A Survey on Methods of Service Recommendations

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***Abstract*—A service recommendation system is a service predictor that predicts a service appropriate to user's interest. Recommendation systems are widely used to recommend service such as online books, hotels, and other products. The main goal of recommendation system is to give personalized services appropriate to the user's interest. In this paper we survey on different recommendation systems approaches that can be used for research.**

Keywords—reccommendation system; content based; colaborative filtering; keyword based; review based; bayesian; usage history;

I. INTRODUCTION

The recommendation system is an information filter that helps people to get appropriate information or services such as online books, hotels, and products. They serve as software tools for suggestions of items or services to users. Most of the online vendors use recommendation systems to predict books, music, etc. They help users to take decisions by capturing the behavior of a large set users or the behavior of a single user. So the recommendation systems are capable of developing a user model from the user behavior. A profile or model of user is formed from the users most searches, web page visits, etc. They help users in various decision-making processes such as what to buy, what books to read, what music to listen.

The recommender system is an intelligent system that predicts items to users in which they are interested. The recommendation systems give the output based on three types—content-based filtering, collaborative filtering and hybrid. In content-based filtering[1], users profile and description of items are used for recommendation. In collaborative filtering[2][3], user's past behavior and similar tastes of users are used for recommendation. The disadvantage of content-based filtering is it has limited scope while the advantage is it needs less information to start. The disadvantage with collaborative filtering is that it needs large information to start, it has cold start problem while the advantage is that it is more accurate. The hybrid is uses a combination of both content-based and collaborative filtering approach for recommendation. The hybrid approach is more accurate than the single technique approach. The combination of multiple recommendation methods will have a high accuracy output. The disadvantage of one recommendation method is overcome by the other method when both methods are combined together, which is an advantage with hybrid method. The hybrid method uses weights to combine the output of more than one the recommendation method. A weight is a numerical score given for a user preferred item or service. The hybrid method may also switch the output between the two recommendation methods by comparing the two outputs and discarding the less accurate output. The other attribute based methods for recommendation are keyword based[4], review based[5], usage history based[6], Bayesian based[7], audiovisual based[8], community based[9], QoS based[10]

II. RELATED WORK

The major category of recommendation systems are content based[1], collaborative filtering[2][3] and hybrid[4]. The collaborative filtering is further divided into item based[2] and user based[3]. The different approaches according to attributes considered are keyword based[4] which is a hybrid approach, review based[5] which analyses positive and negative reviews, usage history based[6] which makes use of user logs for recommendation, Bayesian based[7] which constructs Bayesian network on the ratings of friends, audiovisual based[8] recommends by using metadata of videos, community based[9] makes user group based prediction, QoS based[10] use the quality of service ratings to recommend services.

III. LITERATURE SURVEY

A. Content-based filtering

In content based service recommendation, the description of service is compared with the user model of interest. The keywords which describe features of service is considered and compared with user preference model. The candidate services rated by the user in the past are compared. The matched services are listed out after comparison. This method has information retrieving process and filtering process. To build a user preference model it has learn from the past interests and interactions with the system. The services are recommended by the importance shown by the user towards the service. It mainly learns from user's interest shown to one type of service and utilizes them to recommend other types of services. The disadvantage being scope limited to a user without considering other users with similar interests. The advantage is that less data is needed to start. In [1], author presented a TV recommendation system which records the user

interests in a TV program or TV channel and forms a user model by capturing the TV programs watched in the past. The user preference model formed is used for recommendation of TV programs.

B. Collaborative filtering

In collaborative filtering, large amount of user behavior are collected and services are recommended based on the similar tastes of other users. It is based on the assumption that people with similar interests in the past, will have the same in future. The data is collected in two forms explicitly and implicitly. In explicit form, the data is collected by asking the user to rate the services and rank most favorite to less favorite services. In implicit form, the data is collected from user online searches observed, services viewed by users, items purchased by user and user likes in social media. The advantage is that it considers others users with similar interest which makes a wide scope for recommendation and the disadvantage being cold start problem as it is requires large data of users. There are two types of collaborative filtering, item to item based and user based collaborative filtering.

In item to item based, the relationship is form between items bought by users, for example, users who bought x item also bought y item. In [2], authors presented item based recommendation system where the metadata of videos are used to recommend videos to users, the related metadata between videos used for recommendation.

In user based collaborative filtering, users are grouped together if they have interests in common and then services are recommended to the user belonging to set of users with similar preference for service. In [3], authors proposed user-based collaborative filtering in cloud computing services based on ratings for services of similar users in the past, the algorithm uses MapReduce programming model for Big Data processing.

C. Keyword based

In [4], authors proposed a keyword based recommender system where the keywords are extracted from the reviews of services given by users in past and appropriate services are recommended to the user. The keyword set is generated from previous user reviews and domain thesaurus is used to contain words similar to keyword for a given domain. Jaccard similarity coefficient and cosine similarity is used to evaluate similarity between keywords. It is implemented on hadoop for large scale and efficient processing for Big Data applications. The advantage of this approach is that it is scalable and efficient for big data processing. The disadvantage of this approach is Jaccard coefficient has less accuracy and the positive and negative reviews of user are not taken into account.

