

A Literature Review on Recommendation Systems

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Abstract - Recommendation system is a data filtering technique. They are used to provide suggestions to the users according to their interest and need. It is a very popular technique in recent years and used by many e-commercial websites and other platforms to recommend news, books, movies, shopping items, novels, music and much more that is why recommendation system has become a hot topic. Recommendation systems are the subset of data filtering systems. The different types of recommendation systems are used in different platforms and have become an important part of various applications. It is a decision making process that will help the users to buy items in which they are interested. Recommendation systems are very useful and effective technique of filtering the data. This paper is a review of recommendation systems that will describe recommendation system, how it works and helps in different platforms, and the different types of it with their merits and limitations.

Keywords - Recommendation System; UBCF; IBCF; Hybrid Systems;

1. INTRODUCTION -

According to Anna Gatzoura and Miquel Snchez [1], the aim of recommendation system is to provide effective and meaningful content (item) to the user which is active on the platform. Recommendation systems have become very popular in latest years. The first paper on collaborative filtering is appears in mid-1990s after that recommendation systems become an active area of research. Recommendation system is a technology which is used for filter and retrieval the data. With the help of these systems the sales of e-commercial websites and other platforms is also enhance. These systems are basically a software tool that provides the services and items to user, in which they are interested and help the users to find the item which they like. It is now a general term for providing the services to user according to him/her taste. According to K. Shah, A.k Salunke, S. Dongare, and K. Antala [2], recommendation systems are a machine learning technology that comes under unsupervised learning machine learning models in which data is not labelled, as mention in following figure-

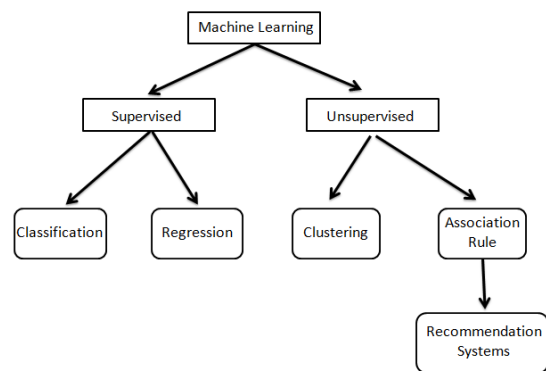


Fig.1. Recommendation Systems in Machine Learning

In the methods of unsupervised machine learning, the task of machine or model is to group the uncategorised data, according to similarities, patterns and differences without given any kind of training to the machine. Recommendation system is a part of unsupervised machine learning in which the data is not labelled; so the hidden and cluster information is revealed by unsupervised learning methods. Many websites are using recommendation systems to give a better experience to the users. The best examples of recommender systems are given by J. Ben Schafer, Joseph Konstan, John [18], that you have seen the suggestions on Amazon like “Customer who bought”, “Amazon.com Delivers”, “Book Matchers”, on Moviefinder.com like “We Predict”, “Match Maker”, on Reel.com, eBay and more. They summarized the technologies, applications and the things by which the user is able to find the suggestions and how the user find these recommendations. Recommendation systems are very useful techniques to filtering data because it helps to know about the user more. Every platform has different kinds of recommend system, according to the platform.



Fig.2. Recommendation System

As show in above figure, a user bought a camera so recommender system gave him/her suggestion to buy a tripod. The products have been shows at the top of the screen, on the basis of past behaviour and user's taste. Basically this is the working of recommendation system in these platforms. These recommendation systems are using for filter the data and gave the user a better experience and they are become a common part of everyone's life because providing recommendations to anyone is a very difficult task but it is done by these systems, that is why these systems become more popular in area of research.

2. TYPES OF RECOMMENDATION SYSTEMS -

Recommendation systems are of two types, Personalized and non-personalized. Personalized recommendation systems are those in which the group of different users is receive different suggestions where as in non-personalized recommender systems all users get same suggestions [2]. According to J. Ben Schafer, Joseph Konstan, John [18], Non-personalized recommendation systems are automatic because in these systems recommendations are not based on customers so these systems doesn't recognized the users from one session to another and these systems requires a physical storage. Recommendation systems are grouped into these categories- Content Based Filtering, Collaborative Filtering and Hybrid Systems. All the techniques are using in different platforms and they have their advantages and disadvantages. The paper will describe all the techniques with their advantages and limitations in the following sections.

