

Recommendation Systems: Different Techniques, Challenges and Future Directions

Indu Sharma

RIMT University, Mandi Gobindgarh, Punjab, India

Email Id- indusharma@rimt.ac.in

ABSTRACT

As a significant research focus, the Recommender Systems (RS) has developed to assist customers find goods online by providing suggestions that closely match their interest. This article provides a review of achievements and the future direction in the area of Recommended Systems. It was believed that helping users deal with the problem of data overload was the original purpose of information retrieval systems or search engines, but what differentiates proposed solutions from the current search engines is the needs of customized helpful and entertaining. The "intelligence" element is what makes a proposal more intriguing and helpful. Intelligence is one of the major ways of customization to know the interests of the user, predict the unknown preferences of the user, and ultimately offer recommendations by matching the query and the material beyond a simple search. This study has resulted in many significant findings, which will enable present and the future generation researchers of RS to assess and define the roadmap of their research in this area.

Keywords

Challenges, Feedback, Filtering techniques, Future direction, Issues, Research trends, Recommendation Systems.

1. INTRODUCTION

Which four-wheeler should I buy? "Which restaurant am I meant to see this weekend?" "Where do my family have to travel to spend the holidays?", these are some of the instances of a very common inquiries for which our friends and acquaintances often seek recommendations. Unfortunately, nearly every one of us has noticed that these pleasant suggestions are not always effective in many circumstances, even with their best purpose, since the taste of others does not necessarily imply harmonizing with that of ours. Sometimes these recommendations are prejudiced as well. Really, RS is a major insightful computer-based technique that predicts and assists people pick items from a huge pool of web stuff on depending on the customer adoption as well as use. Most of the Internet users rely upon the RS in one or the other manner. For example, potential friends are suggested by Facebook, movies in accord are advised by you tube agreement, Matching jobs are recommended by Glasspool, TripAdvisor offers us ideal holiday locations, Goodreads recommends the books which are fascinating and so on. E-Commerce sites (Examples, Amazon, eBay etc.) utilize RSs to attract consumers by utilizing the products that people are likely to desire[1-5]. This has enabled them to attain an enormous sales boost. These are not limited for online companies alone, but also there are numerous applications which ultimately take advantages of RSs, to name a few, social networks, entertainment sites, news via online portals and many more applications for knowledge management. In fact, in the communication method between

consumers as well as the service providers, RSs have generated a new dimension. Many companies are increasingly adopting RS methods as an extra advantage to enhance their client offerings. While the RS implementation relies upon the unique recommendation technique used by the application and likewise, the fundamental work of the recommendation systems for all applications stays more or less the same. The primary goal of recommendation systems is to aid consumers in assisting them in the process of decision-making so as to choose an item through internet by promoting high accuracy suggestions in-hand. People from diverse areas including data processing, data retrieval, knowledge discovery, theory of approximation, theory of forecasting, artificial intelligence, information retrieval, business, marketing etc., have made significant contributions to various research methods. The research group has done a great lot of effort to enhance applicability as well as efficiency of RSs in the last several years[6-9].

To address many of the technological difficulties, new methods have been created, such as giving more accurate suggestions while reducing online computing time. A wide variety of Artificial Intelligence techniques have been incorporated into recommended system research, including (ML) machine learning, data science, user simulation, as well as case-based reasoning. The idea of a clever computer that can think as well as learn like a human being has led to most of the humanized methods which is known as Computational Intelligence (CI)[10-13].

Social networking sites (For example, Twitter, Facebook etc.,) have now emerged as a significant venue for the application of RSs. Of course, these renowned sites are regarded as the primary source of people-related information and therefore to be a fantastic option for utilizing new and innovative ways to the suggestion, supporting the old techniques, in order to enhance accuracy[14,15].

