

Study and Comparative Analysis of Existing Recommender Systems

Sanjay^{1*}, Yogesh Kumar², Rahul Rishi³

^{1,2,3} University Institute of Engineering and Technology, MDU Rohtak, (India)

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Abstract: This article provides an overview of the various recommender systems, their classifications and comparative study. A recommender system is a software tool used for making suggestions about the items which are of interest to the user and the word “item” refers to the products or services that the system recommends to the individuals. With the emergence of internet, the amount of information available to the users is immense which may lead to confusion while making the final decision of selecting an item. Therefore, it becomes highly imperative to assist the users in selecting the final item. The recommender system attempts to solve the problem by exploring large amount of information and bring personalized content for the users. Such systems are being used for making decisions in different contexts ranging from movies recommendation to news feed.

Keywords: Recommender System, Collaborative, Content-based Filtering, Hybrid Recommendation

I. INTRODUCTION

The recommendation systems are software tools and techniques which are used to provide suggestions to the end user depending upon his/her recent searches. The recommendation systems are being used at every aspect where customers have to choose between various choices and they don't have appropriate tendency to judge about the products/items. In the recent years recommender systems have played a significant role in decision making. As the web has grown to a large extent with a lot of information and huge number of users so here is a big question for companies that how they can fulfill the requirements of the end users based on their preferences and tastes.

The rest of the paper is organized as follows; Section 1.1 gives the idea about various types of approaches to give the appropriate recommendations to the end users, Section 2 contains the literature analysis of recommender systems in different domains using various principles and methods, Section 3 contains the comparative analysis of various literature reviews such as what methodologies were used and key features, year the research was made, Section 4 concludes the research work done so far and future prospective of research on recommender systems.

I.I Classification of Recommendation Approaches (RA):

Table1. Recommendation Approaches

Type	Description
Content-Based RA	In this approach the RS recommends the items which have same properties as the items chosen by the user in the past.

Type	Description
Collaborative-Filtering RA	Here in Collaborative-Filtering RA the recommender system uses the past behavior of the users/community to predict the items that user will like the most
Demographic Recommendation Approach	Here in Demographic RA the RS chooses the products on the basis of the demographic profile of the user. Users have different recommendation needs as per their demographic profiles.
Utility-based (Knowledge-based RA)	Here the RS recommend the products as per the preferences of the users and the information received about the user's opinion about which type of items the user will like the most. This approach recommends in two ways: <ul style="list-style-type: none"> • Cased Based: To get the recommendations system uses the information received so far about the users and the products. • Constraint Base Recommender: It uses the recommendation rules with knowledge base to map item characteristics with user requirements.
Community-based RA	Here in this RA, the RS recommend the products to the users based on their friend's choices as people trust more in recommendation from friends instead of unknown recommenders. In this type of RS the social networks have generated more interest.
Hybrid RA	This RA is the combination of content based and collaborative recommendation approaches. This RS gives more accurate recommendations and uses available facts in a better way.

II. LITERATURE ANALYSIS

II.I. 'Collaborative Filtering Recommender Systems'

Collaborative filtering approach is among the most frequently studied technique in the literature. This system is based on principle of finding the other users with the similar preferences and utilizes their opinions to provide recommendations to the active user. MovieLens is the system based on collaborative filtering. These systems started with the development of pull-active collaborative filtering at Xerox, PARC. Then, a better system called automated collaborative filtering (ACF) was developed to deal with the limitations of earlier system. This system was based on constructing a matrix of correlations between the users to find the other users having similar taste and make final choices based on the feedback provided by these neighbors (Schafer *et al.*, 2007).

The content based system ignores the contribution made by other similar users. The CF system suffers from the problem of 'cold start' where no previous information about the user and item is available.

The content based system only bases the recommendations on matching the content to the user characteristics and information. Based on the past information and feedback given by the users, the items closely related to the positively rated items are recommended. News Dude is an appropriate type of the system using content based filtering to recommend news.

