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EFFECTIVE AND FAST RETRIEVAL OF MEDICAL RECORDS FROM RECOMMENDER BASED SYSTEMS

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Abstract— **We witness exponential increase in the amount of information being produced. Effective decision making based on such huge amounts of data can be achieved only if useful knowledge is extracted automatically from them. A recommendation system is basically used for predicting users preferences and interests. Here, we propose a framework to combine an intelligent information retrieval (IIR) along with the user profile learning to develop a recommender system. This work also proposes a new intelligent and effective information retrieval (IEIR) approach to develop a recommender system framework for processing large medical/clinical data sets. Here, three major recommendation algorithms are also described. The recommender system is based on patient's medical history by combining "data relevance" from multiple sources that facilitate in arriving at a reduced data set intelligently and provide fast results.**

Keywords— **Intelligent Information Retrieval, Recommender Systems, Collaborative recommendation; User-based recommendation; Item-based recommendation; Content-based recommendation.**

I. INTRODUCTION

High-dimensionality indexing of feature spaces is critical for many data-intensive applications such as content-based retrieval of images or video from multimedia databases and similarity retrieval of patterns in data mining. Similarity-based retrieval has become an important tool for searching image and video databases, especially when the search is based on content of images and videos, and is performed using low-level features, such as texture, color histogram and shape.

However, there are tremendous existing medical or clinical records or documents whichare majorly accessed for getting information about a patient's health data or history. There should be quick access to the relevant health records as per user or patient or clinic requirements through Personal Health Records System (PHRS). For the above purpose, to access the patient's health records very easily, the proposed system will be fruitful and advantageous.Hence, Intelligent Information Retrieval (IIR) methods and policies are necessary for an efficient assimilation of such information leading to timely and productive decision making.

Recommender systems are beneficial to both service providers and users . They reduce transaction costs of finding and selecting items in an online shopping environment. Recommendation systems have also proved to improve decision making process and quality. In ecommerce setting, recommender systems enhance revenues, for the fact that they are effective means of selling more products . In scientific libraries, recommender systems support users by allowing them to move beyond catalog searches [1]. Therefore, the need to use efficient and accurate recommendation techniques within a system that will provide relevant and dependable recommendations for users cannot be over-emphasized [1].

Apart from the above purpose, the proposed system can be made useful for the other areas like Government sectors, Medical Sectors, Media sectors, Social Sectors, Education sectors, Technical conferences, Literature review/survey etc where huge and high dimensional database is existing and there is a tremendous need to access the user required query based text documents/records very easily[2].

Along with relevant text retrieval, if the outcome of required text documents is achieved through mostly and frequently recommended data, the search of a user becomes complete and satisfactory in any domain [2].

II. COMPARATIVE ANALYSIS OF EXISTING RECOMMENDATION SYSTEMS

The term recommender system was coined to refer to a system using the opinions of a community of users to identify more effectively content of interest from a potentially overwhelming set of choices (Adomavicius &Tuzhilin, 2005). These types of systems have been used by online e-commerce sites to recommend items to their customers since 1990s [11]. The proliferation of learning resources in the internet requires the use of recommender systems that support learners in finding their way through the multiple thousands of learning resources offered. However, recommending suitable resources for learning processes is more complex than recommending commercial items [11].In the following section we present six

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e-commerce businesses that utilize one or more variations of recommender system technology in their web sites [8].

1. **Amazon.com** Customers who Bought: Like many E-commerce sites, Amazon.com (www.amazon.com) [8] is structured with an information page for each book, giving details of the text and purchase information [8]. Amazon.com Delivers: Amazon.com Delivers is a variation on the Eyes feature. Customers select checkboxes to choose from a list of specific categories/genres (Oprah books, biographies, cooking). Periodically the editors at Amazon.com [8] send email announcements to notify subscribers of their latest recommendations in the subscribed categories [8].

