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Review: Recommender System

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Abstract— Internet users are increasing at an amazing speed. With increasing use of internet, the use of online sites for the purchase, sale of products such as movies, songs, books, videos, apparels etc. has also increased. This led to the competition among the web site owners and forced them to provide the personalized recommendation to their customers. The concept of personalized recommendation increased the trust and loyalty relationship between the web site owners and the customers. With this thought recommender system came into existence. Recommender system is a dynamic concept which is expanding as an influential research area and has its applications in various fields like e-commerce, business, entertainment, education, medical sciences and so on. This paper presents an overview of the recommender system and the different methods used for making recommendations. This paper also discusses the various limitations of the recommender systems that are still an area of research. There are some recommender systems in education domain which recommends research paper, articles to students and research scholars. However, application of recommender system to recommend faculty of an education institution to the students, management and other members does not exist. Therefore, this paper proposes to implement Faculty Recommender System and justify its importance.
Index Terms— Recommender system, collaborative filtering, content based filtering.

I. INTRODUCTION

The explosive growth of internet in recent years has increased. The number of internet users and variety of information available on the web has increased at an astonishing rate. This leads to the swift production of the e-commerce sites (which included buying, selling of products, comparing products etc) as more and more people rely on online web sites. Thus increased availability of choices among the internet users resulted in problem for users to select the best suitable option. The increased competition among these online sites led to development of the personalized recommendations to the customer.

To deal with this problem of information overload and to provide the personalized recommendation, recommender systems proved to be helpful. Recommendation systems are blend of tools and techniques which provides suggestions to the user regarding the items (things which are recommended to users) that are anticipated to be useful for the user. Recommender System [1] assists the users by suggesting new and not yet experienced items. These items can be predicted by recommendation approaches. For generating the predictions and recommendations, recommender system uses the data stored in the database of recommender systems.

The user can look through the recommendations. It's up to users that they like the recommendation or not and later can provide the feedback also. These feedbacks are stored in database by system and used for generating more new recommendations.

The recommendation approaches can be categorized on the basis of the process of generating recommendations. Collaborative filtering approach identifies the users in user set (the set of all users) similar to active user, and predicts from their ratings the ratings of an item for active user. Content based filtering is another valuable approach. It identifies the rating behavior of an active user and determines the possibility of liking an item by the user. Hybrid approach uses the two different approaches together to improve accuracy and efficiency of results of a recommender system. It mostly combines the content and collaborative filtering approach. Knowledge based filtering determines the interests of user and the features of an item. Then it infers the match between the item set and users need. These approaches can be applied in different areas. The area of application of recommender system has become wide within few years. These include e–commerce area, business area (include property, car trade recommenders, etc.), entertainment (includes movies, songs, video recommenders), medical (includes recommenders for doctors, medicines), education (include books, articles, research paper recommenders) and many more.

This paper presents a recommender system for the academic purpose which recommends the faculty to the students, management and other members of education fraternity. Depending upon the knowledge and data collected of users (faculty, students, management), recommendations are generated. We believe that this system will save the time of members of education al and provide results with accuracy.

The rest of paper is organised as follows. Section II summarizes the literature survey. The concept of recommender systems is

discussed in section III. Section IV presents the proposed system. Section V discusses the work done till now related to the proposed system. Section VI discusses the conclusion of the whole paper and the future work that would be done further.

II. LITERATURE SURVEY

In the early 1990's, the problem to deal with the overabundant information on the web arose. Collaborative filtering began as a solution to this problem. [2]The term 'collaborative' was coined by Drug Terry coined the term 'collaborative' at Xerox PARC. This was the part of development of information Tapestry System. It allowed the users to determine its relevance in reactions with other previous readers and also to annotate the documents read by them.

Next, lotus note developed in collaborative filtering and soon, the collaborative filtering followed the path of automation. It automatically located the relevant opinions and used them to generate recommendations. GroupLens [3] started in 1992 used this technique to simplify the data on the 'Usenet'. Users provide ratings and GroupLens identified the articles which seemed to be interesting to particular user. It built on the premise of Tapestry but in GroupLens user need not know about the relevance with previous readers.

At this stage the recommendation system became an interesting topic among the researchers related to the various fields such as Human Computer Interaction, Machine Learning and Information Retrieval. At MIT, Pattie Maess developed a music recommendation system FIREFLY [4] with use of collaborative filtering. Many recommendation systems developed using technique of collaborative filtering such as Mosaic allowing users to publish comments on web pages, HOMR and Ringo[5] for music recommendations.

