

Recommender System Approaches: A Survey

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Abstract:

Recommendation was mainly used within the online purchasing to propose list of products. Recommender is depending on the information that filtered when seeking about the predicting of ‘score’ of the user might provide to an item. Recommender systems are carried out in type of programs like movies, track, information, instructional occasions, venue, books, studies articles, and tourism, seek queries, social tags and merchandise in general.

Recommendation systems apply practice of data mining and prediction algorithms to expect person’s hobby according to facts and most quantity of the merchandise he had. The paper offers outline recommender systems alongside the description of various strategies which might be being used for generating pointers. Recommendation strategies can be classified to a few classes: Collaborative Filtering, content material based totally and Hybrid guidelines, we've got discussed numerous strategies of recommender and techniques carried out to implement it. The intention of this work is to find out existing traits, open troubles and feasible directions for future studies.

Keywords:

Recommender System, Collaborative filtering, Content based filtering, Hybrid Recommender, data mining.

1. INTRODUCTION

Recommender Systems are widely used in many application domains for providing personalized information to users based on their preferences. The rapid increase in the usage of GPS-equipped smartphones boosts the development of Location-Based Social Networks (LBSNs) and Location-based services [1]. LBSNs helps the users to share the current locations to their friends while they check-in to any

Point-of-Interests (POIs) such as restaurants, theatres, shops, malls and other physical world venues.

Though LBSNs helps the users to share their ratings and experiences as reviews for the venues, still it is a crucial task to exploit the users’ historical check-in behaviour for making personalized predictions to generate recommendations.

Recommendation system changed into generally used inside the on-line shopping to endorse the listing of product, to recommend an object to the user, the system filter the information that looking for to anticipate the ‘rating’ or ‘preference’ that a person could provide to an object. Recommender is applied in style of programs like films, track, data, academic occasions and products in popular.

Many customers are interested by structures that suggest some products to them based totally on sure elements, and therefore a tool is wanted on the way to decide which product is useful to the clients regarding to the understanding of the consumer have much or less about the domain, This machine is called a recommender system (RS)

Recently, many initiatives have been taken by the researchers in the development of methodologies for the recommendations. These existing methodologies combines social attributes of the POIs with the temporal property and geographical property with the recommendation approach for the personalized list generation. The most existing methods suffer from low-quality recommendations due to consideration of only single factor (e.g. Check-in), ignorance of relationships between POIs and users, and failure in exploiting change-in user behaviour. The research on the utilization of user’s current context for the personalized recommendation has received a notable momentum. The contextual information is mainly classified into the user, device and environmental/physical context. In many recommender systems, the physical and user contexts have higher priorities than the device context for generating personalized POIs.

The physical and user context helps in filtering information in a better way for planning.

With the growth of smartphones and location-based service providers, the need for an effective user-context aware recommender system is high.

The personalization of digital services in the RSs has been explored to the wider new concept of group users' recommendation. With the impact of social environment, people make the decision together in groups while doing activities like travel, shopping, etc. The major difference between individual and group of users recommendation generation is the user preference utilization methodology which exploits the active target user's preferences and interests for the individual recommendation results and combines multiple users' preferences and interests for the predicting recommendations to the users group.

Recommender system (RS) is defined by Rokach [1] as an intelligent system that deliver suggestions to the user about a specified object assisting him in the decision making operation as shown in Figure.1

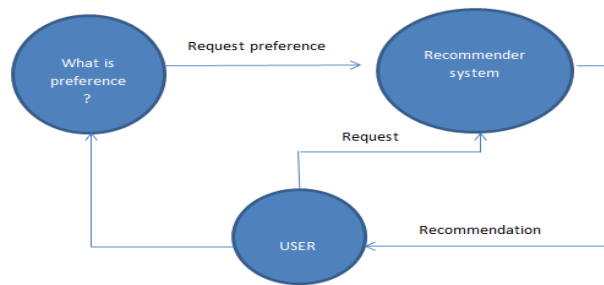


Figure.1 The model of process for recommender system [1]

Recommender system can get data explicitly (e.g. collect score from customer) or implicitly (tracking customer conduct, Meditation of the e-book study), Recommender systems can be described as applications which strove to advise the most appropriate gadgets (products or services) to specific customers (people or companies) through expecting a customer's attention in an object based on associated information about the gadgets, the customers and the interactions between objects and customers [1].

2. TYPES OF RECOMMENDER SYSTEMS

Many tactics are to be had for advice engine [2], these tactics are labeled into classes as displayed in Figure.2:

- Content -based technique:

Is given based totally at the person's preferred objects within the beyond.

- Collaborative technique:

Are advocated based totally at the hobby of similar preceding people.

- Hybrid technique:

This is a combined method of content-based totally and Collaborative guidelines.