2. **CDNOW Album Advisor**: The Album Advisor feature of CDNOW (www.cdnow.com) [8] works in two different modes. In the single album mode, customers locate the information page for a given album. The system recommends 10 other albums related to the album in question. In the multiple artist mode, customers enter up to three artists. In turn, the system recommends 10 albums related to the artists in question.

3. **eBay Feedback Profile**: The Feedback Profile feature at eBay.com (www.ebay.com) [8] allows both buyers and sellers to contribute to feedback profiles of other customers with whom they have done business. The feedback consists of a satisfaction rating(satisfied/neutral/dissatisfied) as well as a specific comment about the other customer [8].

4. **Levis Style Finder**: Style Finder allows customers of the Levi Straus (www.levis.com) [8] website to receive recommendations on articles of Levi's clothing [8]. Customers indicate whether they are male or female, then view three categories -- Music, Looks, Fun -- and rate a minimum of 4 "terms" or "sub-categories" within each. They do this by providing a rating on a 7-point scale ranging from "leave it" to "love it." They may also choose the rating of "no opinion." Once the minimum number of ratings are entered customers may select "get recommendations." Here, they are provided with thumbnails of 6 items of recommended clothing [8].

5. **Moviefinder.com Match Maker**: Moviefinder.com-Match Maker (www.moviefinder.com) [8] allows customers to locate movies with a similar "mood, theme, genre or cast" to a given movie [8]. From the information page of the movie in question, customers click on the Match Maker icon and are provided with the list of recommended movies, as well as links to other films by the original film's director and key actors [8].

6. **Reel.com Movie Matches**: Similar to Amazon.com's Customers who Bought, Reel.com's Movie Matches (www.reel.com) [8] provides recommendations on the information page for each movie. These recommendations consist of "close matches" and/or "creative matches [8]."

Following Table 1 shows the comparative study of above mentioned Recommendation algorithms for sample E-commerce applications [1].

Table-1 Comparison Table of RS Algorithms

Algo.	Efficiency	Quality	Scalability	High Relevance	Accuracy	Examples
Content	Less	Low	No	Yes	Less	News Dude Pandora and Radio
CF	Less	High	No	Yes	Less	Amazon and Last.fm
Hybrid	High	Highest	Yes	Yes	More	YouTube and Netflix

III. Proposed System Architecture

Recommender based Systems can be seen just as an implicit information about the user's interests where there is no explicit query. Thus, it acts as a specific case of personalized Information Retrieval System [3]. Recommendation tasks generally involve a large set of items –such as books, movies or songs– and a large set of users to which the system provides suggestions of items they may enjoy or benefit from. Recommender systems technologies [3] have experienced a considerable development with significant impact and introduction in commercial applications [3].

The diversity dimension of search results is being researched in the IR field as a means to address the ambiguity and/or under specification involved in user queries. Current approaches [3] to enhance and evaluate the diversity of search results use concepts such as query intents and document similarity [3]. Query intents can be seen as the different meanings or purposes an underspecified query can represent. Taxonomies and query logs have been used for discovering and describing these intents. The identification of query intents and interpretations is then used to discover categories or refinements which may suit a query. Maximizing the range of categories covered by returned documents is a means to cope with the initial ambiguity of a query[3].

Information about Medical domain available for patient-oriented decision making [4] has increased drastically but is often scattered across different sites [4]. As a solution, personal health record systems (PHRS) are meant to centralize an individual's health data and to allow access for the owner as well as for authorized health professionals. Recommender systems (RS) suggest items of interest to users of information systems or e-

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business systems and have evolved in recent decades. A typical and well known example is Amazon's suggest service for products. We believe the idea behind recommender systems can be adapted to cope with the special requirements of the health domain [4].

