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A Survey Paper on Location Aware Recommender System

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Abstract: On the Internet, where the number of choices is overwhelming, there is need to filter, prioritize and efficiently deliver relevant information in order to alleviate the problem of information overload, which has created a potential problem to many Internet users. Recommender systems solve this problem by searching through large volume of dynamically generated information to provide users with personalized content and services. This paper explores the different characteristics and potentials of different filtering techniques in recommendation systems in order to serve as a compass for research and practice in the field of recommendation systems.

Keywords: Recommender system; Information retrieval; Collaborative filtering; Content based filtering; Hybrid filtering technique.

I. INTRODUCTION

The advances in information technology and entertainment technologies have accelerated the availability of various alternative items in each and every domain in the online market like hundreds of books ,songs, products etc. In addition to this ,the emergence of world wide web has opened up new possibilities for the users to know the details/specifications of items seamlessly without visiting shops and outlets. It is an easy task for an individual to choose from limited number of available alternatives .When the collection became large ,it is a tedious and time consuming task for any individual to really evaluate the features of items/products while purchasing quality, economic, and useful items. In such circumstances ,people seek suggestion or recommendation from friends and experts who have knowledge about the items and products. The main purpose of the recommender system is to provide tools to leverage the information hunting and gathering activities and interest of other people and groups of people. Recommendation systems have been an important application area and the focus of considerable recent academic and commercial interest. Generally, recommender system are used online to suggest item that customer find interesting, thereby, benefiting both customer and merchant.

The need of effective information retrieval and filtering tools become essential for easy access to relevant information. Technological aids such as information retrieval systems, information filtering systems, intelligent agents, ranking algorithm, clustering techniques, categorization techniques, data mining techniques, web mining techniques, personalization and recommender systems to tackle the problem of information overhead.

As e-commerce websites began to develop, a pressing need emerged for providing recommendations drive from filtering the whole range of available alternatives. User were finding it very difficult to arrive at the most appropriate choices from the immense variety of items(product & services) that these websites were offering.

Recommender systems can be used by various applications like e-commerce can be categorized in two ways:-

Personalized Recommender System: These are used by e-commerce sites to suggest product to their customers. The products can be recommended based on their top sellers of a site, demographic of the customers, or analysis of the past buying behavior of the customer as a prediction for future buying behaviour. For example, eBay.com website is treated as personalized recommender system.

Non-Personalized Recommender System: These recommend products to customers based on what other customers have said about the products on average. The recommendations are independent of the customer, so each customer gets the same recommendations. These are automatic, because they require little customer efforts to generate the recommendations and are momentary. For example, Amazon.com and moviefinder.com websites are treated as non personalized recommender systems.

II. RELATED WORK

Due to increasing adoption of mobile devices, location-aware systems are becoming more widespread and the demand for them continues to grow. Such systems employ various means to obtain position estimates, such as GPS (Global Positioning System) (outdoor only, with a precision of about 10 m), active badges(Want, Hopper, Falcao, & Gibbons, 1992) (Precisions ranging from a few centimeters to room size), or by exploiting the radio propagation properties of the wireless networking medium (Bahl & padmanabhan, 2000) (with precisions of a few meters for Wi-Fi). These location-aware systems use the estimated position to provide various services. For example, the "Active Badge Location System" proposed by Want et al.(1992) is considered one of the first location-aware applications. This system used infrared technology to determine a user's current location, which was used to forward phone calls to a telephone close to the targeted user. The cyberguide system (Long, Kooper, Abowd, & Atkeson, 1996), developed by the Future

Computing Environments group at the Georgia Institute of Technology, used wireless transmissions and GPS to build mobile tour guides that provided information to tourists based on knowledge of their positions and orientation.