1.1. Different Phases of Recommendation Systems

There are various stages in the development of Recommendation systems as indicated in the Figure 1 Phase 1-Information collection: Gathering the particular user information to create a profile of a user or say a model for purpose of prediction tasks, that contains characteristics of actions of the user, or resources that are being acquired by user is done in this phase. Till the profile of the user or model of the system has been properly developed, an agent of suggestion cannot function sent percent correctly. In order to provide an open-ended recommendation straight away from the start, the system needs to learn from the user as much as feasible it can. Recommendation systems depend on various types of inputs, like the very much convenient feedback taken explicitly which are of standard quality, which includes input which are straight forward from users regarding their attentiveness in products or feedback which is implicit by

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implicitly inferring user likings via user behavior observation[16].

Explicit Feedback: In order to build and improve its model, the system usually reminds the user through the interface of the system to provide rankings for items. The suggestion accuracy truly is reliant on quantity of user ratings or rankings given. The one and only shortcoming of this method is that it requires user effort and users as such are not always willing to give sufficient information. It is even today recognized as giving more accurate data, in spite of the fact that more user effort is needed for clear feedback and also provides clarity in suggestion process.

Implicit Feedback: Automatically, the system collects the tastes of the user by tracking various user behavior, notably

purchase history, history of browser, time spent on certain web sites, email content, and clicks of buttons. Implicit feedback reduces the strain on web users by inferencing the wishes of their users from their device activities. This technique is less accurate compared to explicit input; nevertheless, no effort is needed by the user.

Hybrid Feedback: To minimize their limitations and obtain a better working system, the advantages of implicit as well as explicit feedback, both may be combined in a system termed hybrid. This is done by making use of implicit data truly as an explicit rating audit, or by forcing users to give explicit input only when demonstrating explicit interest.

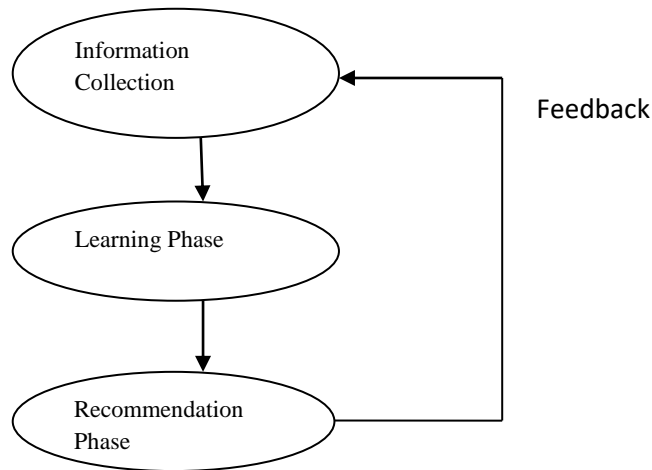


Figure 1: Recommendation Process: Different Phases

Phase 2-Learning Phase: This phase utilizes any of the learning algorithms to clarify and to make use of the characteristics of the web users via the feedback obtained in the collecting process of data.

Phase3-Prediction Phase: This recommends or predicts what sort of goods or things that the consumers will like. SO, this is accomplished immediately on grounds of data set obtained in the information collecting process that may be either model-based or may be memory-based by the user's recorded actions of the system.

1.2. Different Filtering Techniques for Recommendation

To a system which can provide excellent and practical advice to the system's individual users, usage of suitable and accurate suggestion techniques is extremely important. This shows the importance of understanding the features and possibilities of different techniques of suggestion. Figure 2 shows the anatomy of different techniques for filtering suggestions.