An example of commercial deployments recommender system is Amazon.com [6] which started in the late 1990's. They suggested recommendations to the user by determining the items liked in past and items currently viewed by user and community.

Beyond the collaborative filtering, the approaches of recommendation grown further to content-based which was based on information retrieval, Bayesian inference and case-based reasoning. By the combination of the collaborative and content based filtering, the new approach named Hybrid Recommender system emerged. In 2006, when Netflix launched Netflix Prize to improve movie recommendation, the research work related to recommenders then gained and is still gaining significant attention. Yahoo, Points Top5%, PHOAKS, fab, Web doggie, Alexa Internet are some other well-known names of recommender systems [4].

The trend of recommender system has made its place in different areas and also the research in area of recommender system is taking place at fast pace. But recommending the best and better item to the particular user with the maximum usefulness, from the large space of user and items got difficult and lead to some problems. The researchers then focused to find the optimized and best result in recommendation.

Cold start problem is that the recommender system does not have enough information by which it can conclude the inferences for users and items. Researchers recently proposed technique to solve the cold start problem. They proposed that by combining the association and clustering technique this problem can be solved [8]. The proposed technique to address the important issues like improving accuracy and dealing with sparsity problem is also proposed by researchers [9]. The proposals of efficiently generating the self-similarity matrix are made with much less computational cost than the traditional systems [10].

III. RECOMMENDER SYSTEM

Recommender systems are the subpart of the information filtering systems. They compute the rating and preferences that user would might give to an item.

[1] Let there be a set of users U and the possible set of items I which can be recommended to the users. The set of users and items may be in a large bulk. If we want to calculate the usefulness of an item *i* to user *u* that means we want to measure utility function:

$$UF, UF: U \times I \mapsto O \quad \text{..... (i)}$$

Here O is the ordered set. Then for each user $u \in U$, we want to choose the items $i \in I$, so that the user's utility is maximized.

This utility function should be calculated with the best method so as to get accurate results of UF, by which we can find out the usefulness of an item to user and recommend the best to him from the bulk of items.

Recommendation system targets to provide the first-rate recommendations to the users. On the basis of the ratings given to the items liked by users or by utilizing the information of neighbor users or by using the contextual information provided by users, recommendations are made. Neighbor users are those which form the community of the active user. The suggestions are made to user either by providing characteristics of the product or by summarizing the opinion and critiques of the neighbor users.

Recommender system builds a relationship of confidence and trust between the user and the websites. These websites learn about

their customers and use the recommender systems to act on that learning. Then recommender system predicts the recommendations that match consumer needs and consumer shows their loyalty by acting on the recommendations made. Loyalty means that he would visit the website again for more purchasing.

There are different types of approaches [1] of recommender systems that vary in terms of the knowledge used, the recommendation algorithm followed, how the recommendations are generated, assembled and presented to the user. These different approaches are discussed in brief below.

A. Collaborative Filtering

[1, 7] is a popular approach for predicting recommendations on the basis of ratings and information provided by the user. The key assumption behind this type of recommendation is that it might happen that people related to each other might have same likings and interest. So other users with same likings and interest are selected and by using their data and ratings the recommendations to the active user is made. But this approach requires the users' active participation and an appropriate algorithm that is able to find and match the people with similar tastes. Collaborative filtering can be done by two ways: in first, the users who share same ratings pattern are identified with respect to the person for whom the prediction is to be made and then rating of other users is used to calculate prediction for active user. This is called user based collaborative filtering.

In item based collaborative filtering, item-item matrix is designed by examining the pairs of items. Then it identifies the interests of active user with by matching the data with the matrix. The idea of item based collaborative filtering was created by Amazon.com.

1) Amazon : which is an example of commercial deployment of recommender system started in the late 1990's. When user selects an item at Amazon site, the Amazon recommends other items. These other items are recommended to users by analyzing the items purchased by other users based on similarity with the original item. Amazon patented this approach of recommendation and called item-to-item collaborative filtering.

2) Last.Fm [4] recommends music using the collaborative filtering approach. It observes the bands and tunes that are most played by the user and recommend those tunes to the user with similar listening habits.

