

Recommendation Systems, Incorporating Sentiment Analysis with Specific Reference to the Academic Domain

Anil Kumar^{1,2*}, Sonal Chawla²

¹Dept. of Computer Science, GGSDS College Haryana, Hoshiarpur, Punjab, India

²Dept. of Computer Science and Applications, Panjab University, Chandigarh, India

*Corresponding Author: anil.dadhwal@gmail.com

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Abstract— In recent years, Internet is growing exponentially and so is the amount of learning resources. Due to overload of information, learners find it difficult to retrieve the appropriate learning resource. In academic domain, recommendation systems are facing problems in providing accurate suggestions to learner due to difference in types of learning resources, learner preferences, knowledge level and quality of the learning resource. In this context, the objective of this paper is four folds: Firstly, the paper discusses various techniques used in creation of recommendation system with a special focus on Academic Domain. Secondly, it compares and contrasts the existing recommender systems in practice today. Thirdly, the paper looks at the possibility of including Sentiment Analysis as an effective technique for recommending learning resources to the learners & it goes at length to give a sequential flow chart for a pilot study of book recommender system. Finally, the paper concludes by drawing the inferences on the introduction of sentiment analysis as a useful technique for recommendation system.

Keywords—Book Recommendation System, Recommendation System, Sentiment Analysis.

I. INTRODUCTION

Learning resources are growing ‘leaps and bounds’. Since a large amount of learning data is available on web, learner find it difficult to extract the appropriate resource with desired quality. Learning resources can be in form of image, lecture, video, text, audio, presentation, books etc. Because of diverse nature of learning resources, it is difficult to judge the quality of a learning resource without actually using it. There should be some mechanism to filter out the relevant learning resources and suggest the same to learner and save the efforts and time of the learner by getting the learning material, in which learner is interested.

A continuous research is being done to help the learner to get appropriate relevant resource by devising recommendation systems. Recommendation systems are developed to help learner to have personalized suggestions. A recommendation system recommends the learning resource to the learner based on algorithm by considering parameters like its peer data, his profile, history of navigation, interest etc. Learner also faces difficulty in relying on the suggestions provided by the system because most of the systems consider the numeric rating for recommendations without considering quality.

Improving the relevance, usefulness, acceptance rate and suggesting the quality learning resources is the major

concern of the researchers. Recommendation systems can be viewed as a filtering technique in which algorithm tries to filter out the best items from a set of available items in which learner is interested in. Rest of the paper is organized as follows, Section I contains the introduction to recommendation techniques, Section II describes the related work to recommender systems, Section III compares and contrasts the recommendation algorithm with special focus to academic domain, Section IV proposed a book recommendation system incorporating sentimental analysis and Section V concludes the research work which future directions.

I.I RECOMMENDATION TECHNIQUES

The recommendation system development involves the review of various recommendation techniques. These techniques are divided into two broad categories.

Traditional techniques: These are the techniques, which are most widely used in recommendation systems. These include Collaborative Filtering Technique and Content Based Technique.

Advanced Methods: Since traditional methods suffer from problems like sparsity, cold start problem, scalability, over specialization, grey sheep problem [1] etc. So to deal with

such problems advanced techniques are there, such as Knowledge Based, hybrid techniques, social network based recommendation system, fuzzy recommendation techniques, context awareness based recommendation techniques, group recommendation techniques, trust based recommendation techniques.

Collaborative Filtering: In this technique, items are recommended to the people based on the items liked by similar peoples. It is like people are relying on the knowledge and experiences of others to make their own decision. This technique can be divided into Model Based or Item Based approach in which items are recommended to the user based on the similar items earlier liked by the him and Memory Based or User Based approach in which items are recommended to the user based the items like by other similar user. Similarity between user and items can be calculated using techniques like Pearson Correlation Coefficient, Adjusted Cosine based, cosine based, Neural Network, Bayesian Network[1].

Content Filtering: In this technique, similar attribute items rated by the user are recommended [2]. The weight of the attribute extracted from the item is added to the weight of the corresponding item in the user profile if the user is interested in[1]. Content Based filtering uses various techniques like rule induction, nearest neighbor method, linear classifier and probabilistic method.

Hybrid Techniques: To overcome the drawbacks of Collaborative filtering technique and Content Based filtering, both the techniques are combined to propose a recommendation system based on hybrid technique. Mostly in Hybrid technique Collaborative Filtering technique is combined with other recommendation technique[3].