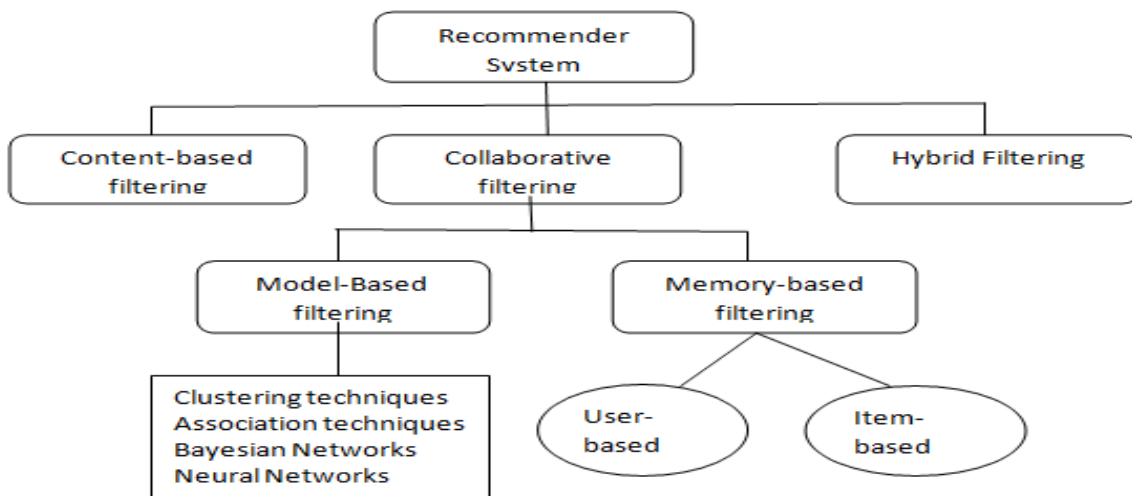


Figure 2: Different filtering techniques for Recommendation

Content-based Filtering (CBF): Content-based recommender system works with user supplied information directly or indirectly. A user profile is built on the basis of such information, which is used to offer recommendations to the users. The engine tends to be more comprehensive because the customer gives more inputs or takes action on the recommendations. In information recovery systems and content-based filtering methods, the concepts of WF i.e., Word Frequency and IDF i.e., Inverse Document Frequency are employed. They are used to evaluate the relative worth of a text / post / news story / video etc. In a document, TF is the word frequency. Out of the total pool of documents, the IDF is the inverse of the document frequency. "TF-IDF is primarily utilized for two reasons: Suppose that on Google we search for "the rise of critics. It is certain that ""they"" would appear more frequently than "critics" yet critics' relative significance is larger than viewpoint of the search query. In such circumstances, the weighting of TF-IDF nullifies the effect of words with high-frequency on the value of an item. But the log of course is employed to minimize the impact of words with high frequency when calculating TF and IDF. $TF = 4$ vs $TF = 5$ is significantly different when compared $TF = 20$ with $TF = 2000$, for instance.

Challenges of Content-based Filtering: Recycling of news articles to be suggested is the biggest barrier in news suggestions. Readers of the news prefer to read about current events. Recommending the most essential articles news and new or fresh news in lieu of outdated news articles is thus a big problem. The new articles news is more very much relevant than the old ones, in some instances it may be acceptable to provide the old or prior news to the reader rely upon the context or viewpoint of current events in order to get comprehensive details and knowledge of the subject. News readers prefer to read the articles connected to news from

various sources in order to acquire comprehensive information of an event that has happened or the current development of a news story or different views and points of view. It is a challenging task to have relevant bulletin articles produced in alternative publication discussing the same situation devoid of adequate system references. Recommendation algorithms for the display of news items published in just one language, from a single one source are usually created. Recommendation of multi-lingual articles linked to news from various sources and deploying productive news items using similarity techniques are a tough task for appropriate recommendation.

Collaborative filtering: Collaborative filtering utilizes similarities between people and objects concurrently to give suggestions in order to get rid of the limitations of content-based filtering. This enables for spontaneous suggestions which is based on likings of a comparable user B, collaborative filtering models will propose an item to user A. In addition, without depending on hand-engineering of functionality, the embedding may be automatically taught. The method of collaborative filtering operates by building a database of user likings or preferences for items. Then, individuals are paired with suitable interests and likings or preferences to create suggestions by assessing the user profiles similarities[17-19]. A user makes recommendations for certain specific items which has not been rated previously, nevertheless, those users in their area have been favorably rated positively before. Recommendations provided by CF are either predictive or suggested. Prediction is really a numerical number, R_{ij} , for the online user I indicating the item j 's projected score, while as Recommendation is record of the top N items that the web user loves most, as stated in below diagram Figure 3'. Collaborative filtering method is being classified into 2 classifications: memory-based as well as model-base.