Some *social networking* [11] sites like Facebook, MySpace, LinkedIn use collaborative filtering to recommend new friends, groups. LinkedIn which is a social networking site which recommends people you might know, jobs you might like, groups you might want to follow, or companies you might be interested in.

A streaming-video website called *Hulu*, recommends the content to users by identifying the interest similarity between users. It uses the collaborative filtering for recommending.

B. Content Based Recommendation

[1,7] approach is another approach for making recommendations by content filtering of data. The evolution of the content based recommendation started from the concepts of information retrieval and information filtering research. This filtering approach is different from the collaborative, as collaborative approach predicted the items based on the identification of similar rating pattern between the users. This approach predicts and recommends the item to the user by evaluating the content of the items and profile provided by the user. This approach looks at the content of particular item with respect to the type of item and finds the other items with common features. Then the item with more similarity rate is recommended to the user.

1) Netflix, [12] the video rental and streaming service make recommendations by observing the watching and searching habits of users with similarity on basis of collaborative filtering and also by analyzing characteristics with films that a user has rated high on basis of content-based filtering.

2) eBay is other example of shopping site which provide recommendations with help of user and buyer both. The user rates the items and on basis of ratings, liking on the items, the recommendation mails are sent to user.

3) Pandora is based on content based recommendation and uses the content such as the properties of a song or artist to make recommendations.

C. Hybrid Approach

[1, 13] combines collaborative and content-based filtering and also increases the efficiency of recommender systems. Incorporating the results of collaborative and content-based filtering creates the potential for a more accurate recommendation. The hybrid

approach could also be used to address collaborative filtering that starts with sparse data known as cold start.

D. Knowledge Based Recommendation Approach:

[1] There are some other areas where many of the customers are one time buyers. In these types of domains recommender system by using the above mentioned approaches is not able to predict accurate recommendations for the user. Suppose we have a recommender system of LED's and in this recommender system the customer can find the model that matches his requirements. But recommender system is not able to recommend LED's that others liked s many of the customers are one time buyers in this domain and recommender system fails to create a user profile.

Knowledge based approach efficiently makes use of information either it is about active user or items available.

Despite of all the advances, there are number of limitations in recommender systems. These limitations need to be addressed to get more accurate and efficient results. Some of these are [1]:

1) Cold Start: Some approaches of the recommender system require a large amount of data as an input, on which recommendations method can be applied. As they require more amount of data so as to make accurate recommendations. And this is not possible for all cases.

2) Scalability: Scalability is also a problem. Recommender systems have to make recommendations from the millions of products for millions of users. This requires high computation power to calculate recommendations.

3) Sparisity: We use the concept of ratings in recommender system. But the user that even is most active of all will only have rated the a subset of the overall database and due to this even most popular items have less ratings. This affects the recommendation accuracy.

From the survey of existing recommender systems, it is concluded that there are less applications of recommender systems in the field of education. The applications in education field are limited to recommending articles, research papers to the students and research scholars. However, application of recommender system to recommend faculty of an education institution to the students, management and other members does not exist. Section IV proposes the recommender system for the members of educational institution.

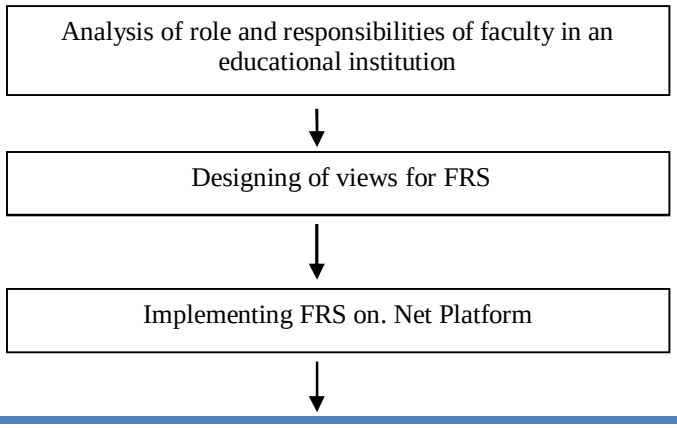
IV. PROPOSED WORK

For any educational institution, students are the central heart as all the uphill battle by faculty, management of the institution is done for ensuring students satisfaction. FRS acts as an aid for students that facilitate them to steer the faculty dossier effortlessly. It computes and estimates the recommendation to the students of the faculty members. The inputs required for making recommendation can be originated either from the users (students) for whom we are making recommendations and other from the users who form the community of the targeted user. The inputs can be gathered by implicit and explicit navigation. The implicit navigation gathers input data by inferring the user behavior without making the customer aware. And the explicit navigation collects the input by the user which is knowingly provided by him to make the system know about his preferences.

