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PCRS: Personalized Course Recommender System Based on Hybrid Approach

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Abstract

The traditional system of selecting courses to carry out research work is time consuming, risky and a tedious task, that not only badly affect the performance but the learning experience of a researcher as well. Therefore, choosing appropriate courses in seminal years could help to do research in a better way. This Study presents a recommender system that will suggest and guide a learner in selecting the courses as per their requirement. The Hybrid methodology has been used along with ontology to retrieve useful information and make accurate recommendations. Such an approach may be helpful to learners to increase their performance and improve their satisfaction level as well. The proposed recommender systems would perform better by mitigating the weakness of basic individual recommender systems.

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Keywords: Recommendation, Ontology, Knowledge Modelling, Personalization, E-learning;

1. Introduction

The key issue for today's learner is that they need tailored access to information based on the preferences and requirements. To overcome this issue Recommender Systems (RS) are used that analyzes the information

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automatically according to the user preferences and most suitable one is presented in a large space of possible items [1]. To personalize information, recommender systems are used either to recognize a similar user or to identify particular objects of the user's interest. RS's prioritized the Information, related to items and provides user with meaningful recommendations as per their Interest. RS's are subset of information filtering concept having immense potential to help users in creating personal learning environment by identifying the most relevant and Interesting items from a large database then recommend it the user based on preferences and interest as shown in Figure 1.

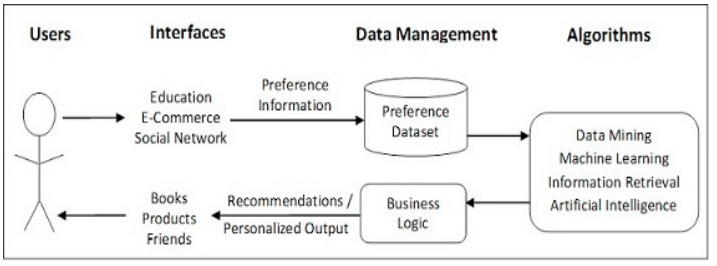

Fig. 1. General Recommendation / Personalization Process

Successful integration of recommendation system by online companies like Amazon, eBay, Flipkart etc impelled the research community to avail similar benefits in E-learning domain to recommend learning objects [2]. Learning objects are present in different forms that include Course objects, Content objects, information objects, reusable objects, nuggets, learning components, and units of learning [3]. Four categories of recommender systems such as Content-based, Collaborative, Knowledge-based and Hybrid systems based on how recommendations will be offered has been developed. Collaborative systems recommend items based on ratings with of similar users. On the other hand, content-based recommender systems propose items based on matching user profile. Knowledge-based recommender systems adopt techniques from artificial intelligence and check similarity between item and user. These systems use the deep knowledge about item features rather than user ratings. Furthermore, hybrid methods of combining the conventional recommender systems were proposed to mitigate the problems associated with individual recommender systems [4]. Nowadays, educational scenario is changing very quickly, new learning system trends are coming with new features but with the limitation of personalizing learning environment (PLE) using recommender system approach [5]. Since research scholars need courses from multiple domains they spend a lot of time to search courses from the curriculum. Integrating recommender systems in learning systems will be beneficial for both scholars and other learning tools by providing high potential to achieve personalization.

The aim of all recommender systems is to provide recommendation that will be favourably evaluated and accepted by its users. The objective of this study work is to design and develop a hybrid Recommender system that can be integrated to enhance the effectiveness of any E-learning system, to ease information access and to provide personalization to learners. The experimental results in this study show that using RS to choose courses performs well than traditional methods. The remainder of the paper is organized as follows: The next section 2 presents Literature survey, while as in Section 3 methodology is discussed. Section 4 will discuss the results. Finally, Section 5 will conclude the paper.

2. Related Work

This section shows an epigrammatic review of some of the relevant work on various approaches of recommender systems. Recommender systems made filtering of information easy and simple for its users because recommender systems use different information retrieving techniques to find and recommend items of interest to its users. Therefore, if a recommender system is able to recognize the intent and requirements that a user express in the form of queries, it can generate more valid recommendations.

In Google news, 38% of the total views are the result of recommendations; similarly 60% of the rented movies from Netflix come from recommendations and more than that Amazon sales percentage due to recommendations are 35%. Therefore, recommendation systems are considered an impending factor in business nowadays. But in education sector learners are still being provided with static and predefined patterns of learning courses, tasks, materials, objects in-spite of the fact that learner differ in characteristics such as learning interests,

objectives, needs, skills and personalities. Taking all these differences into account it has become essential for personalizing learning items for individual learners using recommendation systems [6].