Content Based Filtering: According to Po-Wah Yau and Allan Tomlinson [7], Firstly the quality of item is analyzed and after that the properties of product are matched, for this the present database is used. In content based filtering techniques, the items are described with the help of keywords. Content based filtering algorithms predict the item that the user liked in the past and according to the rating of user the items are recommended. In content based filtering the quality of the product or services are utilized for recommendation. For an active user content based filtering techniques provide transparency. In content based filtering the system compare the profile of the user with the content (item) and then find similar item and suggest to the user.

According to a an text classification survey by Mladenic [17], in the technique of content based filtering the similar items are searched by the algorithm in the system, then the system construct a model based on user interest. This model generates the recommendation. The following diagram clearly shows that how the content based filtering algorithm works in the e-commercial websites.

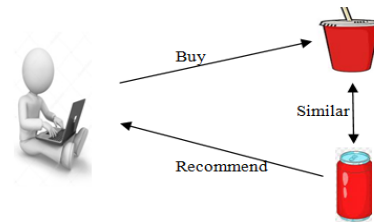


Fig.3. Content Based Filtering

The merits of using content based filtering are that these techniques are less cumbersome because they provide user independence with the help of rating used by the user. For a new user content based filtering techniques are good where as the limitations of content based filtering is that sometime it can be suggest same type of items this is called a over specialization problem and in case of a user does not give rating or feedback then it is difficult to suggest any item or suggestion may be wrong.

Collaborative Filtering: In 1992, "Collaborative Filtering" was invented by Goldberg et al. [4], they conclude that for humans the process of information filtering has become very effective. The meaning of word collaboration is that people collaborate to help each other to complete a task. In collaborative filtering techniques, data and information is collected by the system (database) from different users and then based on likes and dislikes of the user the results are compared and similar item will be suggested. In the methods of collaborative filtering the interest of one person is compared with the other user's interest and then similar items are suggested to the user.

According to G. Gupta and R. Katarya [3], Collaborative Filtering is a technique in recommender systems in which the recommendations are dependent on the user's neighbors and this technique use the concept of matrix factorization in which a matrix contain the users, items and the rating provide by the item with the different kind of users. These techniques are used in many kinds of e-commercial platforms and provide a better experience to suggest contents (items) than other techniques. The following diagram easily defines the working of collaborative filtering techniques-

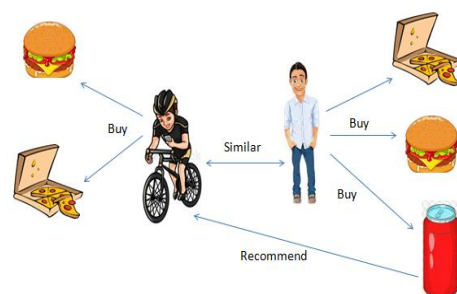


Fig.4. Collaborative Filtering

Collaborative Filtering is a majorly used technique to make recommendations. According to Recommender systems, Handbook by F. Ricci, Lior Rokach, B. Shapira, Paul B. Kantor [5], these methods can be classified into two methods- First is Neighborhood based method and second is Model based method.

In Neighborhood Based Method the ratings are provided by users and the system compute the similarities between users and items [2]. It is also known as memory based or heuristic based methods. These methods are simple to implement, easily understandable and do not require training phase. For this, the ratings provided by user stored in the memory and new item is recommended directly to the user. According to K. Shah, A.k Salunke, S. Dongare, and K. Antala [2], neighborhood methods techniques can be done by two types- User based collaborative filtering (UBCF) and item based collaborative filtering (IBCF).

