A Review of Different Techniques for Recommender Systems

Ashwini N. Mankar[1] Prof. Gogate Uttara Dhananjay[2]
[1]P.G. Scholar [2]Associate Professor
[1,2]Department of Computer Engineering
[1]A.R.M.I.E.T, Mumbai University, India [2]S.S.J.C.O.E, Mumbai University, India

Abstract— Recommender Systems is considered as a software tool or technique which provides recommendations for items which would be beneficial for the user. The ultimate aim of providing recommendations is to support the user in their several decision-making processes, such as which product to purchase, which type of music they should listen, or what news to read. In the E-commerce user is loaded with lot of information about various items available on the internet, the Recommender systems have recognized to be important mean to help the online users. Different techniques for recommendation generation have been proposed. The techniques for recommender systems can be categorised in four main types they are Collaborative Filtering (CF), Content Based Filtering (CBF), Knowledge Based Filtering (KBF) and Hybrid Filtering (HF). This paper contains an outline of given techniques of recommender systems.

Key words: Recommender System, Collaborative Filtering Content Based Filtering, Knowledge Based Filtering, Hybrid Filtering, Information Filtering

I. INTRODUCTION

Using the Internet business world have found more customers and more profit. On the internet variety of online shops, auctions markets are opened up. Today, each user of the World Wide Web can buy several items that may belong to any part of the world. The major E-commerce sites suggest number of items for sale. Selecting among so many options is very difficult for users. To solve such problems the recommender system assists the user. Recommender systems can be the part of personalized information filtering skills. It aims to implicitly advise which items or products amongst the available may be of concern to a specific user. While making recommendations, system goes through three essential stages that are preferences

Gathering (getting priorities from the data entered by user),recommendation calculation (calculating the recommendations using suitable means) and recommendation presentation (giving the recommendation to the user).The below figure 1 shows the categorization of present recommendation systems it include the techniques as (1) Collaborative Filtering. (2) Content Based Filtering (3) Knowledge Based Filtering and (4) Hybrid Filtering [1][2] [4].

This paper is structured as follows: Various functions performed by recommender system, Collaborative Filtering Approach, Content Based Approach, Knowledge- Based Approach, Hybrid Approach, and conclusion.

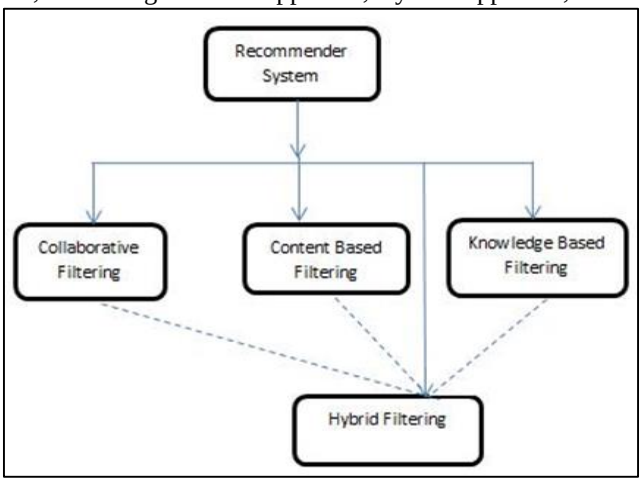

Fig. 1: Recommender Systems Techniques.

II. FUNCTIONS PERFORMED BY RECOMMENDER SYSTEMS

Various functions performed by recommender systems are as follows:

- Rise in the quantity of products sold: This is perhaps the very essential function for a commercial Recommender Systems that is it helps to sell surplus number of items than the normally sold without making use of any kind of recommendation.
- Sell more different items: Another important function of a Recommender Systems is to allow the user to choose particular product that may be difficult to discover without a particular recommendation.

- To improve the rate of user satisfaction: A properly planned Recommender Systems can also increase the involvement of user in the site or the application. With a properly designed system user can discover the recommendations exciting, related and the user will also love to use the system.
- Increase user reliability: A person who uses the system should be faithful to a Web site, when visit again, the site identifies the old customer and treats him as a important user. It is also important feature of a Recommender Systems. It maintains the information assimilated from the user in earlier interactions, e.g., the ratings of the products.
- Better understanding of what the user wants: Another main function of a Recommender Systems is to collect the user requirments. The description of the user's likings either collected explicitly or predicted by the system [3].