E-commerce has seen the emergence of many types of recommender systems that are designed to provide personal recommendations about various types of products and services, including news and emails (Billsus & Pazzani, 1999; Goldberg, Nichols, Oki, & Terry, 1992; Konstan et al., 1997; Lang, 1995), webpages (Balabanovic´ & Shoham, 1997; Terveen, Hill, Amento, McDonald, & Creter, 1997; Armstrong, Freitag, Joachims, & Mitchell, 1997),books (Mooney & Roy, 2000), music albums (Shardanand & Maes, 1995), and movies (Alspector, Kolcz, & Karunanithi, 1998; Ansari, Essegaier, & Kohli, 2000; Basu, Hirsh, &Cohen, 1998; Pennock, Horvitz, Lawrence, & Giles, 2000; Schafer, Konstan, & Riedl, 2001). The location-aware systems based on location based ratings that are classified in three categories:

- Spatial ratings for non-spatial items: Represented by the tuple (user; ulocation; rating; item), where ulocation is the user's location.
- Non-spatial ratings for spatial items: Stated by the tuple (user; rating; item; ilocation), where ilocation represents an item's location.
- Spatial ratings for spatial items: Represented by the tuple (user; ulocation; rating; item; ilocation). In this case, the location of the user and the location of the item are both relevant.

A. LARS for Shopping Environment

In the field of mobile commerce (m-commerce), several types of LARS have been designed and presented in the literature to suggest a variety of products and services that may be of interest to users. An example is the location-aware recommendation system that recommends vendors' web pages to interested customers in mobile shopping. Another example is CityVoyager , a recommendation system based on the user's location history, which is obtained by using a GPS device. It recommends shops to the users based on the locations of previous shops visited. In order to avoid the need to type text, along with the associated spelling problems and possible ambiguity, when the user needs to specify the types of items he/she is interested in. Specifically, the location-based shopping recommendation system proposed uses an image of the desired item (e.g., shoes, clothes) provided by the user, as the query, as well as the smartphone's GPS coordinates, to recommend retail shops (with information including their GPS coordinates, promotions, and special offers) to mobile users.

III. RECOMMENDATION PROCESS

In general, every recommendation system follows a specific process in order to produce product recommendations, see figure 1. The recommendation approaches can be classified based on the information sources they use. Three possible sources of information can be identified as input for the recommendation process. The available sources are the user data (demographics), the item data (keywords, genres) and the user-item ratings (obtained by transaction data, explicit ratings).

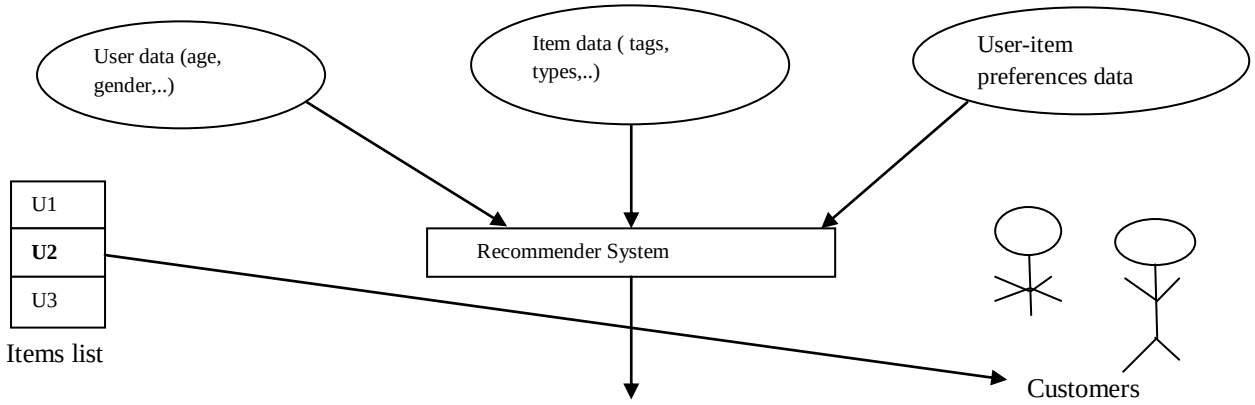

Fig 1. Recommendation Process

(Figure 1 has been taken from the paper " A Categorical Review of Recommender Systems" by RVVAV Prasad and V Valli Kumari in IJDPS at page no. 74.)