2.1 Recommendation System in Education

Recommender systems for learning tools is getting importance because they provide personalized information in the interest of learners by providing relevant and personalized information. Artificial Intelligence techniques in this respect might useful with their ability of developing and imitating human decision making and reasoning process to minimize uncertainty for effective learning to ensure lifelong learning mechanism [7]. Recommendation systems strongly depend on domain to operate upon and it's not easy to take recommendation from one system and transfer it to another domain. Therefore, the challenge for recommender systems is to understand the learner's interest and the purpose of domain in a better way [8]. Association mining based recommender was developed for recommending tasks related to learning which are most suitable to learners based on the performance of the targeted learner and other similar learners [9]. Course recommendation system was proposed to check the program completion percentage of learners. Learners who have not completed their program will be recommended to complete. Ontology based approach is used for the recommendation but the recommendations are confined to a particular curriculum and recommendation are offered during middle of the program instead at the beginning [10]. An ontology based model was proposed for E-learning personalization to recommend learning objects by refereeing past preference history of learners. This system also suffers cold start problem like traditional systems and is limited to learning objects only [11].

A hybrid recommendation system was built for course recommendation with professor and student information dataset. Since the base of this recommender system is of collaborative in nature, it uses a filter of professor's ratings in course recommendation and proves that the quality filter in terms of professor's ratings does not interfere with the predictions of the proposed recommender system [12]. New E-learning systems should appear to ensure the personalization not only in terms of content but the courses and such issues can be overcome by applying recommender system to E-learning systems [13]. However, in one way or the other the major portion of information retrieval also involves machine learning techniques but both techniques evolve separately with time and left so many opportunities to use them in hybrid way especially where knowledge bases are created [14]. These systems are beneficial in situations where a learner is already enrolled and is undergoing some program. The proposed recommender system will be beneficial for non-formal and project based learning where learner before enrolling for research program has to choose courses to match his requirements. This process is tedious and can lead to skipping and ignoring some important courses which in turn can affect the performance of the learner.

3. Proposed Architecture and Methodology

This study focus on N-gram query classification and expansion based information retrieval for course recommendation along with ontology support. Given a set of courses, our recommendation system is comprised of the following steps: (1) the query will go for pre-processing to converted query into N-Grams. (2) Apply query expansion using WordNet to retrieve similar words (3) Retrieve courses and Apply TF to remove redundancy (4) Related courses are also extracted with the help of course ontology. The construction of proposed Architecture is shown in Figure 2.

3.1 N-Gram Classification and Query Expansion

The main objective of proposed methodology is to check the use of Information retrieval technique and enhances information retrieval when input to recommender system and thus results in better recommendations. Henceforth, validating its usage and predicting its impact will be helpful to enhance the information retrieval. While most of the recommender system is based on keyword based searching or they use ratings from learners.

The proposed system is based on a mixed combination of three individual techniques used in recommender information retrieval systems. The fundamental principle of our work is how to utilize N-Gram and Query Expansion approach and upgrade basic information retrieval technique along with the support of Ontology. The aim of N-Gram Classification is to convert the single query into N number of queries in the form of Gram list (Unigram, Bigram and Trigram). This classification converts a given query Xi into a list of N number of categories Xi (X1, X2, X3, X4 ... Xn) to maximize the information retrieval process in the sense if a single query have one keyword and fetches 3 related courses, multiple queries will generated more number of keywords and can fetch more courses,

thereby increase the chance of more accurate number of recommendations. The example of permuted query is given below. The N-Gram process starts with tokenization and the stop word removal.

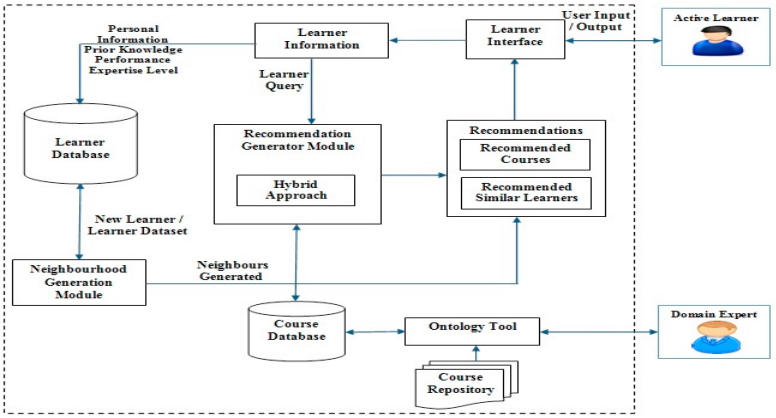

Fig. 2. Framework of Proposed Recommender system

User Query: Opinion Mining and Social Interaction Using Clustering Algorithms.
N-Grams: Opinion Mining, Mining Social, Social Interaction, Mining Interaction, Opinion Mining Clustering, Clustering Algorithms, Mining Clustering Algorithms

In this study WordNet is used that will generate synonyms which may help us to improve the recommendation generation in case system don't receive enough information from user area of interest or from their input queries. The basic aim of WordNet is to provide automatic text analysis and to produce the permutation of both thesaurus and dictionary. Mostly the query provided by the users in real world scenario contains terms that didn't match with the relevant items and this word mismatch makes information retrieval more difficult. Sometimes even relevant items are named with different terms than those present in the query. In order to solve such problems it is mandatory to modify the query and query expansion methods were proposed to expand the query. Query expansion works by reformulating the existing query by adding more relevant words as seen in Table 1 into the basic query to improve and to achieve better information retrieval effectiveness. Many expansion methods have been suggested but Query expansion remains most effective among all other approaches for improving the performance for information retrieval. The Similarity values between words are normalized as shown in Equation 1.