Knowledge Based: In this technique, items are suggested to the user based on available knowledge about item, user and their relationship. Knowledge is kept about item and user using Ontology, which represent the set of concepts, hierarchical organization and additional relation between them[4].

Social Networking Based Recommendation Techniques: To improve the user experience regarding recommender system, user's social information[2], social interaction with other users like online friends, social comments, and social tags are tracked. It improves the sparsity problem as user is connected by a network of trust, which exhibits significantly higher similarity on items.

Computational Intelligence based Recommendation Techniques: Computational intelligence techniques include artificial neural network, clustering techniques, fuzzy set

techniques, Bayesian techniques and Genetic Algorithm are used for making recommendations [3].

Context Awareness Based Recommendation Techniques: Context information is the additional information like time, geometrical information, friends, family, colleagues, age etc. which is needed for making recommendations. This technique is used in those systems where information about item and user is not sufficient to make recommendations, for example travel recommendation system [3].

Group Recommendation Techniques: This system proposes a set of recommendations to a group of users, when group members can't negotiate on their preferences in spite of meeting with each other [3].

This research paper mainly focus on progress of research done in recommendation systems developed in academic domain. This research paper will make following contribution:

- The paper will uncover the techniques used in existing developed recommendation systems in academic domain.
- A comparative analysis will be performed based on existing tools or techniques used in Recommendation systems of academic domain.
- A new recommender system will be proposed.
- Methodology being followed to create the system.

II. RELATED WORK

When it comes to Recommender System for academic domain, the tools and technologies related to it vary. Various researchers have incorporated these technologies in a different manner.

Stuart E Middleton[5] et al. explained ontological approach for creating user profiles within recommendation system to recommend research papers. They use collaborative filtering algorithm to recommend research papers seen by similar users. The experimental systems developed were Quick Step and Foxtrot.

Khairil Imran Bin Ghauth and Nor Aniza Abdullah [6] proposed a framework in which items are recommended based on the similarity of content items (Using Vector Space Model) and good learner average rating strategy.

Fabian Abel et al. [7] suggested that recommender system needs to generate recommendations based on small amount of available input. They evaluate different recommendation strategies for Comtella-D system (Discussion Forum). They designed a general-purpose semantic web service based framework to encapsulate generic personalization algorithm. Rule based technique, Collaborative filtering technique and ontology was used to develop the recommendation system.

Aleksandra et al. [8] further enhances the module of a programming tutoring system – Protus, which can automatically adapt to the interest and knowledge level of learners. They show that a combination of testing the learner's learning style and mining the frequent sequences in the web logs by using AprioriAll algorithm along with Collaborative filtering approach can improve the quality of intelligent tutoring system.

Chhavi Rana and Sanjay Kumar Jain [9] embedded temporal dimension in content based recommendation of Books, which gets updated with the time to improve the recommendation process.

Boban Vesin et al. [10] created an adaptive and intelligent web based programming tutoring system – Protus, which was implemented using recommendation and adaptive hypermedia techniques. It supports learning path generation and personalization based on the learning style identification. Proposed system uses ontology, integrates content and link adaption.

Saman Shishehchi et al. [11] developed an interface by implementing knowledge based recommendation techniques with the help of ontologies to get wide spread knowledge about learner and learning domain.

Sunita B. Aher and L.M.R.J. Lobo [12] proposes a recommendation system that uses the combination of clustering technique - Simple K means and association rule algorithm -Apriori to give course recommendations to the learners, based on choice of the other student's for particular set of courses collected from MOODLE(Modular object-oriented dynamic learning environment). The system was compared with Weka open source data mining tool.

Wei Chen et al. [13] pointed out that multimedia nature of learning resource make difficult to go for content similarity and to use Content Based filtering technique. Because of this, user's information related to preferences provides a good assistance for recommendations. They propose a hybrid approach to combine both collaborative filtering and sequential pattern mining technique, which has ability to capture learner's historical learning sequence.

Salam Fraihat and Qusai Shambour[14] proposed a framework of a semantic recommender system that utilizes

the intra and extra semantic relationships between learning resource and learner's need. The semantic recommendation algorithm is based on extension of the words in the query by using semantic relations and domain ontology.

Alvaro Tejad-Larento et al.[15] present a system name AyudasCB based on fuzzy linguistic modeling. The system could recommend personalized activities to students to strengthen their individual education.

Yongfeng Zhang[16] proposes to incorporate phrase level sentiment analysis on reviews along with Collaborative based technique to improve the recommendation.