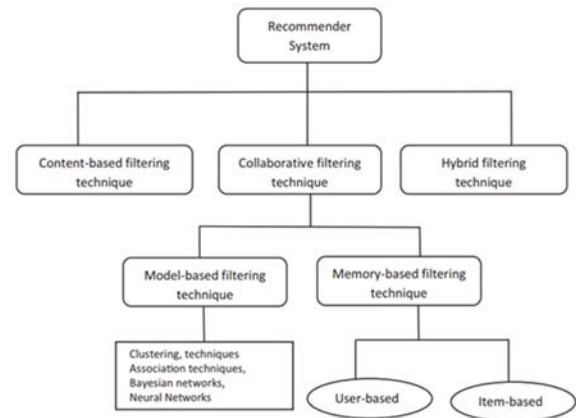


Figure.2 Types of Recommender systems [3, 19]

2.1. Content based approach:

In this approach user interests are analyzed and based on the interaction the user recommendations are given to the customer. Users are recommended based on their past interest. Let (s) be the item and (c) be the customer then the utility (u) is calculated i.e. $u(c,s)$. Here utility is calculated based on the utilities which are assigned by user (c) to items (s_i), (s_i) is similar to item (s). Below figure.3 shows the flowchart for content-based approach. This approach most widely used recommendation technique in the business field.

- Advantages

- For each individual client, content material primarily based approach makes use of person-based personalization technique and offers the excellent advice for every person.
- category overhead could be very much less as this approach makes use of person modeling idea

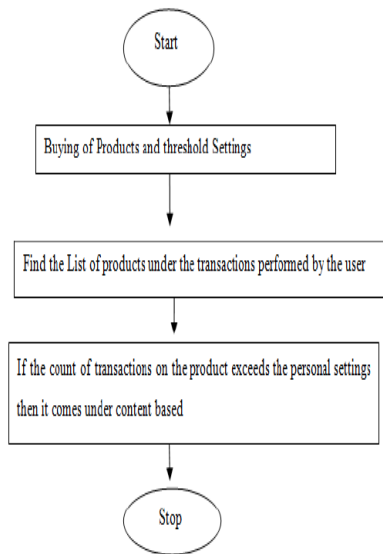


Figure.3 Flowchart of Content based recommendation approach. [2]

- *Disadvantages*

- Content-based filtering technique calls for greater computation strength.
- This method doesn't paintings correctly for brand spanking new person, because it refers formerly preferred items for advice.
- This technique includes following steps like evaluation of the features, building person models and calculation of similarity for every object that person interacted. As a result it takes a whole lot of time.
- It additionally doesn't consider the best issue while recommending.

2.2. *Collaborative approach:*

- Collaborative filtering approach works based on the preferences and ratings given by the like-minded people. It implies that the current user is recommended based on the ratings given by the previous like-minded people, the recommendations are given based on the user similarity but not based on the item similarity. When like-minded users are identified, items which are rated by one user are recommended to the other similar users [4].

- Unlike Content-based approach, in this approach items are predicted which have been rated by the users who are similar to the current user. Let(s) be the item and c be the customer then the utility u is calculated i.e. $u(c,s)$. Here utility is calculated based on the utilities which are rated by the user c_i to items s, c_i is similar user. The flowchart of this method shown in Figure 4.

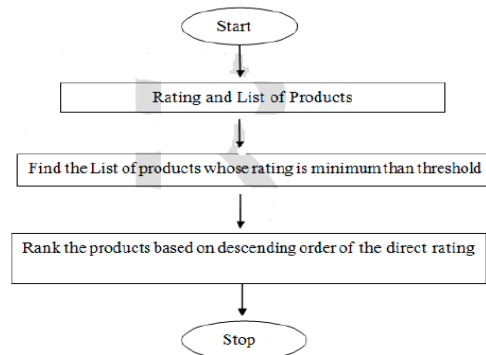


Figure 4 Flowchart of Collaborative approach. [2]

- Collaborative filtering can be used along with the machine learning concept in order to improve its prediction accuracy [6].
- The most popular collaborative approach is:
- Nearest Neighborhood (NNH) algorithm.
- Association rules
- Matrix factorization

- *Advantages*

- Collaborative filtering is content independent hence it doesn't requires error prone item processing.
- Since the Collaborative filtering includes human involvement, it considers the quality aspects. [4]

- *Disadvantages*

- Collaborative filtering approach requires user participation to predict the recommendation. However, the motivation for this participation of user is not available. This is known as cold-start problem.
- If the item is new and not rated by any customer then it can't be recommended to any user.
- Further, if the new user doesn't rate any item then it will be not possible

to find the like-minded people for further recommendation [4]

2.3. Hybrid approach:

- Hybrid approach is developed to enhance the performance of recommendation system.
- In this approach collaborative approach is usually combined with other approaches. Few hybridized methods are mentioned and defined as show in Figure 5.