IV. FILTERING TECHNIQUES FOR RECOMMENDER SYSTEM

A. Content-based Filtering Recommender Systems

Content-based filtering systems recommend items based on descriptions or content of items rather than other user's ratings of the system. Instead of deriving a user-to item correlation and defining methodologies, they use item-to-item correlation for generating recommendations. In these systems, the process of recommendation first starts by gathering content data about the items. For example, title, author, cost etc. for the books, are the some of the common content information. Most of these systems use feature extraction techniques and information indexing to extract the content data. In content-based filtering, the system processes information from various sources and tries to extract useful features and elements about its content. Websites like Bargain Finder and Jango try to collect information from many different web

information sources. Different sources have different inputs (e.g., CGI scripts, Java applets) and presentation methods, so recommender systems have to adjust their interaction methods depending upon the web site.

Advantages:

Content based approach does not require data of other users and has capability of recommending item to users with unique taste and does not suffer from first rater problem i.e., they are capable of recommending new item and unpopular item to every customer.

Disadvantages:

The feature extraction and representation can be achieved automatically e.g. news or papers. But human editors have to manually insert the features for items e.g. movies and songs. Content-based filtering techniques have no other method for finding something unexpected issues which are useful while searching. In content-based filtering systems, items are limited to their initial descriptions or features i.e. the features are specified explicitly.

B. Collaborative Filtering Recommender Systems

The goal of collaborative filtering systems is to suggest new items or predict the utility of a certain item for a particular user based on users past liking and the opinions of other like minded users. It is widely used and perhaps the most familiar recommendation technique implemented in several e-Commerce applications. In general, collaborative filtering systems collect the ratings for a list of items from a list of users. Opinions can be explicitly given by the user as a rating score or can be implicitly derived from the historical data of the user.

Advantages:

Collaboration Filtering Approach does not need a representation of items in terms of features but it is based only on the judgment of participating user community. Example websites, movies, songs, books, jokes, etc. Scalability of the items database is large because it does not require any human involvement. They can have cross type recommendations for predictions which are different to users and does not require any domain knowledge which saves time. The recommendations can be improved over a period of time.

Disadvantages:

The item cannot be recommended to any user until the item is either rated by another user(s) or correlated with other similar items of the database. In practice, in many e-commerce applications the active users rate only few items in spite of having a large item database which leads to very sparse results.

C. Hybrid Filtering Recommender System

Hybrid filtering technique combines different recommendation techniques in order to gain better system optimization to avoid some limitations and problems of pure recommendation systems. The idea behind hybrid techniques is that a combination of algorithms will provide more accurate and effective recommendations than a single algorithm as the disadvantages of one algorithm can be overcome by another algorithm. Using multiple recommendation techniques can suppress the weaknesses of an individual technique in a combined model. The combination of approaches can be done in any of the following ways: separate implementation of algorithms and combining the result, utilizing some content-based filtering in collaborative approach, utilizing some collaborative filtering in content-based approach, creating a unified recommendation system that brings together both approaches.

There are different strategies by which hybridization can be achieved and they are broadly classified into seven categories that are summarized in table 1:

(Table 1 has been taken taken from the paper " A Categorical Review of Recommender Systems" by RVVAV Prasad and V Valli Kumari in IJDPS at page no. 79.)

Hybridization method	**Description**
Weighted	The ratings of several recommendation techniques are combined together to produce a single recommendation
Switching	The system switches between recommendation techniques depending on the current situation
Mixed	Recommendations from several different recommenders are presented at the same time
Feature Combination	Features from different recommendation data sources are thrown together into a single recommendation algorithm
Cascade	One recommender refines the recommendations given by another
Feature Augmentation	Output from one technique is used as an input feature to another
Meta-level	The model learned by one recommender is used as input to another

