BVG Trust

J. Sci. Trans. Environ. Technov. 2016, 9(4) : 200-204

Scientific Transactions in Environment and Technovation

A Study on methods of personalized E-Learning recommender system

V.Bhuvaneshwari* and V.Geetha

Department of Computer Science, Sengamala Thayaar Educational Trust Women's college, Sundarakkottai- 614016, Mannargudi, Tamilnadu, India

Abstract

A huge amount of heterogeneous learning materials are generated on the web everyday with the rapid increase in the development of online learning technology. Besides, the learning resources are growing infinitely making it difficult for users to choose appropriate resources for their learning. Recommender systems, a subset of information filtering shows a great potential to help users in a personal learning environment to identify relevant and interesting items from a large number of items by suggesting actions to a user based on the preferences and ratings of other learners. The recommendation could be an online activity, running an online simulation or just a simple web resource. The technology finds its applications in a wide range of fields such as movies, music, news social tags, research articles, experts, social tags ,products, restaurants, jokes, financial services etc., This paper reviews the main paradigms of recommender systems and also the various methodologies that have been implemented to design recommender systems for personal learning environments.

Keywords: E-learning, Personalized Recommender Systems, Collaborative Filtering, Content-based filtering, sparsity, learning environment.

INTRODUCTION

Learning resources available in the web are heterogeneous and in various media formats as well. The probability of learners accessing the relevant items is of greater concern and is intensively researched by the Technology Enhanced Learning (TEL) community. Recommender Systems are software tools and techniques that provide suggestions to a user in various decision making processes.

In the e-learning context, a recommender system is a software agent that recommends useful and interesting learning resources to a learner by accounting the ratings, preferences and expertise of other learners. The greatest challenge is that people preferring web based education differs a lot in their interests and it is necessary to provide a personalized learning environment that can adapt to the levels and interests of learners. The basic elements which constitute a recommender system are event, session and recommendation process. An event is a call to the system provoked by an action performed by the user. For instance, every click on a hyperlink generates a new event session s(u) is a set of close events provoked by a user.

A recommendation process is the sequence of actions that a recommender executes to produce a set of recommendations. An item denotes what the system recommends to users. A recommendation event can have one or more sessions. The basic units of a recommendation event are the set of items available to be recommended, a recommendation window created for each event, a filter for creating and filling a window, and a guide to wrap and display the items to be recommended.

RESEARCH ISSUES IN RECOMMENDER SYSTEMS IN E-LEARNING

Sparsity and cold start are the important problems in the e-learning environment. Recommender systems are engaged to evaluate very large datasets when it is probable that the number of ratings given by the users is very small compared to the total number of (user; item) pairs in the system leading to sparsity.

Cold-start refers to the situation in which an item cannot be recommended unless it has been rated by a substantial number of users. This problem is particularly detrimental to users. Different learners have different knowledge and preferences making similarity measure an unreliable one which also poses the sparsity and cold start issues.

Overspecialization is another problem which occurs when the recommended items are much similar and the recommendation list is not diverse. Inadequate attribute information about users and items is the main reason for overspecialization .The vital challenge facing the research community is how to gather the detailed attribute information and use it to model the multipreferences of a learner. These challenges serve as potential motivators to identify suitable recommendation techniques to discover relevant learning resources for the users.

PERSONALIZED RECOMMENDER SYSTEMS METHODS - A SURVEY

The two main approaches that are used while building an e-learning recommender system are Content-based filtering and Collaborative Filtering (CF) .Content-based

*Corresponding Author :
email: vbhuvana1991@gmail.com

filtering techniques suggest items similar to the ones that each user liked in the past, taking into account the objects that the user has evaluated in the past. Collaborative filtering techniques recommend items to learners based on the idea that other learners with similar behaviour in the past have similar interests and preferences. Majority of current research involves employing a hybrid approach by combining the content-based and collaborative filtering approaches to meet the challenges of the field. Specific data mining techniques are applied whenever necessary during the entire recommendation process, Fig.1. illustrates the different types of recommendation approaches.