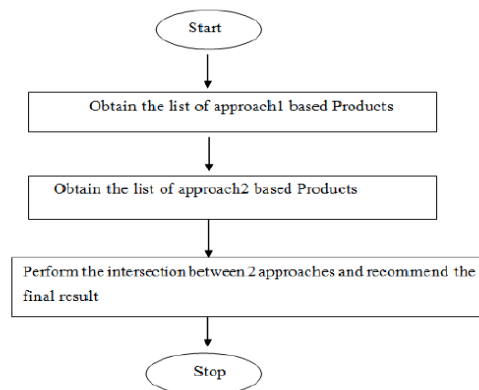


Figure 5 Flowchart of Hybrid approach. [2]

This method merge different approaches to realize the preferable performance or contribute quality of recommendation; solves problems like cold-start problem; and overcome some impediment with other methods. There are some ways of these approaches:

- Weighted hybrid recommender: utilize the recommendation approaches which are accessible in the system and calculated score of object recommendation from the results.
- Switching hybrid recommendation: exchange between approaches and use some measures to do the switching.
- Mixed: applies concurrently an enormous number of recommendations.
- Feature combination: use content- based approaches to develop dataset and use collaborative as an extra factor.
- Cascade: it makes a primary ranking of nominee and other recommended zones.

- Feature augmentation: this method assort an object or calculate the rating and after that this information is used in the handling of other methods.
- Model: it uses the outcome of one selected method as an input for another one[8]

- Advantages

Hybrid approach increases the benefits and reduces the drawbacks of approaches which are used in the combination [5].

- Disadvantages

Different approaches can be combined for hybrid approach but the most promising approach is not found yet.

2.4. New approaches:

- *Context-aware approaches:*

It is the information about the surroundings of the consumer some specifics about the circumstance he is presently in which could play a critical function in tips extra than rating of objects [10].

- *Computational intelligence-based recommendation approach:*

Computational intelligence (CI) strategies include synthetic neural networks, genetic algorithms, fuzzy set techniques, Bayesian techniques and clustering techniques. Those computational intelligence strategies in recommender structures, are broadly used to assemble advice fashions [9].

- *Cross-domain based approach:*

Cross-domain approach improves prediction accuracy via decreasing records sparsity and offering added values to hints with the aid of offering variety, novelty and serendipity predictions [11], computing resemblance between customers over their rating of an object and constructing a perfect neighborhood is significant operation in RS, but analogous rating in an individual field does not imply the same likeness in another field.

- *Social network-based recommendation approach:*

Social network analysis (SNA) has been utilized in recommender structures as a result of the spectacular boom of social networking gear in internet-based totally systems in latest years. To assist enhance person revel in, recommender systems increasingly offer customers with the potential to attract in social interaction with other customers, which includes online friending, making social comments, social tags, and so forth. Those traits provide opportunities for making pointers via using customers' social ties, specifically for systems whose rating facts is just too sparse to behavior collaborative filtering. [9]

- *Group Recommendations approaches:*

In real-life, users may have different types of relations like friendship in the form of business and sports relations, these relations make groups. They could be sharing their interests and reviews, that's taken into consideration a very critical function of social networks. The most important purpose of RS is to recommend an object/s for person users, so unique tips are sent to one-of-a-kind users. But, in circumstances in which the item become selected not most effective for the person to apply, however also for institution of consumer's e.g. DVD could be watched via a set of own family or friends. These organizations can differ from solid groups to advert hoc companies asking hints simplest from time to time, so some modern work has diagnosed the trouble "appropriate for" a group of users. Group recommendation technique is based totally on included organization profile generations; the

gadget is also intended to work in extraordinary area, along with: song, tourism, television program, webpage [12].

- Group recommendation techniques:
 - Groups with more users: This technique recommends agencies with an excessive number of users; its miles non-customized and recommends the same agencies to all customers.
 - Recommendation based on users' friends: In this way, user recommendations are given to the top two companies that are popular among consumer friends, it's far primarily based at the concept of graphs and is likewise a customized approach.
 - Recommendation based on association rules: through the usage of affiliation regulations and taking into consideration customer memberships, it discover extra carefully related groups and recommends to user a group he has not joined yet which is carefully associated with a set he's currently in [12].

3. RECOMMENDER SYSTEM AND DATA MINING

Data mining is used to describe the gathering of evaluation methods in Recommender System as shown in figure 6, which is used to deduce recommendation rules or construct recommendation fashions from massive information units. RS carries strategies that construct their advice by the use of know-how from customer attributes and behaviors. It is regularly primarily based at the evolution of person profile. Those methods consist of clustering type, affiliation policies and the manufacturing of similarity graphs via one of methods kind [20].