II.II 'Empirical Analysis Of The Impact Of Recommender Systems On Sales'

A RS proves useful for both user and the service providers. On one hand, it helps the users in making better decision while on other hand it helps to improve overall revenue of the business by increasing the sales. The RS consider the interaction among recommendations, sales and prices. This RS shows the positive effect of recommendation on the retailer's sale of items. The RS provides efficient support to the retailer to increase/decrease their product prices depending upon the demand of the products. The retailers can analyze the demand by getting the recommendations about the quality and match of products (Pathak *et al.*, 2010). This recommender system uses the collaborative filtering approach to make the recommendations.

II.III 'Recommender Systems Survey'

The Evolution of RS has grown enough with the growth of the web. As per survey done on recommendation system mainly three types of RS came into existence. The first generation of RS uses the information collected from websites based on the content based i.e. the items purchased by individual users, demographic data and memory based data of the users. In addition to above mentioned kinds of systems, in the second generation of Recommender Systems

the researchers are attempting to improve the performance of RS by incorporating the social and contextual information (trusted users, followers etc.) into it. The social information can be collected by creating the implicit social networks of the users or by studying already existing social networks present in the community (Bobadilla *et al.*, 2013). In the third generation of recommendation system will use the information collected from the devices integrated on the internet such that data will be collected by sensors on the internet to get the location information, and to sense the local temperature and pressure at a specific time and location.

II.IV 'Recommendation Systems: Principles, Methods And Evaluation'

In order to evaluate this similarity the content based systems use different techniques as Term & Inverse Document Frequency, Decision Trees and Neural Networks. The advantage associated with this method is that the system does not require the information about other users and it can easily make adjustments in the recommendations with the change in the profile of a user. It can also make the recommendations even when no past ratings are available. However, it is limited on the pretext of the need of comprehensive knowledge about the features of the items present in the profile (Isinkaye, Folajimi and Ojokoh, 2015).

Although both kinds of the models prove to be the successful techniques for recommender systems, yet these methods have certain drawbacks associated with them which lessen the performance. In order to overcome the pitfalls associated with these models, the hybrid filtering models have emerged as a probable solution. This filtering method combines two or more techniques to achieve better accuracy and performance of the recommendations. The models are combined together to attain the benefits associated with all the constituting models and suppress their individual drawbacks. The models can be combined in different ways such as weighted hybridization, cascade hybridization, switching hybridization etc.

II.V 'Implementation Of A Recommendation System Using Association Rules And Collaborative Filtering'

These systems may even be useful for the businesses such as the RS developed to suggest local businesses about the probability of the visiting customers (Jooa, Bangb and Parka, 2016). The RS uses the association rules to specify how possibility of occurrence of one event is related to another event. There is a database D and transactions are occurring on the database as $D = (T_1, T_2, T_3, \dots, T_n)$, then the association rule will be expressed as $R: A \rightarrow B$ i.e. when event A occurs then there is probability of occurrence of event B .

Collaboration filtering is used to identify the purchasing behavior of the users and the type of businesses. The RS makes a list of recommendations based on the businesses not tried by users. In this way both the businesses and users may get the recommendations which are related to them.

II.VI ‘A General Framework For Intelligent Recommender Systems’

In addition to the business context, the RS are also being used in the context of educational affairs such as course, book and research paper recommendations. The extant literature focuses on number of RS which may be classified into following categories: the content-based system, collaborative filtering based system and hybrid systems (Aguilar, Valdiviezo-Díaz and Riofrio, 2017). Intelligent RS consist of a framework which contains mainly four elements such as:

- Knowledge Acquisition mechanism
- Knowledge Explicit Modeling – It represents facts to make recommendations.
- Reasoning Mechanism – to convert the facts from stored knowledgebase to information
- Criticality System – based on automatically generated inference capability.

Intelligent RS recommends items based on the interest properties which user likes about the product. It is mix of both the general RS as well as critically deduced information of the items which are not in capacity to fulfill the expectations of the users. The IRS exploits all the available knowledge and to do this all information retrieval and data mining techniques are used.

II.VII ‘An Effective Collaborative Movie Recommender System With Cuckoo Search’

The lot of work have also been done to improve the overall performance of the algorithms by incorporating new optimization algorithms inspired by natural phenomenon such as cuckoo search (Katarya and Verma, 2017). The application of other nature inspired optimization algorithms such as ant colony, bee colony algorithms can be explored in the context of recommender systems. The RS uses the clustering technique as a data mining tool which partitions a set of data into homogenous parts with some specific similarity and dissimilarities metrics. Hybrid clustering an optimization approach is used to enhance the movie prediction accuracy and to remove the drawbacks of content-based and collaborative recommender systems.