Following proposed system architecture in Fig.1 represents the detail flow:

In this paper, we present a method for formulating the Recommender Systems problem in an Information Retrieval [9].Recommender Systems problem can be described in this way: a user corresponds to a document, a movie corresponds to a term, the active user (whose rating we want to predict) plays the role of the query, and the ratings are used as weights, in place of the weighting schema of the original IR algorithm. The output is the ranking list of the documents ("users") relevant for the query ("active user") [9].

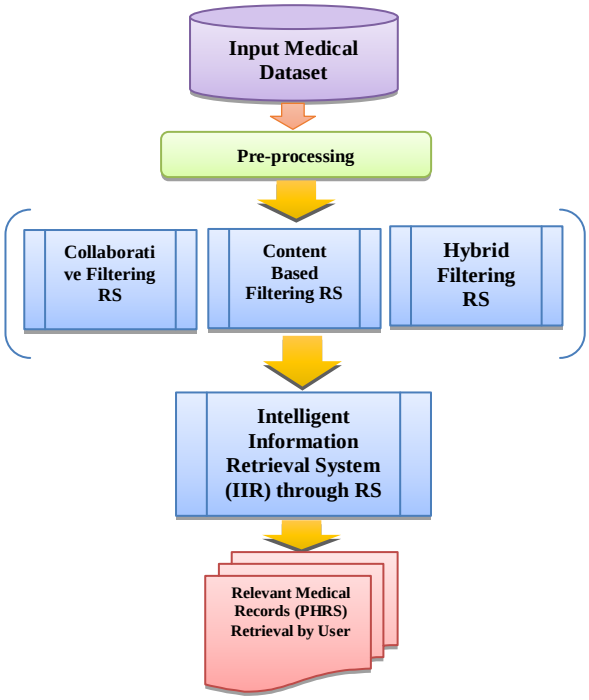

Fig.1. Proposed System Architecture

IV. System Modules

A. Datasets in Medical Domain:

Information can be gathered from a patient's Personal Health Records (PHR) and combine it with further information of related web resources (e.g., FDA MedWatch (see: http://www.fda.gov/Safety/MedWatch/)). PHR in combination with recommendation system is termed as Health Recommendation System (HRS).

The medical content (i.e., health information artifacts) to be rated by the group of physicians is provided by the German Institute for Quality and Efficiency in Health Care IQWiG (see: http://www.iqwig.de). It is an independent publisher of evidence-based consumer health and patient information.

B. Recommendation Techniques

Recommendation techniques are information agents that attempt to predict which items out of large pool a user may be interested in and recommend the best one to the target user. Recommendation techniques have a number of possible classifications. The interest in this discussion is not the type of interface or the properties of the user's interaction with the recommender, but rather the sources of data on which recommendation is based and the use to which that data is put. Specifically, recommender systems have (i) background data [8], the information that the system has before the recommendation process begins [8], (ii) input data [8], the information that user must communicate to the system in order to generate a recommendation [8], and (iii) algorithm that combines background and input data to arrive at its suggestions [8].

