prediction of courses. The proposed algorithm was compared with the apriori algorithm to validate its performance. The entire framework comprised of steps like data collection, data selection, evaluation of existing apriori algorithm and proposed hybrid algorithm and their comparisons.

Jovanovic et al.[13]Proposed a scheme for the analysis of learner behavior using data mining techniques. Here, two types of data mining models were employed that included the classification and clustering models. The classification models were utilized for predictingthe performance of the learners and the clustering models were used for clubbing the learners that follows similar learning patters. Using the classification models, the learner's performance was predicted, and accordingly suitable coaching was provided to improve their performance. Using the clustering models, the appropriate learning materials were delivered to students belonging to similar learning capabilities. In this way, methods were proposed for improving the quality of e-learning platform.

III. PROPOSED METHODOLOGY

Two schemes are being proposed for the adaptive up-gradation of e-learning portal that are designedto support the needs of the learners.In the first scheme, namely, Learner History-based E-learning Portal Up-gradation (LHEPU), the portal up-gradation is done based on the web log records generated by the learner and in the second scheme, namely, Learner Assessment-based E-Learning Portal Up-gradation (LAEPU), the portal up-gradation is done based on the based on the performance of the learner in a short training assessment test. The details of the two schemes are presented below.

A. Learner History-based E-learning Portal Up-gradation (LHEPU)

In the LHEPU scheme, the entire portal up-gradation methodology is performed using four main steps, namely, data acquisition, attribute extraction, data mining and portal up-gradation. These steps are explained in detail in the following sections. Here, the history of the learner's behavior is used as a key for the portal up-gradation. The flowchart of the proposed LHEPU scheme is shown in Figure 1.
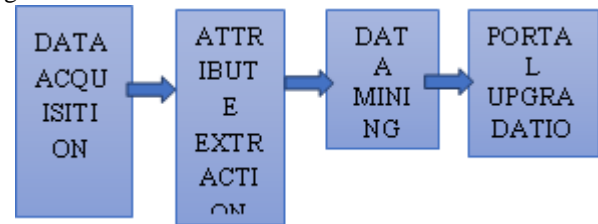

Figure 1. Flow chart of proposed LHEPU technique

B. Data Acquisition

In thisstep, web log history data and portal data that is generated by the learner is acquired. These data are very important because they can be used for the generation of useful learner-based attributes. In addition, using this data, the navigational behavior of the learner can be obtained. This data is stored and later processed to extract the attribute information of the learner. The attributes extracted from the acquired data can be used for the up-gradation of the portal based on the learner's history.

C. Attribute Extraction

Using the web log history data, several attributes are extracted. The key attributes include, navigational path of the learner, most accessed web pages,time spent in each module while learning, time spent in each module while taking the assessment, number of attempts taken to pass an assessment, average marks scored in the assessment, number of questions answered with right answers, number of questions answered with wrong answers, types of software downloaded while learning, types of query's asked in the query box, etc.

D. Data Mining

Different types of data mining tools are used for the portal up-gradation. These tools include pattern analysis, machine learning, frequency distribution, correlation analysis, sequential mining, and machine learning.

Pattern analysis: Pattern analysis can be used for analyzing the patterns in the web log data. The results of this analysis can be used for the analysis of learner behavior. Based on the learner behavior, dedicated coaching can be provided.

Frequency distribution: Frequency histograms can be used for identification of frequency of occurrences of different types of data. Based on this, the frequently searched topics can be identified. This can be used for course recommendation. Based on the courses previously taken by the learners, the topics that are likely to be chosen next are predicted and recommended.

Correlation analysis: Correlation analysis is used for the identification of correlation or connection between two or more independent variables.

For instance, it can be used for finding the relation between the time spent on a topic and the marks scored. Or it can be used to find the relation between the number of assignments taken and the marks scored. The results of this analysis can be used for the enhancement of the e-learning web portal.

Sequential mining: Sequential mining can be used to analyze the sequence of the path traversed by the learners. This path can be used for predicting the actions of the learners. Based on this prediction, the learner's future grade can be estimated. This can be helpful for further coaching from the instructor.

Machine learning: Machine learning models can be used for classifying the learners into different categories based on their learning skills. These models include random forest, naïve bayes, support vector machine, etc. Discussion forums can be arranged, so that learners belonging to different groups can have their discussions online.