III. TECHNIQUES USED FOR RECOMMENDER SYSTEM

On the basis of the techniques used in the computation of recommendation, current recommendation systems can be categorized into four fundamental groups. Table 1 Shows the comparison of different recommendation techniques.

Technique	Method used	Advantages	Disadvantages
CF	In CF, system locates the peer user by considering his rating history which is similar to the current user. Using the neighbourhood it generate the recommendations.	The main advantage of CF is that it does not depend on machine analysable content, so it is capable of giving accurate recommendations for complex items	Cold start, Scalability, and sparsity
CBF	It is learning base approach. Base on the features of product and user's like and dislike it classifies the items.	It gives correct recommendations if the ratings that user has given and the features that are associated with items is perfect	This system is unable to recommend the items for new users and if the product have few ratings.
KBF	It recommends the product based on interpretations about user's needs and likings.	This system have knowledge about how particular product satisfies particular users need	It need for knowledge acquisition.
HF	It combines more than one recommender system into one to recommend the items.	As compare to pure approach it gives more accurate results.	May contain drawbacks of individual technique that ar taken collectively.

Table 1: Comparison of different recommendation techniques

A. Collaborative Filtering

One method for designing recommender systems that has extensive use is collaborative filtering. The basis of this method gathering and analysing a great extent of information about user's behaviour, actions or likings and guessing the choice of user based on the resemblance with another users. A main benefit of the collaborative filtering method is it does not depend on machine analysable content so it is able for correctly recommending complex items e.g. Movies, for which it does not require an understanding of the item itself. In recommender systems number of algorithms has been used for computing user similarity or item similarity. e.g. the k-nearest neighbour method and the Pearson correlation [7], [8],[9].

Collaborative Filtering is built on the hypothesis that people who fixed previously will be ready in the future, also they may like analogous products that they loved previously. For building a model from a user's, a difference needs to be made between explicit and implicit forms of data collection.

Following are the examples of explicit data collection-

- Requesting a user to give rating for products.
- Asking them to rank a group of items from more favourite to least favourite.
- Requesting a user to search.
- Offering two items to a user and tell them to choose the better amongst them.
- Requesting a user for making a list of items based on their liking preference.

Following are the examples of implicit data collection-

- Noting which items a user is looking for in an online store.
- Analysing the item/user looking times.
- Maintaining the information about items the user purchases online.
- Finding a scope of items that a user looking on his computer.
- Examining the user's social network and determining similar likes and dislikes.

The recommender system relates the collected data to similar and dissimilar data that are collected from others and computes a list of recommendations for the user.

The well-known illustrations of collaborative filtering is item-to-item collaborative filtering (people who purchase x will also purchase y), an algorithm promoted by Flipkart.com recommender system.

Collaborative filtering methods normally suffer from three major problems. The problems are cold start, scalability, and sparsity [10], [11],[12].

- Cold Start: To make accurate recommendations about the items to purchase these systems requires a great quantity of present data about user. Their preferences about the items they required.

- Scalability: In numerous environments where these systems make recommendations where there are number of users and products. Thus, a great amount of computation power is often needed for calculating recommendations.
- Sparsity: Most of the time even more popular items have few ratings as users rates it infrequently. The amount of products vended on main e-commerce sites is very big. Maximum users rated a lesser subclass of the overall database.

A specific type of collaborative filtering algorithm make use of matrix factorization, a low-rank matrix approximation technique.[13][14][15]

Collaborative filtering are categorised as memory-based and model based Collaborative filtering. A recognized example of memory-based approaches is user-based algorithm and that of model-based approaches is Kernel-Mapping Recommender [16],[17].

1) Applications:

- Music recommender system that suggest songs from similar listening choice of other users e.g. gana.com.
- Social networking site like Facebook recommends friends by making use of collaborative filtering. Also Twitter uses many indications, and computations for mentioning who to follow to its users.

B. Content-Based Filtering

Second method used for recommender systems is content-based filtering. In this method it makes use of a information about the item and the user's liking list. [18] In a content based filtering, instead of building a summery about user to specify which sort of product this user likes, keywords are used to define the items. Or we can say the algorithms that are used to recommend the items, attempt to suggest the products that are similar to the products user loved previously (or presently looking for). In precise, several contender items are compared with items whose rating is already saved previously by the user and the item whose similarity ratio is high are recommended. An item presentation algorithm is applied for collecting the features of items .The algorithm used for this purpose is tf-idf representation. To make a model that represents the user well, the system generally emphases on two kinds of information:

- A user's preference model.
- The history of user's interface with the recommender system.