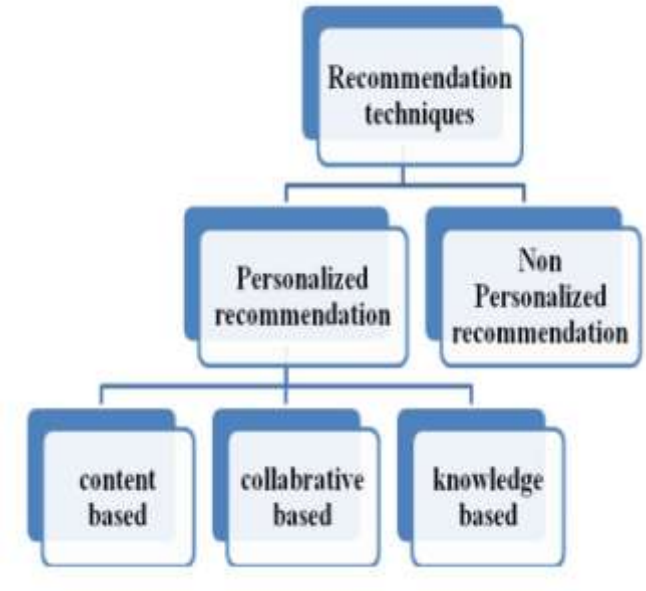

Fig.2. Classification of Recommendation Techniques

The whole classification is broadly categorized into the personalized and non-personalized recommendation as shown in Fig.2, and discuss all the personalized recommendation techniques shown in Fig.1.personalized recommendation is an enabling mechanism to overcome information overload occurred when shopping in an internet marketplace, use personalized information for better recommendations to the user. Non personalized recommendations are the simplest form of recommendations in which without any consideration of user's specifications some items are recommended. The

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most popular method is the recommendation based on ranking of items. However, since they don't take user's preferences into account, the quality of their results are low. For example in an electronic shop most sold items are recommended to all users [8].

Rapid growth of web and its applications has created a colossal importance for recommender systems. Being applied in various domains, recommender systems were designed to generate suggestions such as items or services based on user interests. Basically, recommender systems experience many issues which reflect dwindled effectiveness [10]. Integrating powerful data management techniques to recommender systems can address such issues and the recommendations quality can be increased significantly [10].

In the recommender systems, process of generating recommendations depends on various factors, such as the following:

1. Available user data in the database (such as user Information, interests, ratings, locations, and social Relationships);
2. Filtering mechanism/algorithm used (like, Content based, Hybrid, Collaborative etc.);
3. Techniques used to enhance the results (such as Bayesian networks, singular value decomposition, and fuzzy models);
4. Sparsity level and scalability of database;
5. system performance (such as memory and time consumption);
6. Considered objectives of the system (such as top Recommendations and Predictions);
7. Quality and its metrics used for the result and analysis (such as precision, recall, *F*-measure and novelty) [10].

Public databases are used in the research of recommender systems to develop new methods, techniques and algorithms. Delicious and last.fm are the most popular databases used in the development of recommender systems [10].

B.I *COLLABORATIVE FILTERING*

Since Collaborative Filtering approach was mentioned and described by Paul Resnick and Hal Varian in 1997, it became one of the most researched techniques of recommender systems [2]. The idea of collaborative filtering is in finding users in a community that share appreciations. The two users have similar tastes, if two users have same or almost same rated items in common [2],[5]. Such users build a group or a so called neighbourhood. Collaborative filtering methods have been applied to many non-identical kinds of data including: financial data, such as financial service institutions that combine many financial sources; monitoring and sensing data, such as in mineral exploration [12], environmental sensing [12] over large areas or multiple sensors; or in electronic commerce and web applications where the focus is on user data, etc. Collaborative filtering can be used for making automatic predictions about the interests of a user by collecting preferences or taste information from numerous users by means of collaboration [12].Going in details of methods of collaborative filtering we can distinguish most popular approaches: user-based, item-based and model-based approaches.

1) **User-based Approach**: This approach was proposed in the end of 1990s by the professor of University of Minnesota Jonathan L.Herlocker [5]. In the user-based approach, the users perform the main role. If certain majority of the customers has the same taste then they join into one group. Recommendations are given to user based on evaluation of items by other users form the same group, with whom he/she shares common preferences [5]. If the item was positively rated by the community, it will be recommended to the user. Thus, in the user-based approach the items that were already rated by the user before play an important role in searching a group that shares appreciations with him (See Fig.3) [2]. Fig.3 shows User-based collaborative recommender system [2].