E.PORTAL UPGRADATION

The results obtained through the data mining techniques can be used for upgrading the portal. Different types of upgrading like topic recommendation, provision of course material, re-test allocation, in-depth teaching on specific topics, learner's grouping, allocation of extra time for specific topics, more assessments for tough topics, etc., can be done. This aids in enhancing the e-learning experience for the learners.

Learner Assessment-based E-Learning Portal Up-gradation (LAEPU)

The learning capability of every individual is different. Hence using the same e-learning portal for all the learners may not be an efficient way of e-learning. To address this issue, we propose aLearner Assessment-based E-Learning Portal Up-gradation (LAEPU) technique. This scheme is implemented in two phases. They are the development and the deployment phase.

A. Development Phase

The development phase is shown in the form of flow chart in Figure 2. In the development phase, an initial short duration pre-training program is used to evaluateevery learner. This is done to estimate the level of learning ability of a learner. After the training period, assessment is done to estimate the amount of prior knowledge the learner has about the subject, the speed of acquiring knowledge, coding skills, knowledge application skills, etc. This analysis is initially done for a large group of individuals. Based on the results of the assessment, clustering is done. That is, unsupervised learning is done to group them into several clusters. For each cluster the statistical features like mean, standard deviation, etc., are obtained and stored. Every cluster represents one group of learners that belong to a single category with similar learning capabilities. The e-learning portal is designed to support each group of learners. That is, if n is the number of clusters obtained, and then the e-learning portal is modified with n different adaptive portals, where each portal is suitable for a particular group of learners. The content of these adaptive portals and the level of difficulty in the assessment tests are designed based on the level of the learners in that group.
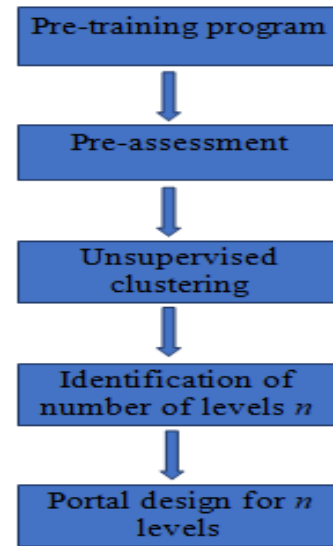

Figure 2. Flow chart of development phase of proposed LAEPU technique

B. Deployment Phase

The deployment phase is shown in the form of flow chart in Figure 3. In the deployment phase, when a new learner joins the e-learning community, he is made to attend the pre-training program. From this program, statistical features are identified. The learner is then mapped to a nearest cluster and the level of the learner is estimated. Using the estimated level, the portal belonging to that particular level is allocated to the learner. In this way, if a learner is totally new to a particular subject, for instance, says Java, then he is allocated to the basic module, where he gets to learn the subject from the very basics. Another learner wishes to learn from the portal, which he has some prior knowledge about Java, then he gets to learn some more advanced features about the subject. In this way, the e-learning portal is updated based on the performance of the learner in the pre-assessment test.
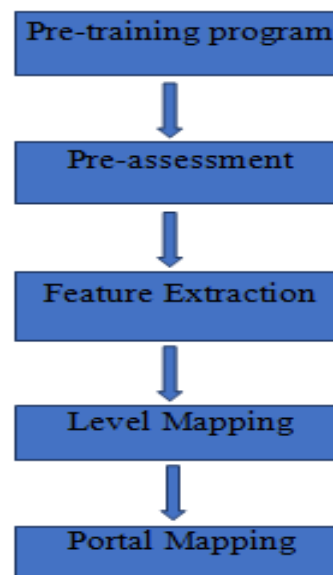

Figure 3. Flow chart of deployment phase of proposed LAEPU technique

IV. CONCLUSION

In this research, we presented two new schemes for improving the web portals for personalized e-learning. The first scheme LHEPU was designed based on the web log history data of the learner. Here, different types of data mining algorithms like pattern analysis, machine learning, frequency distribution, correlation analysis, sequential mining and machine learning were applied on the history data to make useful predictions and classifications. These predictions and classifications can greatly help the learners to have a better learning experience using the customized e-learning portal. The second scheme LAEPU was designed based on the performance of the learner in the pre-training program. It involved two phases (development and deployment). This scheme utilized clustering algorithm as the data mining technique for grouping the students. Both the schemes can be used for creating a customised e-learning portal that exclusively supports each learner.

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