Table.1 Words and their synonyms from Wordnet

Word	Synonym
Picture	Image, Icon, Graphic, Art, Scene, Movie, Film, visualize, visualize,
Investigation	Analysis, Count, Numeration, empiricism; examination, scrutiny; examination, Testing, Inquiry, Enquiry, Research
Asset	Resource, liability , Vantage; Forte,
Video	Picture, Television, Telecasting, TV,

$$Sim_{ab} = \text{Max}\left[- \text{Log}\left[\frac{N_p}{2D} \right] \right] \quad (1)$$

3.2 Knowledge model development.

The Ontology modelling is proposed to create knowledge model for semantic web development and evolution to encourage ontology development because Ontology represent shared understanding of the domain of interest which enables the system and people to collaborate in a better way. Domain Ontologies containing domain-related concepts and relationships in a structured and machine-interpretable format are used to annotate domain resources [15]. Ontologies are explicit and formal description of a shared concept in a domain of discourse where classes are the main attention because classes describe concepts in the domain and individual Classes along with

Ontology constitutes a knowledge base. The basic aim is to develop knowledge representation of a particular domain that can be shared and reused later [16]. Classes represent a unique concept of a domain, and the objects of classes represent particular Items. The properties of objects present some binary relationships between two or more classes like "part-of" relationship shows that some class "B" is a subclass of class "A" [17]. In our proposed system Ontology is developed to create knowledge model for computer science domain. The developed CS ontology was done using with the help of protégé tool encoded in OWL-DL format. From the Figure 3 it can be seen how the developed ontology looks.

Algorithm I.

Input: *Dataset, End User Query*
Output: *Recommended Courses*

1. *Ontology is constructed for Computer science domain.*
2. *Start stemming the input query words.*
3. *Tokenize the query generated from step 2.*
4. *Remove predefined common words from tokenized query.*
5. *For each word find synonym using WordNet.*
6. *The words from the step 4 and step 5 are combined using Permutation to make N-Grams.*
7. *Match N-Grams generated from step 6 with database.*
8. *Related Courses for N- Grams are extracted from database.*
9. *Use term frequency to categorize and filter courses*
10. *Search related courses using Ontology relation from the result generated from step 8.*
11. *Return all the extracted courses.*

4. Result and Accuracy measurements

The objective of any recommendation system is to offer its users with the best possible and satisfactory recommendations. Towards this aim the results should be verified and measured for such recommendation systems as it is important to analyze how the search material is relevant with a particular user intended category. Therefore, accuracy value is used to measure the performance and effectiveness of the system. Accuracy measurement for different domain is also given in Figure 5.

$$\textbf{Accuracy Value} = \frac{\text{Number of Relevant Courses Retrieved}}{\text{Total Number of Retrieved Courses}} \quad (2)$$

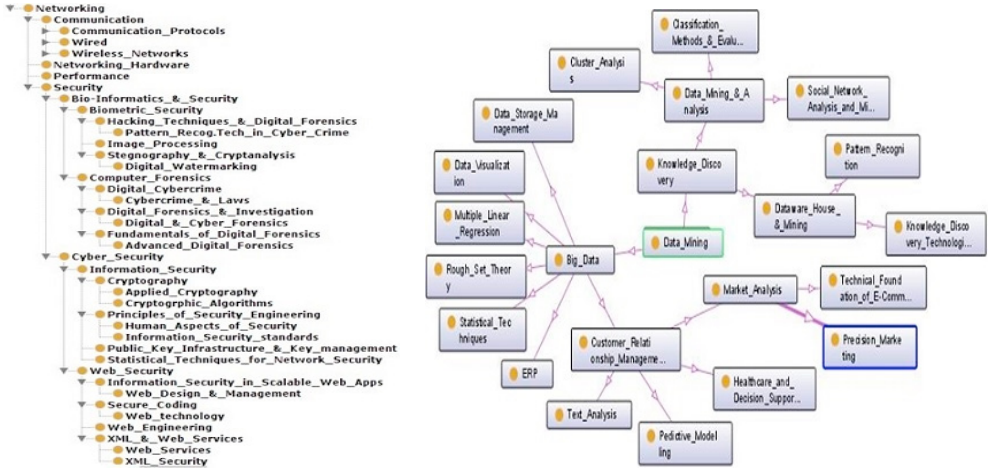

Fig.3. (a) Course Modeling (b) Course Ontograf.