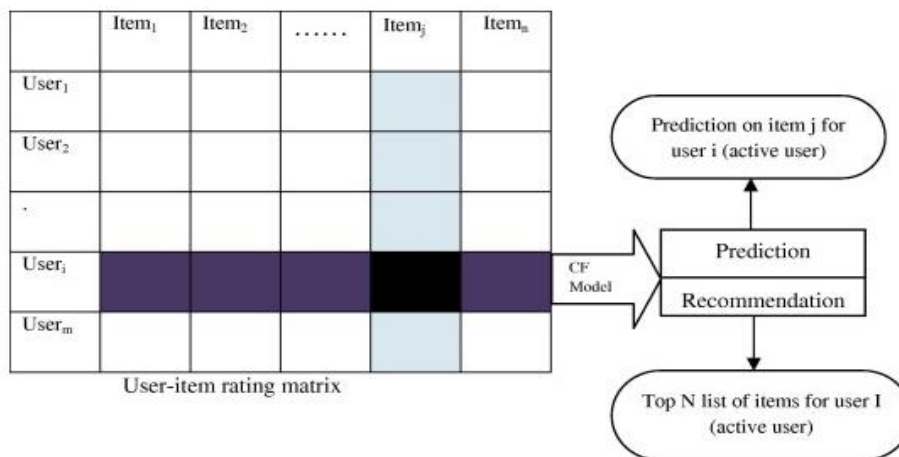


Figure 3: Collaborative Filtering Technique

- Memory based technique: In looking for a neighbor who shares recognition with him, the items which were previously appreciated by the customer before play an acceptable function. When a neighbor of operator is identified, different techniques are used to combine neighbors' preferences to generate suggestions. Widespread popularity was acquired in real life applications owing to the effectiveness of these methods. User-based as well as item-based methods, are the two ways through which memory-based CF may be achieved. Firstly, their evaluations or rankings on the same item are

compared. The user-based approach computes the similarity between users. Secondly, the item-based approach develops the predictions considering the similarities among the items but not that of users.

- Model based technique: To improve the efficiency in Collaborative filtering, this approach utilizes the past rankings for developing a model. Using the approaches like machine learning or data mining methods, the process of creating the model may be finished. In fact, by making use of pre-computed model, truly may simply propose a collection of things and in fact have been shown to

produce recommendation outcomes which are near to neighborhood-based techniques of suggestion. Learning algorithms have developed a lot and have altered the manner how recommendations are produced, in order to suggest what customers should consume, to recommend when a product should really be eaten. Therefore, it is extremely essential that the remaining learning algorithms which are used in this model-based recommendation systems be examined:

- Association rule: These algorithms bring forth the rules which predict the presence of an item depending upon the existence of other objects in any transaction.
- Clustering: In many areas, clustering methods have been utilized, notably design recognition, digital image processing, analytical data and information detection. To discover meaningful classes which existing among them, the clustering method attempts to divide a collection of data based on the similarity characteristics into a number of sub-clusters.
- Decision tree: The approach is modeled as per the tree graph methodology that is created by assessing a set of training samples for which we determine the labels for the class. Then, there are used to find instances previously not noticed. If training is done on a very high quality of data, then reliable predictions may be anticipated.
- Regression: This method is used when a linear connection is believed to consistently link two or more variables. It is a strong method of diversity to assess associative connections among a dependent variable as well as one or more independent variables. Regression utilizes curve fitting, estimate, and a highly methodical hypothesis among connections between evaluations of variables.
- Artificial Neural-network (ANN): This is a composition of many connected neurons (nodes) that are arranged in systematic ways in layers. Depending on the amount of effect that one neuron has on another neuron, the connections of neurons will have weights associated with them. In certain specific issue situations, the usage of neural networks offers some advantages. For example, an ANN is very much resistant against noisy as well as data sets which are erroneous because it includes many neurons, furthermore it distributes weight to every connection.
- Link Analysis: This is a technique of constructing linked object networks in order to analyze trends and patterns. It has generated enormous possibilities for increasing the efficiency in online searches. Link analysis covers algorithms for Page Ranking as well as HITS. A web page is regarded by most of the link analysis algorithms as a separate node in the graph of web.