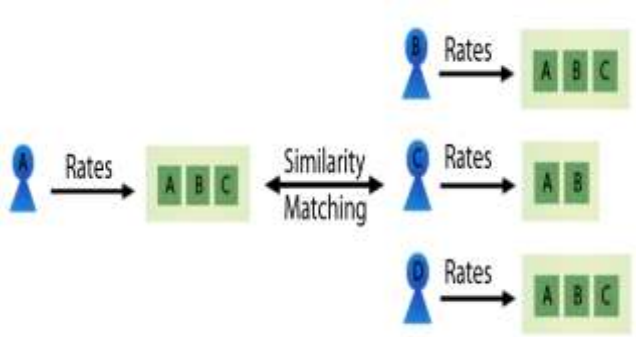

Fig.3. User-based Collaborative Recommender System

2) **Item-based Approach**: This approach was proposed by the researchers of University of Minnesota in 2001. Referring to the fact that the taste of users remains constant or change very slightly similar items build neighborhoods based on appreciations of users. Afterwards the system generates recommendations with items in the neighborhood that a user would prefer (See Fig.4). Fig.4shows Item-based collaborative system [2].

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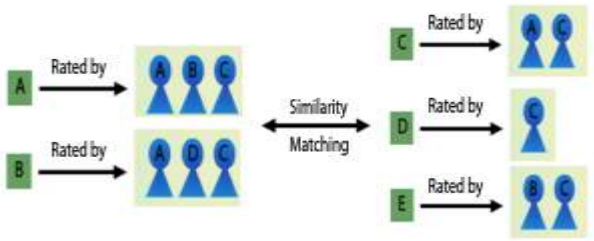

Fig.4. Item-based Collaborative Recommender System

B.II CONTENT BASED FILTERING:

Content-based recommendation method (Fig.5.) is based on the information about item content and ratings a user has given to items. This technique combines these ratings toprofile of the user's interests based on the features of the rated items. The recommendation engine then can find items with the preferred. The recommendations of a content-based system are based on individual information and ignore contributions from other users [1].

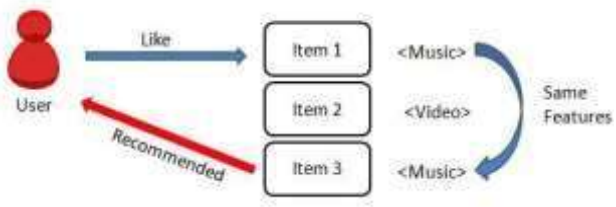

Fig.5. Content Based Recommendation

Recently, more and more attentions have been paid on users' taste and preference to improve the retrieval process in order to generate more meaningful and suitable retrieval results for users. And in real world, users may want to require the newest relevant information as soon as it appears. Compared to those passive information acquirement models such as search agents, our active information acquirement model can dramatically save much time for people who are always busy in this information exploded age. In our automatic recommender system, as illustrated in Fig. 3, we divide the users into groups who appear to have similar preferences according they accessed similar content in Internet. Semantic content features of a new item will be extracted to match the format of feature vector database. After adding it to database, we provide an efficient way to calculate and retrieval the similarities/ distances between the feature vectors of new item and users clusters. Actually, it is a process to find"influent sets" of new item, which can be accomplished by a reverse k nearest neighbor query. Finally, this item will be recommended to these groups of users that seem to have the similar tastes or interests matching with the semantic content feature of this item [1].

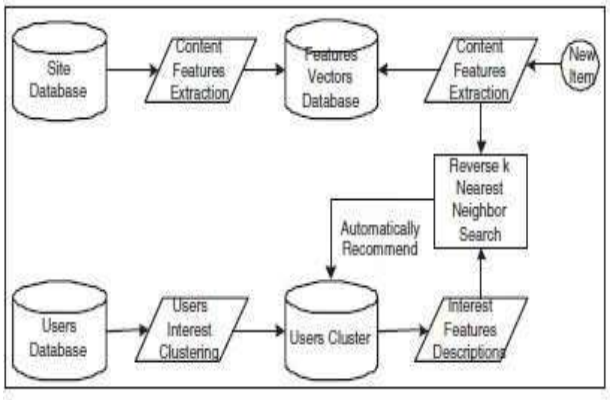

Fig.6. Architecture of Recommender System on Content-based Retrieval

B.III HYBRID FILTERING:

There are advantages and limitations of each recommendation method. For example, collaborative filtering can find users' potential interests by analyzing the historical data, but suffer from serious sparsity, cold start problems. Although the content- based can avoid all these problems and can also make a list of features of recommended products to explain recommendation reasons, it can be constrained by information extraction technologies and hard to find users' potential interest preferences. Thus the study of hybrid recommendation is proposed, which is the hottest research field. The Fig. 7. shows the Hybrid Recommendation model for E-commerce [1].

