Approaching Another Tourism Recommender

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Abstract—With the concurrent spread and development of Internet and a warm welcome to the Age of Big Data, Internet has become a main channel for travelers to obtain online information before traveling, but in the meantime they are often submerged in a large number of information by searching and for selecting. In this case, travel recommender system is created to solve the problem of information overload effectively. This article analyses the concept, application and development status of travel recommender systems through the collection and arrangement of relevant literature published in recent years. Also, it pays special attention to the analysis of key technologies in the system, pointing out its complexity and uniqueness an application. Besides, the limitations of recommendation methods based on collaborative filtering and content-based filtering are considered as well, then the using knowledge-based filtering or hybrid recommendation method is proposed. It also discusses the role and application of tourism decision-making theory in the recommender system, and finally puts forward a general model of travel recommender system and future research hot spots. It's wished that this research can expand the vision and serve as a reference in this field.

Keywords—Information Overload, Personalization, Travel Recommender System, Tourism Decision-Making Theory.

I. INTRODUCTION

A. Concepts, applications and development of travel recommender system

In the 21st century, the travel industry has become one of the most important and active areas of B2C e-commerce. Online information has been the primary source for travelers to obtain information and book services. Previous studies have suggested that nearly three-quarters of travelers prefer to search for travel reviews online in order to make a plan of their trip before traveling [6], and [9]. With the help of Information and Communications Technology (ICT), tourists have been able to conduct a large number of online information, and previously order travel products and services, such as booking air tickets, hotel reservations, trip planning, entrance tickets, etc., thus greatly improving their travel experience. However, they are also often submerged in the explosive online information and various e-commerce services when searching and selecting, which rendering them incapable of making rational decisions. Accordingly, the travel recommender system is thought to be one of the most effective ways to reduce information overload [15, 16].

The value of recommender system lies in its ability to provide users with relevant choices without requiring them to have a clear awareness of their needs [7]. The system can provide useful assistance for decision-making even in the absence of sufficient personal experience. On the one side, it makes the process of Pushing, like recommending products to users; on the other side, it makes the process of Pulling, like providing people with information to help them decide which to buy. For example, a travel recommender system could: (1) enable potential travelers to Experience the destination; (2) simplify the process of selecting a destination and meet travelers' specific needs and desires; (3) facilitate people's on-the-go purchase of products and services; and (4) incentivize potential travelers to visit a place repeatedly through customer relationship management [7]. By Häubl and Trifts, recommender system is defined as a software tool that offers recommendations based on the understanding about user characteristics [10]. A

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recommender system looks similar to the information retrieval system, represented by a search engine, in which a user could look up what he is looking for, and the presented results are same for all users. Nevertheless, if people want to make a better decision, depth-first search like options comparison, knowledge acquisition, and product selection is necessary. A recommender system intelligently tailors the results and ranks the content of its feedback to each user's preferences, habits, and personal needs. Today, recommender systems are widely used in e-commerce or portal applications, and support hundreds of millions of consumers searching for their needs. Take Amazon.com as an example, it was the first who used data mining algorithms and collaborative filtering to find consumers with similar preferences, for predicting and exploring products that they might be interested in. Two of the most successful applications of the recommender system in tourism sector are tripmatcher of triplehop, used on www.ski-europe.com, and MePrint of VacationCoach, which is a platform providing professional advice on travelocity.com. Both systems attempt to negotiate with users like human agents to help them simplify their searching process for holiday destinations [17].

II. Current Status of Academic Research on Travel Recommender System

In recent years, the technology of recommender system has attracted a large group of researchers, which could be counted for the following reasons. One is due to its successful cases in popular e-commerce websites such as Amazon.com, YouTube, Netflix, Tripadvisor, Last.frm and IMDb; the other is due to the wide popularity of conferences and seminars related in this field, such as The ACM Conference Series on Recommender Systems (http://recsys.acm.org/). Additionally, sessions on traditional topics like databases, information systems and adaptive control also include issues related to recommender systems. In order to comprehensively understand the overseas research status and progress, the author performs the retrieve with the keywords of Tourism Recommender Systems in four famous language databases: Springer, ScienceDirect, EBSCO (Hospitality & Tourism Complete) and IEEE Explore. The result revealed that, in terms of the discipline of the journal, the relevant literature is mainly distributed in computer science, tourism management and the inter-discipline of information technology and tourism, including AI (artificial intelligence), semantic network, user modeling, machine learning, data mining, DSS (decision support system), adaptive control, information retrieval, man-machine interaction, etc. Travel recommender systems is a branch of applying recommendation systems in tourism. Since recommendation systems originally came from areas closely related to computers, such as information extraction and information retrieval, the implementation of this system requires theories and technologies related to AI.