Mostly, these methods use a set of discrete attributes and features of items that describe the item within the system. Depending on the information available about user preference and the available features of item the system makes a content-based profile. It include weighted vector of item feature. The weights indicate the rank of each feature to the user. Various techniques can be used to calculate this weighted vector. Simple method is the one which use the average values of the rating. Other methods may use machine learning methods e.g. Decision trees, artificial neural networks for guessing that the user will like the item. The comment from a user is normally either like or dislike, based on the user's comment the system can give higher or lower weights to the attributes or features of the product.

A crucial question about content-based filtering is that if it is capable of learning user likes forms their actions. The system should be able to learn from the available information and suggest the recommendations.The area of applications where recommendations are limited to identical products content base filtering is good. In this type system uses previous value obtained from users. This system can be best suited for suggesting audios, videos, products, discussions etc.

1) Applications:

- Online Radio is a common based on a content-based recommender system which plays songs with analogous properties for a song which is provided by the user as a starting choice.
- The number of content-based recommender systems whose goal is to provide recommendations for movies. The examples of such systems are Rotten, Internet Movie Database, Jinni, Rovi Corporation.

C. Knowledge-Based Recommender Systems

The third type of recommender system is knowledge base recommender system. In this approach system uses knowledge about users and the products. To follow a knowledge-based style for making recommendation, thinking about what products meet the user's requirements. It makes the interpretation regarding the user's wants and choice. Knowledge-based methods are recognised for its functional knowledge, means they have knowledge about how a specific product fulfil a individual user's need. Thus the system can relate the requirement and probable recommendation. Using this implication the user profiles are built which are considered as knowledge structures. The two kinds of Knowledge-based recommendation system are. (1)Case based (2) Constraint base. The main difference between them is the way in which they estimate the results. Case-based recommenders decide the suggestions based on similarity metrics however constraint based recommenders mainly uses previously defined knowledge-bases that comprises of clear rules that relates customer requirements with features of item [3],[19], [20].

1) Applications:

- Items such as apartments and cars are not purchased very often, as it requires the knowledge of that domain.
- These systems are financial services, digital cameras and tourist destination.

D. Hybrid Recommender Systems

This recommender system is a grouping of more than one technique so as to solve the problem of insufficiencies of individual methods used in separation. There exist numerous ways for applying hybrid approach. This can be done either using content-based and collaborative-based estimates separately and then combine their results; or we can add content-based abilities to a

collaborative-based method; other way is by joining these methods in a single model. According to various studies it has been proved that hybrid approach is much better than individual approach. The problems like cold start and the sparsity can be solved using hybrid methods.

1) Applications:

- Netflix is a good example of the use of hybrid recommender systems. They make recommendations by comparing the watching and searching habits of similar users (i.e. collaborative filtering) as well as by offering movies that share characteristics with films that a user has rated highly (content-based filtering).
- Mobile recommendations, News recommendation, restaurant, Life insurance, Online dating, twitter, etc, are some real time applications of hybrid recommendation techniques.

a) Seven hybridization techniques:

- Weighted: The score of different recommendation components are combined numerically.
- Switching: The system chooses among recommendation components and applies the selected one.
- Mixed: Recommendations from different recommenders are presented together.
- Feature Combination: Features derived from different knowledge sources are combined together and given to a single recommendation algorithm.
- Feature Augmentation: One recommendation technique is used to compute a feature or set of features, which is then part of the input to the next technique.
- Cascade: Recommenders are given strict priority, with the lower priority ones breaking ties in the scoring of the higher ones.
- Meta-level: One recommendation technique is applied and produces some sort of model, which is then the input used by the next technique. [22].

IV. CONCLUSION

A variety of techniques have been proposed as the basis for recommender systems: collaborative, content-based, knowledge-based, hybrid techniques. Each of these techniques has known shortcomings, such as the well-known cold-start problem for collaborative and content-based systems (what to do with new users with few ratings) and the knowledge engineering bottleneck in knowledge-based approaches. A hybrid recommender system is one that combines multiple techniques together to achieve some collaboration between them. Along with these shortcomings, we have also discussed the advantages and applications of each of the techniques.

Recommender systems have added-value to business and corporation, at the same time supporting decision making to customers in choosing the product or service from a vast information space.