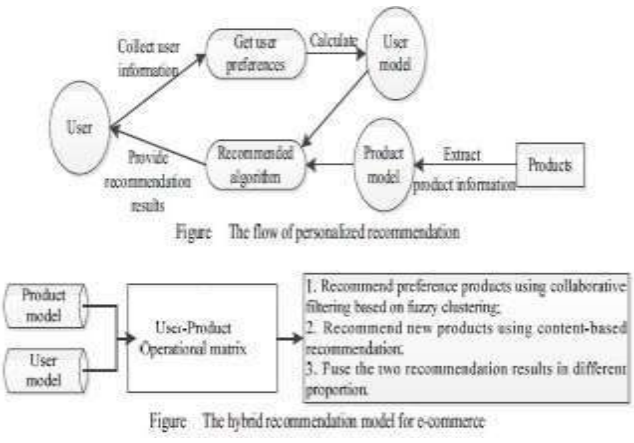

Fig.7. Hybrid Recommendation System

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C. Intelligent Information Retrieval (IIR):

We propose an intelligent information retrieval (IIR) approach that is designed to integrate two disparate methods, namely information filtering and data mining [7]. Simple IR could be time consuming and may not be achievable without manual interventions for data sets that involve different media such as video, audio, images and documents. Our Intelligent IR takes into account the meaning of the words used in the query, their relationships such as the order of words in the query, and thereby establishes the relevance. It is also designed to adapt the query based on the user's direct and indirect profile contexts and relevance feedback. Our model of IIR makes use of information utility and relevance. In this paper, we propose a novel approach that utilizes relevant and pertinent information in the intelligent information searching and filtering process and provides ranking through data mining and a recommender system by constructing a user model [7].

Relevance is a matter of degree [7]; some documents are highly relevant and indispensable for the user's tasks; others contribute just a little bit [7]. From relevance assessments we can compute measures of retrieval performance such as

Recall: How good is the system at finding relevant documents?

Discrimination: How good is the system at rejecting irrelevant documents?

Precision: Depends on discrimination, recall, and the number of relevant documents.

Here, we propose an intelligent IR (IIR) approach [7] to construct a user model through gaining relevant user feedback, which can significantly arrive at a smaller set of ranked documents that are relevant to the user's interests or search intent. A learning technique could then be adopted to arrive at a user profile based on how well the documents are topically relevant and pertinent [7].

D. Personal Health Records (PHR) And HRS

Personal health record (PHR) systems enable users to keep track of their own health data, most of which is still provided by health professionals. Hence, a long term individual medical history can be carried together for an individual. The Markle Foundation [6] defines a PHR as follows:

A PHR is an electronic application through which individuals can access, manage and share their health information, and that of others for whom they are authorized, in a private, secure and confidential environment [4].

The goal of an Health recommendation Systems (HRS) shown in Fig.8., is to supply it's user with medical information which is meant to be highly relevant to the medical development of the patient associated with that PHR. Related medical information may be recommended to health professionals who work on or with the given PHR but also it may be recommended to laymen inspecting their own PHR. Depending on a user's medical expertise an HRS should suggest medical information, which is comprehendible to that user. For a successful integration into any health related information system, it is important to consider the system context of an HRS. As depicted in Figure 1, a profile-based HRS component is implemented as an extension of an existing PHR system. Data entries in a PHR database (DB) constitute the medical history of a PHR owner. Supplied with medical facts, an HRS computes a set of potentially relevant items of interest for a target user (e.g., a PHR owner or an authorized health professional). Such items originate from trustworthy health knowledge repositories and may be displayed while he/she inspects the PHR online [4].