III. Technologies and Systems of Travel Recommendation

A. Classification by Recommender Technologies

1. Collaborative filtering

A recommender system based on collaborative filtering provides personalized recommendations from users' preferences. By users' ratings and purchase history, users' preferences can be found out, and other users with similar interests could be identified as well. Thus, products that similar users like will be recommended to current users as a reference. Collaborative filtering has the ability to introduce new items, make novel recommendations, and explore potential but unknown interests of users, which is suitable when recommending unstructured items that are difficult to analyze (such as images, videos, music, etc.). However, there are some limitations in collaborative filtering too, such as data sparsity (with few user ratings), cold start (including both the project and the user, which means a new project cannot be recommended because of a lack of its rating or user reviews; or a new joining user cannot receive recommendations because of a lack of the understanding about the user’s preferences and similar interests users), or problems of algorithm scalability (with the increasing number of users and projects, computations increases dramatically as well), and so on. Horozonv and his colleagues use three main strategies from collaborative filtering in dealing with the cold start, who assumed that the types of attractions preferred by users are similar to the residences as well [11]. First, they allow the system to randomly generate similarity-driven selections by manually introducing virtual users to categorize and rate restaurants in advance, which allows similar interests

users can be found even with few ratings as references; then, they allow the system to randomly generate similarity-driven selections; and finally, they recommend the closest item with the highest average rating to users.

2. Content-based Filtering

Content-based recommendation constructs user profiles by analyzing the characteristics of those preferred items. It makes use of the user's reviewing history to make user profiles, and new items are used to match the file and find the closest selection. However, content-based recommendation, which is deeply rooted in information abstraction techniques, has its weaknesses which in fact are difficult to ignore [1]. (1) Due to the limited capability of extracting features, content-based recommendation is usually applied only to systems where resource content is easy to find. For unstructured data (such as images, videos, music, etc.), it is hard to make the process due to the lack of appropriate extracted features. (2) The range of recommended resources is too narrow. This is mainly because the system always tries to recommend items that match the content characteristics attracted to users best and often fails to recommend novel items that the system discovers. For example, MePrint categorizes users (Culturazzi, Beach Bum, etc.) by explicitly asking them by themselves, without inferring implicit needs that people did not raise [18]. Meanwhile, TripMatcher takes a more sophisticated approach, taking into account of both users' habitual behaviors and current status and preferences, in order to construct a specialized dialogue-oriented model in domain knowledge, and build a database of tourism destinations to match users' preferences. However, building such a large database is a lengthy and costly process for any enterprise or organization.

3. Knowledge-based Filtering and Hybrid Recommendation

Knowledge-based filtering makes recommendations on the base of user and product information, which means generating a reasoning process to discover which product most fits the user's needs [3]. This technique avoids the problem of cold start because it does not rely on user ratings. However, it requires a large amount of domain knowledge and reasoning techniques. In travel recommender systems, case-based recommendations are used most [2, 16, 17]. The case-based recommendation technology finds cases whether can be directly used or modified to be used from similar cases that are recommended before.

Hybrid recommendation can achieve better results by integrating two or more recommendation techniques. The most common approach is to combine collaborative filtering recommendation technology with another technique to solve the cold start. Hybrid recommendation includes: weighted, combined, waterfall, feature incremental, and meta-level types [3]. Its main purpose is to make full use of the advantages of various techniques to overcome the shortcomings of one technique, improving the performance and accuracy of recommendation.

B. Classification by Recommended Projects

Personalized recommendations in tourism include individual recommendations about attractions, hotels, restaurants, flights, etc., as well as combining recommendations on destinations, travel plans, travel packages of products, activities and services. For example, Travel Planner provides recommendations on accommodation, restaurants, activities and transportation [4], while AVANTI provides recommendations on tourist sites, hotels and holiday villages [8]. The criteria are taken into account when evaluating products and services also vary depending on the items recommended (Table 1). In most recommended flights, price is the primary factor, while destinations and user locations are taken into account by the system as well. Also stops, zones of travel, airlines and ranges are considered by the minority. In the meantime, most of the factors considered for recommended attractions are location, price, time and tourists' interests. For example, SPETA adopts three main factors: the theme of the attraction (culture, leisure, modern art, etc.), the location of the attraction (indoors or outdoors), and time constraints (open time and closing time). Besides, some research focus on learning users' personality, motivation, like why to travel (to enjoy nature, to learn new skills, to discover new things, or to escape from the reality), age, career, features, etc. [12]. There are also some systems providing different recommendations for different services, which means one system contains several factors. When some factors