According to G. Gupta and R. Katarya [3], In UBCF techniques, the recommendations are generate according to the like or dislikes of the neighbors node of the active user and in the techniques of IBCF, the similarity between the items are calculated then item will be suggested to the user. The basic idea of UBCF is, given a database of rating and the current user's id as an input, identify peer users who had similar preference to the current user. In UBCF methods, recommended items have been liked by other users who share their taste & preferences. According to Zhao, Zhi-Dan, and Ming-Sheng Shang [6], the drawback of UBCF is that in case in which the user u like an item i but his/her neighbors not gave good ratings to that item then the item i will not recommend to the user u where as the basic idea of IBCF is to calculate the similarity between two items with the help of ratings that are given by other users in related ways. According to Gao, Min, Z. Wu, and Feng Jiang [8], in IBCF firstly, the similarities between items are calculated and then predict the item to the user. G. Gupta and R. Katarya [3] concluded in their paper that if the recommendations done with the help of previously liked items, then they provide effective results as compared to recommendations in which all the users like similar items it simply means that IBCF provides better results than UBCF.

The next thing is to discuss about the second type of collaborative filtering techniques that is model-based methods. According to K. Shah, A.k Salunke, S. Dongare, and K. Antala [2], in model-based methods firstly train the dataset and then the trained dataset is used to forecast the feedback of user for any new item. In neighborhood methods, the previously stored ratings are used for prediction but in model based methods the ratings obtain the understanding and then predict the model. For this many kinds of techniques like Support Vector Machine [9], Latent Semantic Analysis [10], Singular Value Decomposition [11] etc are used. In these

techniques, the algorithm deals with a very smaller matrix with lower dimensional space that is the advantage of these methods [12]. These methods compare the similarities of result matrix that is very scalable to deal with large datasets [13].

The merits of collaborative filtering technique are the new data addition is easy in neighborhood based collaborative filtering methods. These techniques have the ability to predict personalized recommendations because these techniques analyze the past activity of a user, find similar user and then predict the similar taste to another user. These techniques capture the interest of user according to time where as the limitations of this technique is that the systems has a cold-start problem that means if the user is new in the database (website etc) then it is difficult to recommend anything to the user and these techniques require a huge amount of user to give rating or feedback of a new item.

Hybrid Systems: In content based filtering technique, the algorithm is based on contents of items and collaborative filtering technique algorithm combines the relationship between user and item. Both of the approaches of recommendation system are suffers from some limitations, this is a big issue to predict better recommendations to the user. Hybrid systems are introduced to overcome the main limitations of these both techniques. These systems are make with the combo of content based and collaborative filtering techniques and have advantages of both the techniques. With the use of hybrid systems the quality of recommendations are improved.

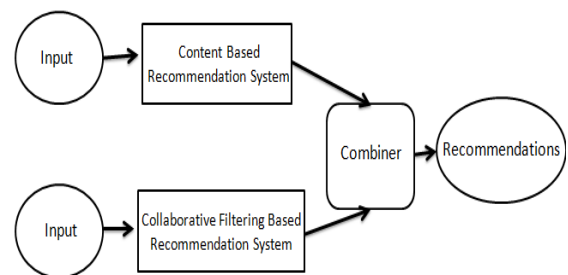


Fig.5. Hybrid Recommendation System

According to International Conference on Intelligent Human-Machine Systems and Cybernetics [14], Hybrid recommendation systems uses previous data of a user to find his/her interest and then they target the set of adjacent user which is similar with that user and according to adjacent user recommend things to the user. Hybrid systems offer the items that share the common things that a user rated highly (Content based filtering) and makes suggestions by compare the interest of similar user (Collaborative filtering). The best example of hybrid recommendation system is Netflix [15]. The hybrid systems can be consist of following types-

1. Integrate the content based filtering methods into collaborative filtering methods or vice versa.
2. Implement content based methods separately and then merge their predictions.
3. Merge both content based filtering and collaborative filtering methods and develop a general model.