An e-learning recommender system is a piece of software that has an intellisense quality of recommending learning resources to a learner by taking into account the actions of previous learners.A wide range of web mining techniques have been used to build a software agent capable of recommending learning activities or shortcuts in online learning by discovering online access patterns. Current research in e-learning focuses on learning person rather than the tools that support learning. The idea is that learning success can reach a marked improvement by specific adaptation of learning content. This paper surveys the various methodologies

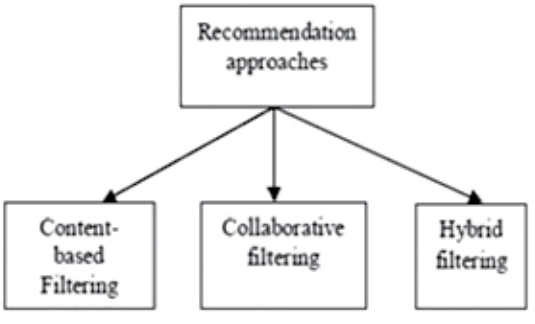

Figure 1. Classification of Recommendation strategies

that have so far been developed and implemented in order to construct efficient personalized e-learning recommender systems.

Most of the research in E-learning recommender systems involved combining content based and collaborative attributes in a single table. Baudisch, P. (1999) proposed a new system architecture that supports the formulation of universal queries by joining the tables in the sense of a relational database.

Walker, *et al.,* (2004) made a review on collaborative filtering techniques and proposed a new system called Altered Vista, using the collaborative information filtering approach to evaluate the educational effectiveness and the usefulness of the approach.

Learning object repositories employ a variety of evaluation instruments which poses a great challenge on how to translate and integrate evaluative data to be shared among different repositories. Combining implicit and explicit measures of preferences to provide relevant recommendations is also an issue. Kumar *et al.* (2005) proposed a new system with two Bayesian Belief Networks (BBN) to model relationships among different reviewers and evaluation instruments.

The model was able to make useful inferences about learning object quality and the model was extended further over geographic distances assuming that reviewers would be distributed. Learning objects require adapted information retrieval systems. Lemire *et al.* (2005) proposed the Rule Applying Collaborative Filtering (RACOFI) system, which consists of two subsystems namely the collaborative filtering system and the inference rule system.

The new system is upgraded to generate context aware recommendation lists. Multidimensional predictions are produced using a collaborative filtering algorithm after which rules are applied to the predictions to customize recommendations according to user profiles. An e-learning system with two pedagogy features namely learner interest and background knowledge was proposed by Tang *et al.* (2005) experiments were carried out to compare content based and hybrid recommendation approaches.

The results indicated that the hybrid collaborative filtering technique not only performed better but could lower the computational costs as well. Learner ability is a factor that is neglected when implementing personalization mechanisms which lead to disorientation of the learner. Chih-Ming Chen *et al.* (2005) proposed a new system for personalized e-learning was proposed by combining the collaborative filtering approach with item response theory to provide individual path to learners, thereby facilitating effective learning.

The method involves using an item characteristic function to model course materials and Maximum Likelihood Estimation (MLE) to predict learner ability. Chih-Ming Chen *et al.* (2004) stated a Personalized Courseware Recommendation System (PCRS) based on the Fuzzy Item Response Theory (FIRT) to estimate learner's ability and also to determine the courseware difficulty. The proposed method outperforms the traditional item response theory even by accepting non-crisp responses.

With E-learning becoming more popular, many SCORM (Sharable Content Object Reference Model)-compliant learning objects are created, published and distributed across the web, placing the burden of selecting suitable learning objects on the users. To address this problem and to recommend the suitable SCORM-compliant learning objects from the repositories, Tsai *et al.* (2006) proposed a new system with an adaptive personalized

ranking mechanism to rank the degree of relevance of a learning object considering the user's own preferences and the neighbor's interests A dataset was collected from the teachers who used the European Schoolnet's CELEBRATE portal and Manouselis *et al.* (2007) developed a simulation was for the first time by implementing a multi-attribute utility collaborative filtering algorithm in order to better understanding collaborative filtering service for a given user community. Gao Fengrong *et al.* (2007) stated a novel approach by unifying partition-based collaborative filtering and meta information filtering.