2. LITERATURE REVIEW

2.1. Challenges of Collaborative Filtering

Since embedding is learnt automatically, we do not require domain knowledge. The model will help users identify new hobbies. The ML framework does not know if the user is truly interested in a particular item in isolation, but the model may nevertheless recommend it since that item is of interest to similar users. To some degree, a matrix factorization model requires just the feedback matrix to be trained using the technique. The framework doesn't need contextual features in specific. This may be observed in practice as one of the numerous candidate generators. For a given (user, item) combination, the model prediction is the dot product of the associated embedding. So, if an object is not observed during training, it cannot be incorporated by the system and cannot

challenge the model for this item. The cold-start issue is also termed this problem.

It is impossible to notice or comprehend the reader's pleasure with the story, to know if the user is truly enjoyed the piece or not, without unambiguous news reader feedback [20]. By utilizing communal or CB- filtering methods, the explicit input of a user may play a key part in correct recommendations of the content to users who are the same news readers.

Predicting the future interest of the user is very difficult and exceedingly complicated in the area of news for all kinds of user-based recommendations. While some of the events happening [21], e.g. a news, the wants of the customer may be changed. Readers may be interested in reading articles about a World Cup season football match.

Hybrid Filtering: In order to obtain better device optimization, the hybrid filtering method combines different ways of recommendation to prevent certain drawbacks and difficulties encountered by certain pure or clear recommendation systems [22]. The idea behind hybrid methods is that algorithms are integrated to give suggestions that are more accurate and efficient when compared to those of a single algorithm, since one algorithm may address the constraints of another algorithm [23]. In a combination model, combining multiple recommendation methods will reduce the limits of a single strategy. In any of the following ways, the combination of methods is done: separate implementation of the algorithm and outcome combination, using few content-based filtering methods in collaborative mode, or using few collective filtering methods in content-based technique by generating a single reference framework that carries all approaches organized.

2.2. Challenges of Hybrid Filtering

When the sparsity rises, a larger number of items are brought to the scheme, this problem will be more common in the news domain, for instance, in a continuing manner, current news when published online and the number of news items increases quickly [24].

Commercial websites are increasingly adopting the recommended methods because they may be utilized to significantly improve the revenue of sellers without rigorous involvement. The proposed methods are being used to highly rate their own goods or product of their own and there are possibilities of displaying significantly fewer ratings of other rival products and other kinds of assaults, such as shilling attacks or attacks via profile injection [25].

3. CONCLUSION

It will always be a difficult and complicated task to make a decision amongst different options based on huge quantity of info accessible online. Recommendation systems (RS) via internet assist us to address this. RSs use efficient information extraction and filtering procedures to perform their work professionally and correctly. In this post, we supplied the background understanding of recommendations systems, general classes, sub-categories, their difficulties along with future prospects. The study methodology, data collecting technique, inclusion & exclusion criteria were thoroughly explained. This paper's primary goal and main focus is to track the advancements in RS research. A few intriguing numbers have surfaced. Most RS analysis, for example, relies on collaborative filtering and knowledge-based methods. We are optimistic that many innovative and creative paths of technologies such as Cognitive Computing, Artificial Intelligence, Internet of things and many more cutting edges would be observed in future RS research. By analyzing personal patterns and habits, recommendations would be more

personal and customized. Digital reality that will engage customers in more personalized purchasing will be utilized by RSs. Future RSs are going to extremely intelligent, instant responsive, connected and safe with the ease technology like virtual reality and potential of data. The RS of the future will enter our daily lives. By monitoring our daily actions, including walking, talking, breathing, sleeping, eating and collecting important data, they will maintain a record of our habits.

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