can be adopted for different services, some can only be used for one. For example, Traveler uses factors like range, location/destination, price, traffic, transportation company (e.g., airline), lodging (hotel name), lodging type (small hotel, five-star hotel, etc.), room type (single, double, standard, suite), and service type. The system only adopts all the factors when required to recommend different services at the same time. Recommending hotels may take into account of the offered facilities, customers' reviews, rooms available, check-in/check-out times, distance to attractions, and prices, while recommending restaurants may take considerations of the cuisine, location, open hours, customers' reviews, menu, and price range.

Table 1. Recommendations for Projects and Guiding Factors

Featured Projects	Factors
Flights	price, stopover, departure, destination, departure and arrival time, airline, etc.
Travel Package	destination, travel season, price, types, historical/ artistic attractions
Sights	type, distance, price, location, time, weather, traffic, experience, interests/goals, visited attractions, mood, patterns of mobility , social surroundings, travel motivation, personality, career, age etc.
Restaurant/Café	price, cuisine, open hours, open days/time, available facilities, location, types of service, menu, customers' reviews
Lodging	location, price, length of stay, date, star rating, types of room (single, double, standard, suite, etc.), category, rooms available, check-in/check-out time, distance to attractions
Travel Plan	travel expectations and constraints (companions, budget, traffic, accommodation, departure, travel season, travel date, travel purpose such as sport, adventure, entertainment, interests of artistic and cultural experiences, etc.), travel package (type of destination, accommodation, activities, attractions)

C. Discussion about the Specificities of Travel Recommender System

Recommender systems in tourism industry have their specificities which make them distinguishable from other recommendation programs. First of all, its design and application are more complex, as travel experience, including its products services, is a complicated process influenced not only by subjective factors when tourists make decisions, but also contextual factors related to the user's current situation (the season, the distance to attractions, etc.); at the same time, recommendation itself also has a certain degree of specificity and complexity. For example, recommending destination is a high-risk thing, involving a large number of unknown factors. In this case, the final selection of a travel destination more or less depends on the available and useful information for tourists. Secondly, although collaborative filtering and content-based filtering has already been successfully applied in some traditional domains, they cannot be solely used in tourism. These are the main reasons: (1) collaborative filtering is implemented on the base of a relatively large community where similar interests' users would maintain their preferences. In this type of system, a given user's reviews, purchasing behavior and the preferences in the community are influential in predicting how much he is interested in a particular item. However, when it comes to recommend travel plans, problems arise, since detailed purchase history and user preferences are insufficient [13, 14]. After all, travel is not that frequent in people's daily life, thus tourists' reviews and travel experiences are not easy to obtain. (2) Travel cannot be reduced to a two-traveler-trip. The experience of past travels is not enough to predict the next one. It is known that contextual factors are essential for considerations, and the user's travel habits ad preferences must be thought as well. The complexity of travel decisions is based on the complexity of travel itself [19]. Therefore, this requires an integrated approach, which is a combination of content-based and

collaboration-based approach [18]. (3) The prediction of user behavior cannot solely rely on their past rating, but also on contextual information and user preferences as well [15] and [5].

IV. Application of Tourism Decision-making Theory to Travel Recommender System

In order to simplify the consumer's decision-making process in a meaningful way, recommender systems should be allowed to know that the process changes according to the complexity of the decision, the contextual information (time, location, etc.), the social surrounding (individuals or groups, responsibilities, etc.), personal characteristics (knowledge, cognitive abilities, motivations, etc.), and so on. For a travel plan, selecting a destination is always the first step and influences the rest, so it is seen as an essential part of the whole plan and an important issue in tourism research. Therefore, a better understanding of how tourists choose their destinations when making travel plans will be key to designing a good recommendation system. Previous studies classify decision-making models of destination into four categories: (1) selected set model, focusing on the process by which one destination is selected from a large set of destinations; (2) universal tourism model, focusing on the process by how an individual tourist judges and chooses his destination on the base of consumption theory; (3) decision-making network model, focusing on every level of a plan from an integrated aspect; (4) multi-destination tourism model. These models are used to explain and predict user particular choices based on different assumptions and premises. Although these models are different, they have one thing in common which is that tourists are always influenced by different psychological and non-psychological variables when making decisions.