Results indicate high efficiency and good performance when the method is applied to a digital resource management. To reduce the time consumed by users in searching for relevant learning objects and to provide a complete personalized augmented learning program, Zhiwen Yu *et al.* (2007) proposed a semantic content recommender system towards context aware learning with an ontological approach to generate recommendations taking into account knowledge about the learner, knowledge about the content, and the knowledge about the domain being learned.

Web based educational systems lack adaptive and personalized assessment. To guide the learners through a friendly environment, Ahmad Baylari and Montazer (2008) proposed a personalized multi-agent e-learning system which presents adaptive tests based on item response theory (IRT) and provides personalized recommendations based on Artificial Neural Networks (ANN). To support content recommendation on a particular learning topic, Khairil Imran *et al.* (2009) proposed a novel framework using the vector space model which recommends learning materials considering two strategies namely similar content in learning resources and good learners' average rating.

The new architecture consists of an instructor module for creating learning materials to be stored in the repository. A converting tool is used to convert presentation and word documents into image file or flash files and an authoring tool to embed the image into the predefined html page.

A new framework with two modules and employing content based and collaborative filtering approaches was proposed by Khribi *et al.* (2008) to provide online automatic recommendations to active learners based on current learners' recent navigation history without requiring their explicit feedback. An offline module constructs models of learners and content, which are used by the online module which to generate recommendations according to the students' needs and goals. To identify, discuss and motivate the most essential modifications to a web based course, Garcia *et al.* (2009) proposed a system which applies association rule mining to extract students' log data as recommendation rules.

Adding to this, a collaborative approach was used to gather and validate the recommendation rules obtained by teachers with similar profiles and other educational experts. Experimented with some real group of students the architecture worked good to generalize results over many course contents. Romero *et al.* (2009) proposed an advanced architecture by integrating a specific web mining tool into the AHA (Adaptive Hypermedia System) system in order to recommend to a learner the most appropriate links/web pages within the AHA system to visit next.

The algorithms and the proposed architecture were found to be successful when experimented with real data from Eindhoven University of Technology. To locate suitable learning resources based on similarity of content and good learners' rating, Ghauth and Abdullah (2010) proposed a novel e-learning recommender framework based on peer learning and social learning theories and experimental results indicate that the proposed recommender system performs better than one which uses a content-based filtering approach.

Zhong and Li (2010) proposed a new method to map collaborative filtering problem to text analysis problem by combining both the implicit and explicit features of users and items. Implicit attributes are calculated using probabilistic latent semantic analysis based on rating data from past events. The proposed method exhibits more benefits than memory-based techniques. Experimental evaluation of the proposed method showed improved accuracy than the previous methods.

There is a serious need for recommendations in an online forum due to its weak size or the structure. Abel *et al.* (2010) proposed and evaluated a generic personalization framework based on the Comtella-D discussion forum. The feedbacks and interactions from users serve as a personalization rule to identify the appropriate recommendation strategy based on user input data. Results indicate that collaborative filtering techniques can be used successfully on small datasets like a discussion forum.

To improve the efficacy of learning in the absence of face-to-face contact with educators, a recommendation of learning experiences(LEs) with a collaborative filtering strategy was proposed by Wan *et al.* (2010). The proposed system captures learning experiences in the form of sequence of events to which sequential pattern mining is applied to determine learning patterns to be shared among peer learners.

A collaborative educational data mining tool based on association rule mining was proposed by Garcia *et al.*

(2011). The tool was specially designed for non-expert educators to further improve e-learning courses by facilitating sharing and scoring of discovered information among non-expert teachers with similar course profiles.

A Web log mining approach integrating Collaborative Filtering (CF), and Sequential Pattern Mining (SPM) was proposed by Li *et al.* (2012) for recommending learning resources to each active learner based on the historical learning path of the learner. Initially, item sets related to content are found out using the collaborative approach, after which sequential pattern recommendations are provided to learners by subjecting the discovered item sets to Sequential Pattern Mining (SPM). Unlike other recommendation strategies, this work unites CF and SPM to optimize the system for an adaptive E-learning environment.

Experimental results indicate good performance of the proposed approach. Concerning simultaneous consideration of dynamic interests, multi-preferences and multidimensional attributes of learning materials, Salehi *et al.* (2013) proposed a new material recommender system framework using approaches. The sequential pattern mining approach uses modified Apriori and Prefix Span algorithms to discover latent patterns in accessing of learning materials and the multidimensional attribute based collaborative filtering approach uses a Learner Preference Tree (LPT) to consider the attributes of learning resources from different perspectives, learners' ratings and multi-preference of learners.