Learning resource recommendations are different from e-commerce domain due to difference of learner's characteristics like learning goal, prior knowledge level, learning style, sequential learning patterns[4]. John et al.[17] consider these different aspect of learning and proposes a hybrid knowledge based recommendation system based ontology and sequential pattern mining to recommend learning resource.

A. Koukourikos et al. [18] proposes algorithms that make use of collaborative filtering and sentiment analysis technique on comments available in merlot repository for making recommendations.

Literature review reveals that still research is needed in recommender system in academic domains to provide more accurate recommendations to the learner. Most of the available studies have ignored that the recommended learning resources should be checked for quality as per previous reviews of learners. Reviews given by learners determine the quality of learning resources in terms of its usage, reliability, knowledge gain.

III. COMPARATIVE ANALYSIS OF THE ALGORITHM, APPROACHES FOR RECOMMENDATION SYSTEMS WITH A SPECIAL FOCUS ON ACADEMIC DOMAIN

Based on the above literature survey, an analysis of the technologies used in developed models, major systems & frameworks of recommender system was performed in Table 1.1 to identify the features of the algorithms.

Table 1.1 Comparative Analysis of the Algorithm, Approaches for Recommendation Systems with a special focus on Academic Domain

<i>S.No.</i>	<i>Model/System/Framework</i>	<i>Technologies Used</i>	<i>Features</i>
1.	Hybrid recommendation model for e-learning based on ontology and SPM[17]	Collaborative Filtering Ontology SPM (Sequential Pattern Mining)	<ul style="list-style-type: none"> • The system could recommend out of 240 learning resources. • Input Used was Real World Data Set of 50 Students • Algorithm is measured for Accuracy of Prediction, Learners Satisfaction. Compared with others using statistical techniques Mean Absolute Error, Precision, Recall
2.	AyudasCBI [15]	Weighted Hybrid using Content Based Collaborative Filtering fuzzy linguistic modeling	<ul style="list-style-type: none"> • Suggest items to the students to boost their knowledge • Input Used: Real World Data of 50 Students • Evaluation: Student Satisfaction based on feedback • Tried to model qualitative information along with quantitative information.
3.	Semantic recommender system framework. [14]	Ontology	<ul style="list-style-type: none"> • Not implemented as a prototype. • Algorithm was not validated for performance and quality of recommendation.
4.	BIT Learning System [13]	Item based Collaborative Filtering Sequential Pattern Mining	<ul style="list-style-type: none"> • Real World Data Set of 30 students was used • System was evaluated using Recommendation error Metrics
5.	Framework for Course Recommendation System in e-learning using clustering and association rule algorithm [12]	Used Association rule mining using and Clustering Technique	<ul style="list-style-type: none"> • Protus is a Java Tutoring System • 82 courses were used as input data. • Evaluated for time and space complexity
6.	Protus System [10]	Ontology Collaborative Filtering Association Rule Mining Adaptive of the system	<ul style="list-style-type: none"> • Real World Data of 70 students was divided into Experimental and Control Group • Evaluation Criteria used were T-test, Learning Curve, Satisfaction using Questionnaire covering Convenience, speed, accuracy
7.	Book Recommender system using time based content filtering [19]	Content Filtering	<ul style="list-style-type: none"> • Real World Data of 150 students • Evaluation Criteria used was Questionnaire of 10 questions
8.	Module for Protus System [8]	Data Clustering SPM collaborative filtering	<ul style="list-style-type: none"> • Input Used was Real World Data set of 440 students which were divided into control Group and experimental Group • Evaluation criteria used were MAE, Questionnaire covering Convenience, speed, accuracy, Adaptive
9.	Module for Comtella D System [7]	Rule Based Ontology Collaborative Filtering	<ul style="list-style-type: none"> • Comtella D is an online community for discussion • Input used was Real World Data Set with 110 registered users • Evaluation Criteria used was Precision Recall distribution.
10.	Quickstep, Foxtrot recommender system [5]	Ontology Collaborative Filtering	<ul style="list-style-type: none"> • These systems recommends research papers • Input data used was Real World Data Set • Evaluation Criteria used were Precision, Recall

During the analysis of all the mentioned models, systems or frameworks in Table 1.1 from various research papers, it was found that most of the researchers have used Hybrid technology. Collaborative filtering technique is mostly used, which rely on numeric ratings to suggest the items. It was also found that sentiment analysis technique was never used for a book recommender system and therefore, there is a huge scope of research in this area.