The data has been collected from M.Tech Courses offered in Computer Science offered at BSAR crescent university, Chennai. This data set comprises of almost 300 courses updated for 5 different programs for the year 2016-17. The accuracy of the recommendation is defined by different classifiers of provided dataset. The recommendations generated are shown in the tables of Figure 4. The Classification resulted in recommending five courses, query expansion added more courses and makes count to nine and also retrieve related courses from ontology. There are various important factors in Accuracy like Precision, Recall, Sensitivity, f-measures. The, accuracy value is used to measure the performance and effectiveness of the system using equation 2. In this study we are calculating the total number of courses and the number of relevant courses for 75 queries for three different methods. For example input query S e.g. "Resource Optimization in cloud computing ".

The accuracy values comparison of our proposed system is shown in table 2. It is also mentioned the average number of relevant and total courses retrieved per query is maximum when course retrieval is done with query classification. Therefore, there accuracy a value will also be high as compared to keyword based searching. We utilized three different approaches together towards recommendation and it was seen that hybrid approach performs well and the accuracy is increased as compared to other two approaches. It has been seen during performance evaluation of that the queries that contains more domain terms are likely to fetch more relevant information as compared to query contains less terms. In this study we first did experiment with 75 queries and calculate precision and recall using confusion matrix which was 0.95 and 0.93 respectively along with F-score of 0.939. The aim of this study is to measure the effectiveness of information retrieval for hybrid process.

Table 2. Query String S Accuracy Evaluation

Input String	Retrieval Type	No. of Queries	Total No. of Retrieved Courses	No. of Relevant Courses	Average % of Total Courses & Relevant Courses Per Query	Accuracy Value
S	Keyword	75	225	169	Average = 3 Relevant = 2.25	75.11%
S	N-Grams	75	276	248	Average = 3.68 Relevant = 3.30	89.85%
S	Hybrid	75	295	281	Average = 3.93 Relevant = 3.74	95.25%

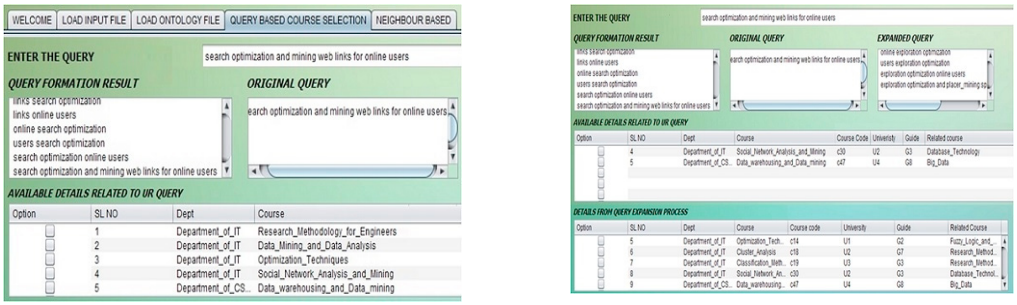

Fig. 4. (a) N-Gram Recommendations (b) Hybrid Recommendation

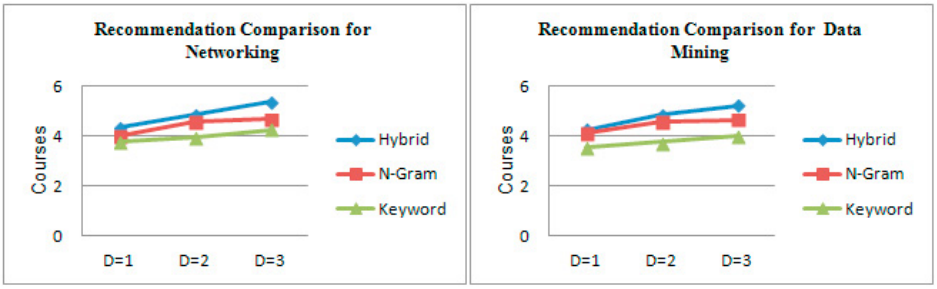

Fig. 5. Accuracy Measurement for two Domains

5. Conclusion

The recommender system is proposed keeping in view by overcoming the limitations of present individual recommendation system approach. Through experiments we have compared three techniques and we found that proposed system is more suitable, effective and beneficial to the learners. There are some common reasons to implement a recommendation system one among them is user satisfaction and another one to increase the fiscal success of the platform. In future neighbourhood generation to generate recommendations from knowledge base will be added. The intention of using neighbourhood formation is to find other similar learners based on their area of interest and requirements of targeted learner.

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