Improved classification accuracy measures are achieved and learner's real learning preference is satisfied accurate according to real-time updated contextual information. As a further extension, Salehi and Nakhai Kamalabadi (2013) proposed a unified approach to address the same issue. The latent patterns of accessing learning materials are presented both as weighted association rules and as a Compact Tree (CT). After clustering learners using K-means algorithm, a Learner Preference tree (LPT) is used to account all the previous factors including the order of the accessed materials. The mixed, weighted, and cascade hybrid methods are employed to generate the final combined recommendations.

The proposed method outperforms the previous algorithms in terms of metrics such as precision, recall and intra-list similarity measures. Salehi *et al.* (2013) proposed a hybrid recommender system for learning materials to improve the accuracy and quality of recommendations. The proposed system is designed with two modules.

The explicit attribute-based recommender module considers weights of implicit attributes of learners' material as chromosomes in genetic algorithm and then these weights or opinions of learners are optimized according to historical rating after which recommendations are generated using Nearest Neighborhood Algorithm (NNA). The second module uses a Preference Matrix (PM) to model learner's interests based on explicit attributes of learning materials, a new similarity measure is introduced and then recommendations are generated using NNA. Experimental results imply that the proposed algorithm shows improved accuracy and can alleviate coldstart and sparsity problems as well.

CONCLUSION

This paper surveys the methodologies adapted for designing personalized e-learning recommender systems. Firstly we introduced the baseline behind recommender systems, the terminology and the approaches used to build a recommender system. Secondly we have focused on describing the various methodologies used in constructing a recommender system along with the objectives and contributions to recommend learning resources to learners based on several factors in the e-learning context.

REFERENCES

Abel, F., Bittencourt, I. I., Costa, E., Henze, N., Krause, D. and Vassileva,J. 2010. Recommendations in Online Discussion Forums for E-Learning Systems. *IEEE Transactions on learning technologies.* 3:165 - 176.

Ahmad Baylari and Montazer, Gh, A. 2009. Design a personalized e-learning system based on item response theory and artificial neural network approach. *Expert Systems with Applications,* 36, 4:8013-8021.

Baudisch., P., 1999. Joining Collaborative and Content-Based Filtering. *Proceedings of the SIGCHI conference on. Human Factors in Computing Systems (CHI '99).* Pittsburgh, PA, USA, May 15 – 20, New York: ACM Press.

Chih-Ming Chen, Ling-Jiun Duh and Chao-Yu Liu. 2004. A Personalized Courseware Recommendation System Based on Fuzzy Item Response Theory *In:* IEEE *International Conference on e-Technology*, e-Commerce and e-Service (EEE'04).Taipei, Taiwan, March, IEEE Computer Society, P. 28-31.

Chih-Ming Chen, Hahn-Ming Lee, Ya-Hui Chen. 2005. Personalized e-learning system using Item Response Theory, *Computers and Education,* 44 : 237-255.

Gao Fengrong, Xing Chunxiao,Du Xiaoyong and Wang Shan. 2007. Personalised service system based on hybrid Filtering for digital library.Tsinghua Science and Technology, 12: 1-8.

Garcia, E., Romero, C., Ventura, S. and Castro, C. 2009. An architecture for making recommendations to courseware authors using association rule mining

and collaborative filtering. *User Modeling and User-Adapted Interaction,* 19:99-132.

Garcia, E., Romero, C., Ventura, S. and Castro, 2011, C.D.A Collaborative Educational Association Rule Mining Tool. *Internet and Higher Education,* 14: 77–88.

Ghauth, K. I. and Abdullah, N.A. 2010. Learning Materials Recommendation Using Good Learners' Ratings and Content-Based Filtering. *Educational Technology Research and Development,* 58: 711-727.

Kumar, V., Nesbit, J. and Han, K. 2005. Rating Learning Object Quality with Distributed Bayesian Belief Networks: The Why and the How. In: *5th IEEE International Conference in Advanced Learning Technologies* (ICALT 2005). Kaohsiung, Taiwan, July 5-8, California: IEEE Computer Society.