In some other cases, the input can be derived by using the keywords and item attributes from the items viewed by user. From the ratings and likings made by the user and community of user the input can be generated.

Outputs produced by the recommender system are in form of suggestion and predictions. Suggestions can be, "if a person liked a thing X then there is a possibility of liking Y". Predictions can be in form of ratings which can be predicted for the targeted user.

The proposed algorithm for faculty recommender system is as follows:



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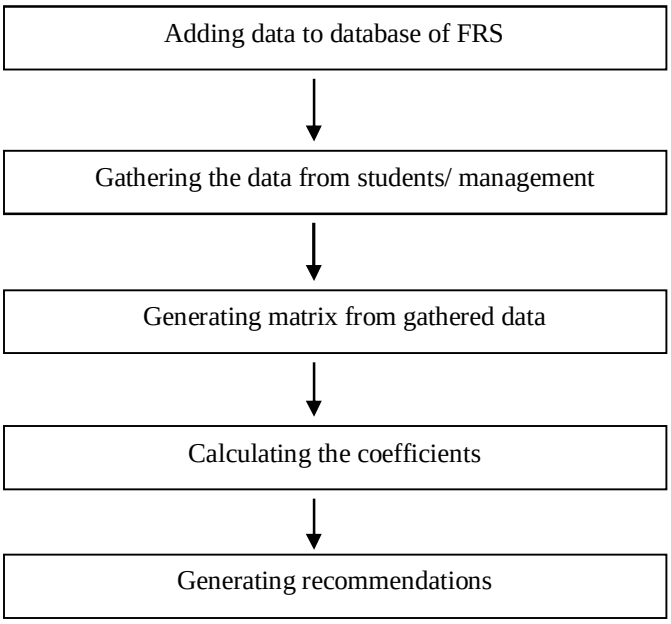

FRS tries to understand the similarities among the faculty members which student has liked in the past (specific subject, expert area, languages, tools etc.). The work to implement FRS is in development process and so far the work completed is described below.
Firstly, the complete analysis was done to determine the roles and responsibilities of the faculty in an educational institution. In the analysis, we determined that faculty has multi tasking roles and responsibilities. This helped us to design different views for the faculty recommender system. FRS can be categorized in four views; admin, management, faculty and student. Admin view manages the insertion, deletion and updating the data of the members of the institution. The management is able to view the faculty data and will get the recommendations of the high rated faculty by students. The faculty is able to view the restricted data of other faculty members. The student view is an important view of FRS where students can like and rate the faculty data. With the input as ratings and likings, recommendations will be generated.
Next, the implementation of these design views on FRS has been done. Then, the data was gathered from the students, management and the faculty. Students liked and rated the faculty data.
After the generation of matrix of students and teachers, then the similarity between similar set of users (students) is calculated by Pearson correlation coefficient [14]. The similarity sim (a, b) of users a and b is defined as:

$$sim(a,b) = \frac{\sum_{p\in P}(r_{a,p}-\overrightarrow{r_a})(r_{b,p}-\overrightarrow{r_b})}{\sqrt{\sum_{p\in P}(r_{a,p}-\overrightarrow{r_a})^2}\sqrt{\sum_{p\in P}(r_{b,p}-\overrightarrow{r_b})^2}} \quad \text{..... (ii)}$$

Here, P = {p1, . . . , pm} for the set of products (items), and R as n × m matrix of ratings, $\overrightarrow{r_a}$ corresponds to the average rating of user a and $\overrightarrow{r_b}$ corresponds to the average of user b.
The similarity between the items (faculty) is calculated by cosine similarity [14]. The similarity between two items *a* and *b* can be viewed as the corresponding rating vectors $\vec{a}$ and $\vec{b}$ is defined as:

$$sim(\vec{a}\,\vec{b}) = \frac{\vec{a}-\vec{b}}{|\vec{a}|*|\vec{b}|} \quad \text{..... (iii)}$$

The results of the similarity calculated by Pearson and cosine coefficients are used for generating the recommendations.