REFERENCES

[1] T. Bogers and A. v. d. Bosch, "Collaborative and Content-based Filtering for item Recommendation on Social Bookmarking Websites," in ACM RecSys '09 Workshop on Recommender Systems and the Social Web, New York, USA, 2009, pp. 9-16.
[2] A. Gunawardana and C. Meek, "A Unified Approach to Building Hybrid Recommender Systems," in Proceedings of the 2009 ACM Conference on Recommender Systems, New York, 2009, pp. 117-124.
[3] Recommender Systems Handbook ISBN 978-0-387-85819-7 e-ISBN 978-0-387-85820-3 DOI 10.1007/978-0-387-85820-3 Springer New York Dordrecht Heidelberg London
[4] C.-L. Huang and W.-L. Huang, "Handling sequential pattern decay:Developing a two-stage collaborative recommender system," Electronic Commerce Research and Applications, vol. 8,pp. 117-129, 2009.
[5] Resnick,p.iacovou,n.,Suchak,mBergstrom,p and Riedl,J(1994)GroupLenens: An Open Architecture for Collaborative Filtering of Netnews.In pocedding of CSCW'94,
[6] Badrul Sarwar, George Karypis, Joseph Konstan, and John Riedl EC'00, October 1720, 2000, Minneapolis, Minnesota. Copyright 2000 ACM 1581132727/00/0010
[7] Beel, J.; Langer, S.; Genzmehr, M.; Gipp, (October 2013). "A Comparative Analysis of Offline and Online Evaluations and Discussion of Research Paper Recommender System Evaluation" (PDF). Proceedings of the Workshop on Reproducibility and Replication in Recommender Systems Evaluation (RepSys) at the ACM Recommender System Conference (RecSys)..
[8] Beel, J.; Langer, S.; Genzmehr, M.; Gipp, B. (October 2013). "Research Paper Recommender System Evaluation: A Quantitative Literature Survey" (PDF). Proceedings of the Workshop on Reproducibility and Replication in Remmender Systems Evaluation (RepSys) at the ACM Recommender System Conference (RecSys)..
[9] John S. Breese, David Heckerman, and Carl Kadie (1998). Empirical analysis of predictive algorithms for collaborative filtering. In Proceedings of the Fourteenth conference on Uncertainty in artificial intelligence (UAI'98).
[10] Sarwar, B.; Karypis, G.; Konstan, J.; Riedl, J. (2000). "Application of Dimensionality Reduction in Recommender System A Case Study",
[11] Allen, R.B. (1990). "User Models: Theory, Method, Practice". International J. Man-Machine Studies.
[12] Parsons, J.; Ralph, P.; Gallagher, K. (July 2004). "Using viewing time to infer user preference in recommender systems". AAAI Workshop in Semantic Web Personalization, San Jose, California.

[13] Collaborative Recommendations Using Item-to- Item Similarity Mappings
[14] Sanghack Lee and Jihoon Yang and Sung-Yong Park, Discovery of Hidden Similarity on Collaborative Filtering to Overcome Sparsity Problem, Discovery Science, 2007.
[15] I. Markovsky, Low-Rank Approximation: Algorithms, Implementation, Applications, Springer, 2012, ISBN 978-1-4471-2226-5
[16] Takács, G.; Pilászy, I.; Németh, B.; Tikk, D. (March 2009). "Scalable Collaborative Filtering Approaches for Large Recommender Systems" (PDF). Journal of Machine Learning Research 10: 623–656
[17] Rennie, J.; Srebro, N. (2005). Luc De Raedt, Stefan Wrobel, ed. Fast Maximum Margin Matrix Factorization for Collaborative Prediction (PDF). Proceedings of the 22nd Annual International Conference on Machine Learning. ACM Press.
[18] Research.microsoft.com/pubs/69656/tr-98-12.pdf
[19] F. Ricci, "Mobile Recommender Systems," IT & Tourism, vol. 12, pp. 205-231, 2010.
[20] M. d. Gemmis, et al., "Preference Learning in Recommender Systems," in European Conference on Machine Learning and Principles and Practice of knowledge Discovery in Databases (ECML PKDD 2009), Bled, Slovenia, 2009, pp. 41-55.
[21] Peter, Brusilovsky (2007). The Adaptive Web. p. 325. ISBN 978-3-540-72078-2.
[22] Rinke Hoekstra, The Knowledge Reengineering Bottleneck, Semantic Web – Interoperability, Usability, Applicability 1 (2010) 1 ,IOS Press