IV. PROPOSED SYSTEM WITH SPECIAL FOCUS ON THE BOOK RECOMMENDATION SYSTEM INCORPORATING SENTIMENT ANALYSIS

The research proposes the introduction of sentiment analysis technique in a recommendation system to improve the quality of suggested resources as per need of learner, while keeping in mind the different characteristics of learner. Sentiment Analysis is also called opinion mining, subjectivity analysis, emotion detection. It aims to analyze people's sentiments, attitude, opinion, emotion towards items such as product, topic, individual, organizations etc [20].

Now as a pilot study, if a recommender system has to be proposed for recommending books to the learner the fig 1.1 would provide the sequential steps for it.

A prototype of the proposed algorithm is to be designed in such a way that learner first needs to get registered by providing basic personal information. Ontology is to be created for the learner based on the information provided during registration. Information related to books of computer science like its name, author details, rating, comments etc. would be kept. Ontology will act as a knowledge base and will help to identify the relationship between learner and books.

Data preprocessing will be done to identify similarity between learners and books based on ontology. Rating prediction will be calculated using Collaborative filtering technique to generate a list of book recommendations for the target user.

Preprocess the reviews of top N recommended books to carry out sentiment analysis. Preprocessing of reviews include removal of stop words, punctuation removal, case conversion etc.

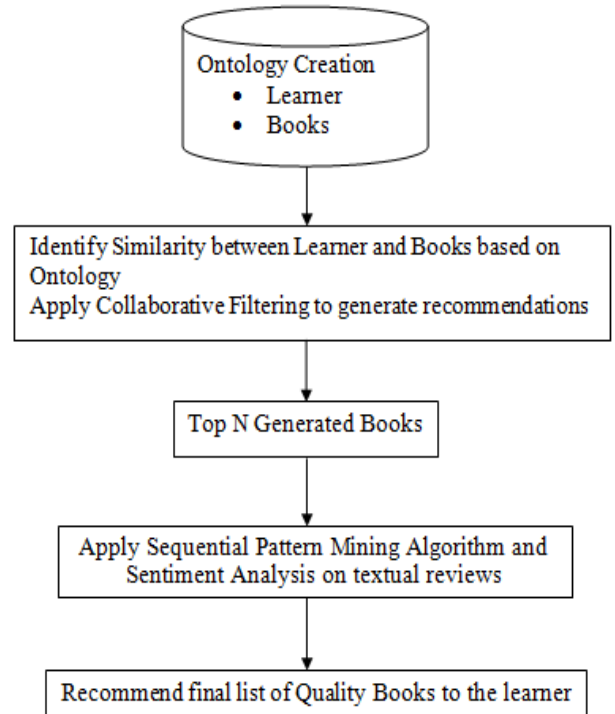


Fig 1.1 Sequential steps of Book Recommendation System

Application of the sequential pattern mining on the list of recommended books is to discover the learners learning patterns and to filter out the recommended books accordingly. Analyze the sentiments behind the reviews given by learners to check for the quality of the books.

System will recommend the final arranged sequence of books according to quality inferred by sentiment analysis. Books with more positive reviews will appear on top as compared to other books with less positive reviews.

V. CONCLUSION

This research paper attempts to incorporate sentiment analysis technique in Book recommendation system to check the quality of books. Existing studies have mostly concentrated on the Collaborative filtering technique and knowledge based technique to suggest the learning resources. These techniques mostly rely on quantitative information by considering the ratings given to the items while ignoring the qualitative information, which could be driven from the reviews related to learning resources given by the learners. Qualitative information can be included in book recommendation system using sentiment analysis technique. We will continue investigating the proposed system to look for results and will measure the performance using statistical techniques like precision, recall etc.

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Authors Profile

Mr. Anil Kumar is working as Assistant Professor in GGSD College, Haryana, Hoshiarpur, Punjab, India. He is currently pursuing Ph.D. form Department of Computer Science and Applications, Panjab University, Chandigarh, India. His main research work focuses is on Recommendation Systems, Sentiment Analysis. He has 2 years of teaching experience.



Dr. Sonal Chawla is working as Professor in Dpeartment of Computer Sciene and Applications, Panjab University, Chandigarh, India. She has published more than 25 research papers in reputed international journals including Thomson Reuters (SCI & Web of Science) and conferences. Her areas of research are Software Engineering, Operating Systems, E-Learning, Semantic Web Applications. She has 20 years of teaching experience and research experience.