Hybrid systems takes the advantages of collaborative filtering, content based etc systems and make the system which minimize the limitations of that systems. According to a study of hybrid recommendation systems [16], there are several types of hybrid recommendations which are classified into three categories- integrated, flow and parallel type.

In Integrated type of hybrid systems, different types of algorithms are combined and different recommendations are generated and in Flow type of hybrid systems, a process is divided into several sub-processes, until a final list of suggested items is ready where as Parallel type of hybrid systems, different types of algorithms are used, in which using some mixing mechanism, recommended item mixed together. This study [16] also describes that the parallel type systems are divided into three categories- Weight hybrid, switching hybrid and mixed hybrid. These techniques are very popular and described as follows-

A. Weight hybrid-

In weight hybrid recommended system, the score of different recommendation components are combine numerically. These systems are used in many restaurants.

$$rec_w(u, i) = \sum_{k=1}^n \beta_k rec_k(u, i)$$

B. Switching Hybrid-

In switching hybrid recommended system, the system chooses one best recommendation from a different group of recommendations.

$$\exists_{k:1\dots n} rec_s(u, i) = rec_k(u, i)$$

C. Mixed Hybrid-

In mixed hybrid recommendation systems, the recommendations from several recommenders are merged together to give the result. This system has a start-up problem. PTV system used the approach of mixed hybrid systems.

$$rec_m(u, i) = \bigcup_{k=1}^n [rec_k(u, i), k]$$

Hybrid Systems reduce the limitations of other recommendation systems and these systems enhance the accuracy and clarity of the system. These are the merits of these systems where as in these systems there has a ramp-up problem. These systems are the combination of two or more techniques and every technique requires a database of rating or feedback so that is the limitation of this systems.

3. RECOMMENDATION SYSTEM- A LITERATURE REVIEW-

The Literature review on Recommendation System is in a format given in Table. 1.

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4. CONCLUSION-

In this era, recommendations systems are very popular technique and help to give a better experience for the user as well as company. These systems are several types such as content based, collaborative or hybrid, according to the system which the developers are made.

In this paper, we review the different types of recommendation systems with their advantages and limitations. Content based filtering methods become an advantage in case of new user where as in these systems also have some limitations. The collaborative filtering methods are divided into two parts in which, neighborhood methods are used to recommend simple contents but they are unable to provide accuracy, and model based methods improve the quality of cold-start problem. Collaborative filtering systems are very popular because they have many advantages. Hybrid systems overcome the limitations of both content based and collaborative filtering systems, improve the result and make the system accurate.

TABLE.1. A REVIEW OF WORK DONE BY VARIOUS AUTHORS

S. No.	Title of the Paper	Key Points	Conclusion	Reference
1.	A Case-Based Recommendation Approach for Market Basket Data.	CF; CB; AR (Association Rule); CBR (Case-Based Reasoning)	After compared the performance of developed RS conclude that CBR is the good method in case of transactions.	[1]
2.	Recommender Systems: An overview of different approaches to recommendations	Recommendation System; Information Retrieval System; CF; CBF; Hybrid Filtering	The three approaches of recommendation system and their advantages and disadvantages.	[2]
3.	Recommendation analysis on Item-based and User-based Collaboration Filtering	IBCF; UBCF; Recommender System	IBCF and UBCF with implementation metrics, and conclude that IBCF provide better results than UBCF.	[3]
4.	Recommender Systems Handbook. Springer.	CF; CB; Multi-criteria recommender; Robust CF Neighborhood-based	In the unique approaches, hybrid robust filtering methods are better.	[5]
5.	Towards privacy in a context-aware social network based recommendation system	Content aware; social networking; privacy	Focus on protecting data and request for data, at the point of data collection.	[7]
6.	A study of hybrid recommendation algorithm based on user.	Personalization; recommendation technology; collaborative filtering; hybrid algorithm	Hybrid algorithms are generates the results according to user's rating and history record.	[14]
7.	Recommender systems in e-commerce	Electronic Commerce, cross-sell, up-sell, mass customization	The ideas of new applications in the field of recommendation systems in e-commerce sites.	[18]