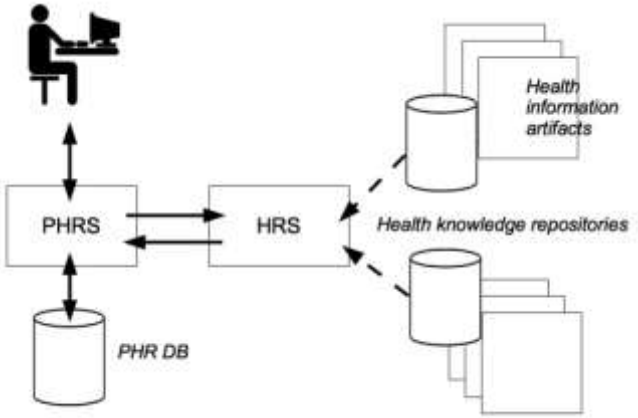

Fig.8. System context of an HRS-enabled PHR system

As health care professionals still play the primary role in the patient-physician relationship it is also important to consider their perspective when designing PHR systems. Doctors suggested that PHR systems should support the min "knowledge discovery as well as to support in sharing patient information. In this context, such a medical recommendation approach can be used "to solve the information-overload problem by suggesting knowledge items of interest to clinicians". We believe that enabling knowledge discovery could be provided by a health recommender system. For this reason, it could a valuable add-on to existing PHR systems. Thus, both sides of the patient-physician relationship could benefit from individualized or case-related recommendations [4].

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V. FUTURE WORK

One growing area of research in the area of recommender systems is mobile recommender systems [8]. With the increasing ubiquity of internet-accessing smart phones, it is now possible to offer personalized, context-sensitive recommendations. Advances in sensor, wireless communication, and information infrastructures such as GPS, and RFID have enabled us to collect large amounts of location traces (trajectory data) of individuals or objects. Such a large number of trajectories provide us unprecedented opportunity to automatically discover useful knowledge, which in turn deliver intelligence for real-time decision making in various fields, such as mobile recommendations [8].
Indeed, a mobile recommender system promises to provide mobile users access to personalized recommendations anytime, anywhere [8]. One example of a mobile recommender system is one that offers potentially profitable driving routes for taxi drivers in a city. This system takes as input data in the form of GPS traces [8] of the routes that taxi drivers took while working, which include location (latitude and longitude), time stamps, and operational status (with or without passengers) [8]. It then recommends a list of pickup points along a route that will lead to optimal occupancy times and profits. This type of system is obviously location-dependent, and as it must operate on a handheld or embedded device, the computation and energy requirements must remain low [8].

VI: CONCLUSION

The above mentioned work proposes a new intelligent and effective information retrieval (IEIR) approach to develop a recommender system framework for processing large data sets. The recommender system is based on patient's medical history by combining "data relevance" from multiple sources that facilitate in arriving at a reduced data set intelligently and provide fast retrieval.

The proposed system will provide more suitable information, which adapts to the preference of each user, by applying the recommendation approach to the system. The system will provide fast retrieval of medical records as per patient's requirements due to reduction in complexity of datasets. The user preferences are obtained from their access history. After acquiring records, the recommender system analyzes and recommends items like medical documents that are appropriate with their own favorite.
All existing recommender systems employ one or more of a handful of basic techniques: Collaborative, Content-based and Hybrid. This paper also shows the advantages and disadvantages of different techniques and their knowledge source. Also, it examines how recommender systems help E-commerce sites increase sales and analyze the recommender systems at six market-leading sites. An introduction is given for the mobile recommender system. A lot of future work has to be done under the mobile recommender system.

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