4. EVALUATIONS OF RECOMMENDATION SYSTEM

The assessment measurement relies upon the user obligations, forms of evaluation and datasets getting used in. [13, 14]

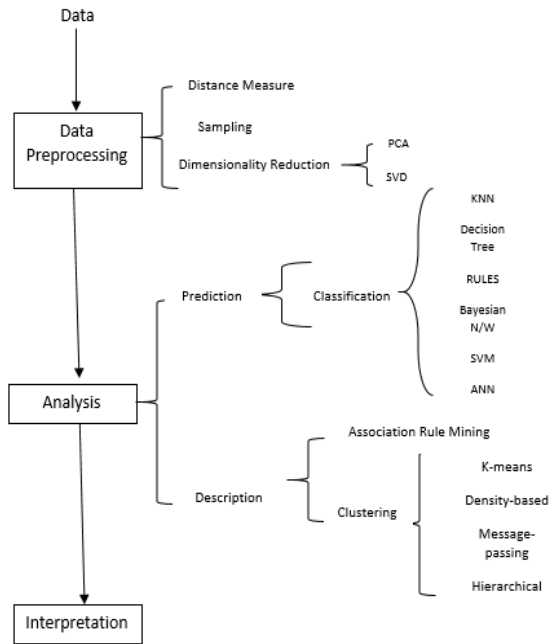


Figure .6 Recommendation Systems as data mining. [20]

4.1. Accuracy of recommendation systems:

- **Mean Absolute Error (MAE):**

$$MAE = \sum_{i=1}^N (p_i - r_i) / N \quad (1)$$

“Where N is the total number of predictions, pi is the predicted value and ri is the true value“.

- **Precision and Recall:**

$$Precision (P) = \frac{Nrs}{Ns} \quad (2)$$

$$Recall (R) = \frac{Nrs}{Ns} \quad (3)$$

“Where Nrs is number of accurate predictions. Ns is the number of predictions.

- **MAP (Mean Average Precision)**

Some ways have been taken to join precisions and recalls,

$$MAP (F) = \frac{2PR}{P+R} \quad (4)$$

- **Classification Accuracy Metrics:**

It measures makes correct or incorrect decisions about whether an object is good.

- **Rank Accuracy Metrics:**

It measures ordering of items that fits how the customers would have ordered the identical items.

- **Prediction-Rating Correlation:**

Two variables are correlated if the variance in the first variable may be clarified with the aid of the variance in the second.

4.2. Confidence:

There are two conflicting dimensions frequently faced researchers in finding out the way to interpret the recommendation consequences:

First is recommendation power: how lots does the recommender system assume this person will prefer this object. Second is the self-belief: how certain is the recommender machine that its recommendation is perfect.

5. PROBLEMS OF RECOMMENDATION SYSTEM:

5.1. Cold start problem:

With recommendation engines, the “cold start” simply means that the situation are not yet optimal for the engine to give perfect probable outcomes, it happens when entering a new customer or new object, with little data about this customer or object, which leads to the system attempting to conclude the customer recommendation. Here are three varieties of this trouble: new customer, new object and new system trouble. It is hard to recommend with this kind of problem because of the insufficient information about new

customer or rating about the new object. This problem is a sub-problem of the covering problem because it evaluate the system coverage given a specified set (customer and object). [15, 19]

5.2. Scalability:

It refers to the capability to deal with an enormous quantity of records. RS has a detonation of facts and it maintains handling with this constant growth. Some algorithms of RS have gauntlets, which boom with the growing range of objects and customers. [16, 18, 19]

5.3. Privacy:

Person desire or records is understood for RS concerning objects that want recommendation; but, it is considerable that no other one uses RS to get information or predilection about the person that he desires to remain private. Thus, the precision of a recommendation should also be estimated according to how private it is. [16, 18]

5.4. confidence:

Customers may want to trust their recommendation system that could be perfect at recommending a few items that are liked by and familiar to a customer, but this is not much of a earning to the customer about a recommendation operation. The system should supply a more sensible recommendation, which would also increase the trust in the system [17, 18]

6. CONCLUSION AND FUTURE WORK

Nowadays as the technology developed, data size also increasing rapidly. With this rapid development we require different recommendation approaches to find people interests and to recommend them.

In this paper various recommendation approaches and techniques are discussed along with their advantages and disadvantages. And also how other technologies can be combined to traditional approaches in order to improve the

performance which in turn helps users to find items of their interest with less effort and time. Finally different areas opened to many additional ameliorations, and where there is still much thrilling and relevant research to be done in future.

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