K-means algorithm is used for clustering and cuckoo search optimization is used to implement optimization. This approach is able to produce a high performance, reliable and accurate Recommender System with specific number of clusters. This approach has a limitation that if the initial

partition doesn't work well then the efficiency of the system may decrease.

II.VIII ‘Personalized Book Recommendation System’

There is always a big question in the minds of students that which book needs to be referred for a specific topic. Here the idea behind the development of recommendation system is to recommend books to the users with increased accuracy and as per the needs of the users (Jayanti Rathnavel, Kavita Kelkar, 2017). The RS used the hybrid recommendation approach which is the combination of both the content-based and collaborative approaches. This RS eradicates the problems like cold start by using the demographic parameters such as age, location etc. and uses the lightfm model to produce a recommendation of books which has not explored by the users. This system aims to provide the personalized recommendations of the books to the users.

III. COMPARATIVE ANALYSIS OF LITERATURE REVIEW

As every recommender system uses a specific approach and algorithms to solve a specific problem and produce the desired recommendations for the users. Comparative study of the various review papers is prepared here under:

Review Paper	Authors	Methodology Used	Key Features
Paper on “Collaborative filtering recommender systems”	Schafer, J. Ben, Frankowski, D., Herlocker, J. and Sen, S. (2007)	Collaborative-Filtering RA	This system was based on constructing a matrix of correlations between the users to find the end users having similar tastes and thus makes final recommendations based on the feedback provided by these neighbors. MovieLens is the system based on collaborative filtering.
Paper on “Empirical analysis of the impact of recommender systems on sales”	Pathak, B., Garfinkel, R., Gopal, R. D., Venkatesan, R. and Yin, F. (2010)	Collaborative Filtering Approach	The retailers can analyze the demand by getting the recommendations about the quality and match of products

Review Paper	Authors	Methodology Used	Key Features
Paper on “Recommender systems survey”	Bobadilla, J., Ortega, F., Hernando, A. and Gutiérrez, A. (2013)	Content-Based, Collaborative filtering and Hybrid recommendation approach	The first generation of RS uses the data collected from websites based on consumer’s behavior. In Second generation RS social information can be collected by creating the implicit social networks of the users or by studying already existing social networks present in the community
Paper on “Recommendation systems: Principles, methods and evaluation”	Isinkaye, F. O., Folajimi, Y. O. and Ojokoh, B. A. (2015)	Content-Based Approach	It can make the recommendations even when no past ratings are available. However, it is limited on the pretext of the need of comprehensive knowledge about the characteristics of the products present in the portfolio.
Paper on “Implementation of a recommendation system using association rules and collaborative filtering”	Jooa, J., Bangb, S. and Parka, G. (2016)	Collaborative Filtering Approach	RS developed to suggest local businesses about the probability of the visiting customers using the association rules to specify possibility.
Paper on “A general framework for intelligent recommender systems”	Aguilar, J., Valdiviezo-Díaz, P. and Riofrio, G. (2017)	Hybrid Recommendation Approach	IRS recommends an item based on the user interest properties It is mix of both the general The

Review Paper	Authors	Methodology Used	Key Features
			IRS exploits all the available knowledge and to do this all information retrieval and data mining techniques are used.
Paper on “An effective collaborative movie recommender system with cuckoo search”	Katarya, R. and Verma, O. P. (2017)	Hybrid Recommendation Approach	In this system a lot of work has also been done to enhance the overall performance of the algorithms by incorporating new optimization algorithms inspired by natural phenomenon such as cuckoo search. K-means algorithm is used for clustering and cuckoo search optimization is used to implement optimization.
Paper on “Personalized Book Recommendation System”	Jayanti Rathnavel, Kavita Kelkar(2017)	Hybrid Recommendation Approach	RS eradicates the problems like cold start by using the demographic parameters such as age, location etc. and uses the lightfm model to produce a recommendation of books which has not explored by the users.