V. EVALUATION

The procedure to evaluate the nearest item/product for an individual is done by using the travel penalty algorithm, specially for spatial items, where area is defined for a user. The algorithm uses three parameters that are user (U), location (L) and limit (K). To calculate an exact travel penalty for a user u to item i, we employ an incremental k-nearest-neighbor (KNN) technique.The algorithm is as follows:

Algorithm 1 Travel Penalty Algorithm for Spatial Items

1: Function LARS SpatialItems(User U, Location L, Limit K)
2: /* Populate a list R with a set of K items*/
3: R ⟵ null
4: **for** (K iterations) **do**
5: i ⟵ Retrieve the item with the next lowest travel penalty
6: Insert i into R ordered by RecScore(U, i)
7: **end for**
8: LowestRecScore ⟵ RecScore of the kth object in R
9: /*Retrieve items one by one in order of their penalty value */
10: **while** there are more items to process **do**
11: i ⟵ Retrieve the next item in order of penalty score
12: MaxPossibleScore ⟵ MAX RATING - i.penalty
13: **if** MaxPossibleScore <= LowestRecScore **then**
14: **return** R /* early termination - end query processing */
15: **end if**
16: RecScore(U, i) ⟵ P(U, i) - i.penalty
17: **if** RecScore(U, i) > LowestRecScore **then**
18: Insert i into R ordered by RecScore(U, i)
19: LowestRecScore ⟵ RecScore of the kth object in R
20: **end if**
21: **end while**
22: **return** R

VI. COMPARISION BETWEEN TECHNIQUES OF RECOMMENDER SYSTEM

Recommendation strategy	Pros	Cons
Content-Based technique	User independence transparency.	Limited content analysis over-specialization.
Collaborative technique	Easy to create and use explainability of the results. New data can be added easily. More applicable in the reality.	It totally depends on human ratings Sparsity(Insufficient data).Scalability ignore the social relationships. Cold start problem (Low Accuracy).
Hybrid technique	Avoid cold start problem. Alleviate the sparsity problem.	Difficult to develop a trust network.

Recommendation System plays an important role over recent years where various method such as content , collaborative and hybrid method are proposed . The paper mainly consist of various hybridization methods like weighted method, which is used to overcome the certain limitations. Different approaches of recommender systems have been discussed in detail. A system that combines content-based filtering and collaborative filtering could take advantage from both the representation of the content as well as the similarities among users. Although there are several ways in which to combine the two techniques a distinction can be made between two basis approaches. A hybrid approach combines the two types of information while it is also possible to use the recommendations of the two filtering techniques independently.

VII. FUTURE WORK AND CONCLUSION

A. Future perspectives

The future perspective for further research in this field is:

Automatic data acquisition and context exploitation: Overall, we believe that location-aware recommendation systems could be more effective if the characteristics of the dynamic environment were effectively exploited.

Evaluation: Firstly, over time, RS have become more complex, by considering new parameters during the recommendation process, such as the location. Secondly, the datasets used for evaluation are usually the same datasets used to evaluate traditional recommendation systems (e.g., MovieLens). Regarding evaluation, there are still significant research challenges to be addressed.

Bridging the gap between mobile computing and LARS: The fields of mobile computing and recommendation systems have evolved in a quite independent way. However, when considering LARS, it is clear that traditional recommendation techniques should be completed with other data management techniques applied in mobile computing.

User Interfaces: From the perspective of mobile applications, user interfaces designed for recommendation purposes (explicit or implicit recommendations) should be simple and easy to understand. Hence, we believe that this could be a relevant research line to take into account during the design of location-aware recommendation systems.

B. Conclusion

In this work, we have provided a survey of location-aware recommendation systems for mobile environments. We first described the basics of LARS and some generic approaches. Then, we presented a number of location-aware recommendation systems for several scenarios. Finally, several future perspectives and challenges, that we believe should guide upcoming research steps, were discussed. In the last decade, location-aware recommendation approaches made an important progress thanks to significant efforts developed by the research community. Nevertheless, more research is needed to solve existing difficulties and design systems able to obtain more effective recommendations.

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