D. Review based

In [5], authors proposed a review based recommender system which applies technique similar to the keyword based approach but it is enhanced with sentiment analysis capability by considering the positive and negative reviews of users in recommending services to users. To get the keywords in root form, the stemming algorithm is used. A sentiment analysis rating from -1 to +1 is given for keywords extracted from the passive user review and are matched with active user query. The list of top-k services is recommended after processing. Hadoop framework is used for Big Data processing. The advantage of this system is it performs sentiment analysis i.e. positive and negative reviews are considered. The disadvantage is stemming algorithm overhead.

E. Usage History based

In [6] authors proposed a usage history based recommender system where web services are recommended based on web usage history of the user and Quality of Service(QoS). The usage log history is analyzed along with user preference which gives information on user's interests. A weight is assigned for usage history, QoS and preference attributes. The weight is the numerical score for the attributes taken into consideration. The top-k services are listed to user after processing. The advantage of this system is high in performance and accuracy. The disadvantage is that the usage history is only used for ranking and user review is not taken into account.

F. Bayesian based

In [7], authors proposed a Bayesian based recommendation system where a users share their ratings for service among friends on social network. The rating similarity between pairs of friend is evaluated with conditional probability. When the user sends query, a Bayesian network is constructed among the friends to predict the rating for a service. The querying user gets a predicted rating for a service on the basis of ratings given by all friends on the social network. The advantage is it is accurate due to friend's recommendation. The disadvantages are cold start and rating sparseness.

G. Audiovisual based

In [8], authors proposed recommendation system based on user audiovisual consumption in sports videos for Olympic Games. The metadata of sport videos such as athletes, nationality, round and type of sport are the attributes considered for recommendation. The user may have interest in different interests in nationality, athletes and sports. The system recommends video according to user interests in sports attribute. The system is implemented on the client-side rather than server side which solves privacy and computational problems of server side implementation. The visualization period

for a video which is the user start time and stop time of videos are also considered for recommendation. The advantage is that it avoids central server problem as it is implemented on client-side. The disadvantage is does not recommend the fragmental part of a whole video.

H. Community based

In [9], authors proposed travel recommender system based on people's attributes detected from the photos uploaded by the user community on social media. It recommends by deriving travel attributes such location where the photo was taken, gender, age and travel group attributes such as friends and family. A user profile is built using these attributes which are later used for recommendation. The geo-tagged images help in mining the landmarks and travel paths in which the users are interested. The advantage is that it is accurate as it considers community perspective of users. The disadvantage is that privacy issue for user photos and complex implementation.

I. QoS based

In [10], authors proposed a recommendation system for cloud services based on Quality of Service(QoS) ranking. The user experience of the each cloud service is considered to rate the QoS value. The cloud services are ranked on based on QoS rating value. The cloud services are ranked and listed out with their QoS value. The advantage is that QoS is used for ranking services and recommending services. The disadvantage is that it needs to be verified in other field of application.

IV. DISCUSSIONS

The recommendation systems are those which have the capability to give personalized recommendation. There are various algorithms and attributes for implementing these systems. With data increasing in size the complexity of recommendation systems become high. The attribute are different for different systems. In order implement the system we must decide the attribute and algorithm to use. We have discussed and compared some of the attribute based recommendation systems such as keyword based, review based, usage history based, Bayesian based, audiovisual based, community based and QoS based.

TABLE 1. COMPARISON OF DIFFERENT RECOMMENDATION SYSTEMS

Recommendation System	***Merits***	***Demerits***
Content-based filtering[1]	Requires less information to start.	Scope is limited to a user.
Collaborative filtering[2][3]	High accuracy. Wide scope as it considers all users with similar interests.	Cold start problem.
Keyword based[4]	Scalable and efficient for Big Data analysis.	Sentiment Analysis not performed. Jaccard Coefficient has low accuracy.
Review Based[5]	Performs Sentiment Analysis. Scalable and efficient for Big Data analysis.	Stemming algorithm overhead.
Usage History Based[6]	High performance and accuracy.	User review is not considered. Usage history is considered for ranking only.
Bayesian Based[7]	Accurate via recommendation by friends.	Cold start and rating sparseness.
Audiovisual Based[8]	Client side implementation.	Cannot recommend fragmental part of videos.
Community Based[9]	Accurate via community of users.	Privacy issue for photos. Complex in implementing.
QoS Based[10]	Cloud services are ranked and recommended using QoS value.	Needs to be verified in other fields of application.

For a recommendation system to be accurate we need to consider the following factors for implementing a recommendation system.

1. Kind of service to be given.
2. User group for whom the system is intended.

3. Input data to be processed.
4. Attributes of the system to be implemented.
5. Scope and area of recommendation.

Moreover, there are other factors to be considered for an accurate service recommendation system depending upon the field of application where the recommendation system is used along with the merits and demerits taken into consideration for a given system.

V. CONCLUSION AND FUTURE WORK

Many recommendation systems have been proposed and with each of them having their own merits and demerits. They have wide range of application in various fields. We have to select the best recommendation system suitable to our domain of work. There is requirement to work on recommendation systems in research area to develop new methods and meet the challenges of existing methods. In future, we can arrive at more advanced and accurate recommendation systems by combining with machine learning techniques.

Acknowledgment

We would like to express our gratitude towards the authors whose papers were considered and studied for reviewing the methods of recommendation systems.

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