Table2. Comparative Analysis of Reviews

IV. CONCLUSION AND FUTURE SCOPE

Evolution of the recommender system is accompanied with the evolution of the web. A lot of research has been done on various types of recommendation systems and algorithms to produce the reliable and accurate recommendations to the

end users. Recommender system uses various approaches such as content-based recommendation (the recommender system recommends product and services based on the users past history), collaborative filtering recommendation approach (based on past history of the users behavior, the products the user will like the most), hybrid approach (combination of both content-based and collaborative approaches). First recommender systems were focused on improvements in the accuracy of the recommendations through filtering and various memory-based methods and algorithms. Later on research was made to make more improvement in the recommendation using trust-worthy algorithms and social network analysis. Currently hybrid algorithms are being incorporated with the earlier recommendation algorithms. So the main concentration of the future research will be to enhance the quality of the existing recommendations systems by making the advancements in the existing methods and algorithms such as:

1. To get most of the benefits from devices and sensors implemented on the internet.
2. To enable the security features and privacy of the individual users in various recommender systems.
3. To create the specific generalized standard for the evaluation measures being used in non-standardized way.
4. To combine various existing recommendation methods in a better way.

REFERENCES

- [1] J. Ben. Schafer, D. Frankowski, J. Herlocker, S. Sen, "Collaborative filtering recommender systems", The adaptive web, Springer, Vol. 4321, pp. 291-324, 2007.
- [2] B. Pathak, R. Garfinkel, R. D. Gopal, R. Venkatesan, F. Yin, "Empirical analysis of the impact of recommender systems on sales", *Journal of Management Information Systems*, Taylor & Francis, Vol. 27(2), pp. 159-188, 2010.
- [3] J. Bobadilla, F. Ortega, A. Hernando, A. Gutierrez, "Recommender systems survey" *Knowledge-based systems*, Elsevier, Vol. 46, pp. 109-132, 2013.
- [4] F. O. Isinkaye, Y. O. Folajimi, B. A. Ojokoh, "Recommendation systems: Principles, methods and evaluation", *Egyptian Informatics Journal*, Elsevier, Vol. 16(3), pp. 261-273, 2015.
- [5] J. Jooa, S. Bangb, G. Parka, "Implementation of a recommendation system using association rules and collaborative filtering", *Procedia Computer Science*. Elsevier, Vol. 91, pp. 944-952, 2016.
- [6] J. Aguilar, P.Valdiviezo-Diaz, G. Riofrio, "A general framework for intelligent recommender systems", *Applied Computing and Informatics*, Elsevier, Vol. 13(2), pp. 147-160, 2017.
- [7] R. Katarya, O. P. Verma, "An effective collaborative movie recommender system with cuckoo search", *Egyptian Informatics Journal*, Elsevier, Vol. 18(2), pp. 105-112, 2017.
- [8] J. Rathnavel, K. Kelkar, "Personalized Book Recommendation System", *International Journal Of Engineering And Computer Science*, Vol. 6, Issue.,4, pp. 149-153, 2017.
- [9] S.N. Patil, S.M. Deshpande, A. D. Potgantwar, "Product Recommendation using Multiple Filtering Mechanisms on Apache Spark", *International Journal of Scientific Research in Network Security and Communication*, Vol. 5, Issue. 3, pp. 76-83, 2017.
- [10] N. Sujatha, K. Prakash, "An Efficient and Scalable Auto Recommender System Based on Users Behavior", *International Journal of Scientific Research in Computer Science and Engineering*, Vol. 6, Issue. 6, pp. 35-40, 2018.

AUTHORS PROFILE

Mr. Sanjay pursued Bachelor of Computer Applications and Master of Computer Applications from Guru Jambheshwar University of Science and Technology, Hisar and now currently pursuing M.Tech (Software Engineering) from Department of Computer Science and Engineering, University Institute of Engineering and Technology, Maharshi Dayanand University, Rohtak (India).



Mr. Yogesh Kumar pursued B.Tech, M.Tech and Ph.D. and currently working as an Assistant Professor in Department of Computer Science and Engineering, University Institute of Engineering and Technology, Maharshi Dayanand University, Rohtak (India).



Mr. Rahul Rishi pursued B.Tech, M.Tech and Ph.D. and currently working as a Professor in Department of Computer Science and Engineering, University Institute of Engineering and Technology, Maharshi Dayanand University, Rohtak (India).