V. Discussions and Summaries

A. General Framework of Travel Recommender System

Based on the modern research and the analysis of its specificities in client-based application and mobile-terminal device application, I have come up with a general framework for travel recommender system (Figure 1). Usually, a recommender system consists of three steps: user modeling, algorithm (recommendation engine), and presentation. The user modeling creates and perfects users' profiles and preferences through explicit and implicit information acquisition, while the recommendation engine generates personalized recommendations and sorts them on the base of user modeling, contextual information, knowledge base and basic database. Finally, the recommendations will be presented in the client browser or mobile terminal in forms of listing, 2D/3D maps and so on.

For tourists, an effective decision support system should be able to meet their various needs and desires and provide them diverse plans and strategies. For a travel recommender system, it should take the specificity and complexity of products and services involved, and generally avoid information overload and maximize user satisfaction. Help inexperienced tourists to make a travel decision and reduce their cognitive load or simplify the process of interaction, which would make the recommender system more like an intelligent agent. To be specific, the followings are required: (1) the final recommendation should involve a combination of various factors, considering the complexity of products and the space time correlation of a travel plan; (2) both short-term (items relevant to the current situation) and long-term preferences should be considered, because short-term ones often meet people's necessities, which deserve more attention; (3) in any case, users' explicit preferences should be satisfied first, although their implicit preferences can be predicted from the searching; (4) the decision-making system should avoid the influence from the incomplete information such as user interaction or consumption records, and ensure everyone with valuable information even though they are temporary or unregistered; (5) the process should support diverse man-computer interactions and minimize users' cognitive load to make a choice simple.

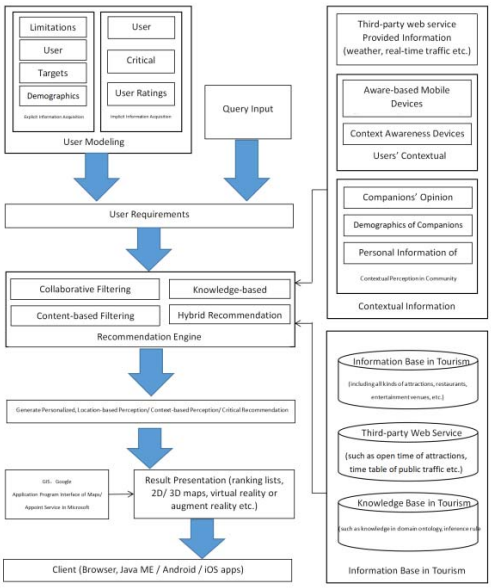

Figure 1. General Framework of Travel Recommender System

B. Challenges and Directions for Future Research on Travel Recommender System

First, make a deeper understanding of the users and travel projects. Since most methods make recommendations only through limited descriptions of the target users and projects, without taking full advantage of other useful information like user interaction history and others available [1]. For example, traditionally, collaborative filtering takes little use of those description files before making a recommendation, instead solely relying on rating information. Although those profiles have gradually been added in some systems, they are still very basic with less advanced analysis techniques in use. In this case, the promotion of data mining techniques in user modeling for automatic application will be major importance to the future research, as well as the facilitation of a non-intrusive mode when acquiring the implicit preferences of users.

Second, carry out multi-dimensional recommendations. As traditional recommendation systems are operated in 2D space: user item. In other words, they simply depend on information about users and items, without considering additional contextual information which is actually critical in relevant applications. It is necessary for the system to take various factors into the consideration, such as the time, the destination and the companion. For example, when recommending a travel package to tourists, the system should collect information like when to travel, who to travel with, what is needed and avoided. Therefore, moving forward from 2D space to a multi-dimensional one is worthwhile.

Third, do multi-criteria evaluation. Currently, most recommender systems are known as multi-criteria ones, mainly on the consideration of multiple specificities or combined filtering. However, while identifying user preferences, especially the similar ones identified in collaborative filtering, users' multi-criteria evaluations should also be taken into account, instead of a single criterion one. Thus, data sparsity will be reduced, and a more accurate and qualified evaluation from similar interest users could be found. In the future, studies on the aggregated similarity measurement on multi-criteria evaluation will be the focus in this direction, as well as some forecasting methods such as aggregation function, probability model, multilinear singular value decomposition.

Finally, protect user privacy. Since recommender systems are constructed relying mostly on user information, including their basic information as well as past behaviors and user interactions. When some systems also integrate different information for providing more intelligent recommendations, they also increase the risk of revealing users' privacy. In fact, the threat to users by location identification has been identified as one of the biggest barriers to the adoption of contextual aware-based services. Therefore, ways need to be found to better protect user privacy, which can ensure the validity and accuracy of recommendations without risking users' private and sensitive information.

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