Khairil Imran, Bin Ghauth and Nor Aniza Abdullah, 2009. Building an E-Learning Recommender System using Vector Space Model and Good Learners Average Rating –Vector space model. In: 9th IEEE *International Conference on Advanced Learning Technologies* (ICALT 2009).Riga, Latvia, July 15-17, IEEE Computer Society: California.

Khribi, M. K., Jemni, M. and Nasraoui, O. 2008. Automatic Recommendations for E- Learning Personalization Based on Web Usage Mining Techniques and Information Retrieval. *In:* 8th IEEE *International Conference on Advanced Learning Technologies* (ICALT 2008), Santander, Cantabria, July 1-5. IEEE Computer Society: California.

Lemire, D., Boley, H., McGrath, S. and Ball. M. 2005. Collaborative Filtering and Inference Rules for Context-Aware Learning Object Recommendation, *International Journal of Interactive Technology and Smart Education*, 2, 3:685 - 687.

Li, Y., Niu, Z., Chen, W. and Zhang, W. 2013. Combining .Collaborative Filtering and Sequential Pattern Mining for Recommendation in ELearning Environment. In: *10th International Advances in Web-Based Learning (ICWL 2011). Hongkong, China, December* 8-10, 2011, P. 305-313.

Manouselis,N., Vuorikari,R. and Van Assche,F. 2007. Simulated Analysis of MAUT Collaborative Filtering for Learning Object Recommendation *In: Proceedings of the 1st Workshop on Social Information Retrieval for Technology-Enhanced Learning and Exchange,* Sissi, Lassithi-Crete,Greece, September 18, CEUR-WS.org.

Romero, C., Ventura, S., Zafra, A. and de Bra, P. 2009. Applying Web Usage Mining for Personalizing Hyperlinks in Web-Based Adaptive Educational Systems. *Computers and Education,* 53 : 820-840.

Salehi, M., Nakhai Kamalabadi. and Ghaznavi Ghoushchi, M.B. 2013. Personalized Recommendation of Learning Material Using Sequential Pattern Mining and Attribute Based Collaborative Filtering, *Education and Information Technologies,*17:1-23.

Salehi, M. and Nakhai Kamalabadi, I. 2013.Hybrid Recommendation Approach for Learning Material Based on Sequential Pattern of the Accessed Material and the Learner's Preference Tree, Knowledge-Based Systems, 48: 57-69.

Salehi, M., Pourzaferani, M. and Razavi, S.A. 2013. Hybrid Attribute-Based Recommender System for Learning Material Using Genetic Algorithm and a Multidimensional Information Model. *Egyptian Informatics Journal*, 14: 1-23.

Tang, T.Y. and McCalla, G.I. 2005. Smart Recommendation for an Evolving E-Learning System: Architecture and Experiment, *International Journal of E-Learning*, 4:105-129.

Tsai,K.H.,Chiu,T.K.,Lee,M.C. and Wang,T.I. 2006. A Learning Objects Recommendation Model Based on the Preference and Ontological Approaches *In:* 6th IEEE *International Conference on Advanced Learning Technologies*, Kerkrade, July 5-7, IEEE Computer Society.

Wan,A. T., Sadiq, S.and XueLi, 2010.On Improving Learning Outcomes through Sharing of Learning Experiences. *In:* 10th IEEE International Conference on Advanced learning Technologies. Sousse, Tunisia, July 5-7,IEEE Computer Society: California.

Walker, A., Recker, M., Lawless, K. and Wiley, D. 2004. Collaborative Information Filtering: A Review and an Educational Application, *International Journal of Artificial Intelligence in Education*, 14, 1:3-24.

Zhiwen Yu, Yuichi Nakamura, Seiie Jang, Shoji Kajita, and Kenji Mase. 2007. Ontology-Based Semantic Recommendation for Context-Aware E-Learning. *In: International Conference on Ubiquitous Intelligence and Computing*, Hong Kong, China, July 11-13, Springer Berlin Heidelberg.

Zhong, J and Li, X. 2010. Unified collaborative filtering model based on combination of latent features. *Expert Systems with Applications,* 37: 5666–5672.