V. CONCLUSION

This paper proposes a FRS which can be efficiently used for the academic purposes. This proposed approach recommends an algorithm for recommending faculty to the members of the institution (students, management, other faculty etc.) which can serve as a

wonderful platform for the students and other member of an education institution. The proposed scheme has been successfully implemented in .Net. In future, the recommendations generated from this system will be processed for further analysis of the incoming recommendations and for generating new recommendations.

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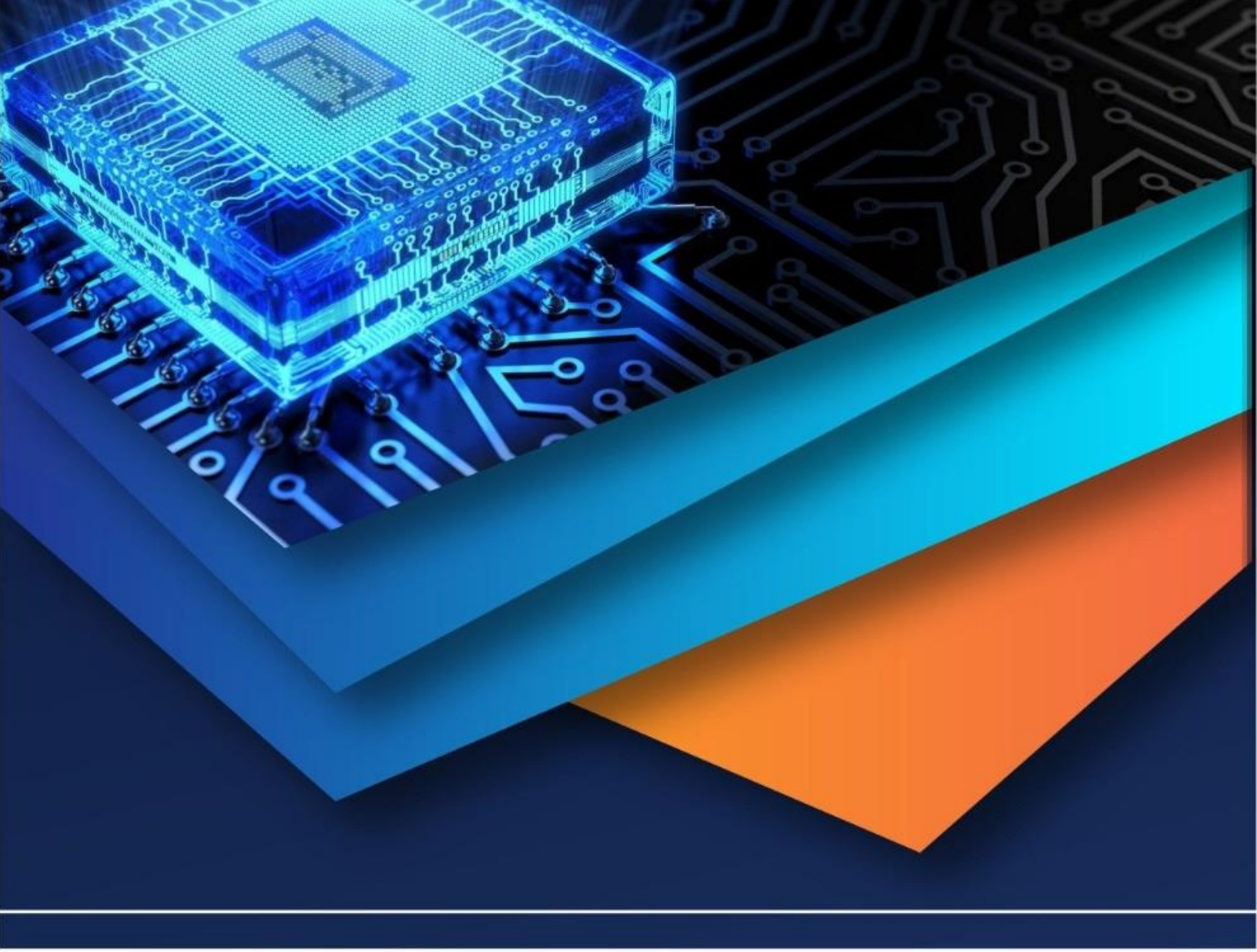

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