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# User-adapted travel planning system for personalized schedule recommendation

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ABSTRACT

Recently, the Internet has made a lot of services and products appear online provided by many tourism sectors. By this way, many information such as timetables, routes, accommodations, and restaurants are easily available to help travelers plan their travels. However, how to plan the most appropriate travel schedule under simultaneously considering several factors such as tourist attractions visiting, local hotels selecting, and travel budget calculation is a challenge. This gives rise to our interest in exploring the recommendation systems with relation to schedule recommendation. Additionally, the personalized concept is not implemented completely in most of travel recommendation systems. One notable problem is that they simply recommended the most popular travel routes or projects, and cannot plan the travel schedule. Moreover, the existing travel planning systems have limits in their capabilities to adapt to the changes based on users' requirements and planning results. To tackle these problems, we develop a personalized travel planning system that simultaneously considers all categories of user requirements and provides users with a travel schedule planning service that approximates automation. A novel travel schedule planning algorithm is embedded to plan travel schedules based on users' need. Through the user-adapted interface and adjustable results design, users can replace any unsatisfied travel unit to specific one. The feedback mechanism provides a better accuracy rate for next travel schedule to new users. An experiment was conducted to examine the satisfaction and use intention of the system. The results showed that participants who used the system with schedule planning have statistical significant on user satisfaction and use intention. We also analyzed the validity of applying the proposed algorithm to a user preference travel schedule through a number of practical system tests. In addition, comparing with other travel recommendation systems, our system had better performance on the schedule adjustment, personalization, and feedback giving.



## 1. Introduction

Because of significant improvements in information technology, the Internet has greatly influenced the travel services industry. The popularization of the Internet has resulted in abundant travel information, enabling travelers to use the Internet to rapidly obtain reliable and accurate travel information and to plan travel schedules or itineraries within a limited amount of time. This method of acquiring information has indirectly stimulated travel motivations and requirements, causing the travel industry to thrive in recent years.

Independent travelers personally plan attractions, routes, accommodations and hotels, and time arrangements. As Internet technology develops, numerous travelers are enjoying sharing their travel experiences and photographs using platforms such as forums and blogs, indirectly stimulating potential traveling populations. However, this type of travel is typically associated with various problems. For example, planning factors worth considering include unfamiliarity with travel route or attractions and timing issues and reservations for accommodations and hotels.

Travel schedule planning comprises numerous personal or personalized conditions. To provide travelers with satisfying travel schedules, travel recommendation systems (TRSs) are valuable [1]. However, most TRSs focus on recommending popular attractions or optimal travel routes without considering various travelers' requirements, such as attractions, accommodations and hotels, restaurants and dining, transportation, routes, time arrangements, and costs to create a personalized travel schedule for travelers. In addition, previous TRS attractions and route suggestions are limited to recommendations based on set rules and conditions, resulting in identical recommendations, which reduces recommendation effectiveness [2].

The majority of current TRSs focus on recommending attractions or accurate schedules or itineraries and route planning, using

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a combination of techniques and additional user variables to increase the attraction recommendation and to schedule planning accuracy to satisfy traveler requirements. However, user requirements vary significantly. The majority of recommendation systems encounter difficulty in completely fulfilling user demands and achieving user satisfaction. Furthermore, most TRSs can only directly select or receive recommended results without adjusting travel routes or schedules based on traveler desires, thus failing to achieve the optimal effects of personalized recommendations.

The previous discussion indicates that numerous factors that are related to travel recommendations must be considered. However, few TRSs can consider all factors to make recommendations schedules. In recent years, the majority of TRSs have been unable to comprehensively consider the following factors: (1) Schedule planning: TRSs only recommend the most popular travel attractions or routes without conducting travel schedule planning and recommendations that consider overall travel requirements. Although a few systems provide schedule planning, no detailed time-arrangement planning is performed. (2) The feedback mechanism: users' fixed input conditions typically result in similar recommendation results, reducing recommendation effectiveness. (3) Schedule adjustments: users can only accept or select recommended results and cannot modify the results according to their personal requirements.

Therefore, this study proposes a personalized travel planning system (PTPS) that simultaneously considers all categories of user requirements and provides users with a travel schedule planning service that approximates automation. With the time framework (TF) and schedule planning adjustment concept, users can adjust the results of schedule planning. A relevant database is then renewed through a feedback mechanism that records users' travel schedule and choices as a basis for future recommendations, further increasing the PTPS planning effectiveness. In addition, this study proposes a result adjustment concept that focuses on aspects following recommendations, which are not considered in most TRSs, enabling users to replace unsatisfying items and increasing their participation and satisfaction.

## 2. Literature review

### 2.1. Recommendation system filtering method

The purpose of developing a recommendation system was to overcome information overload and address the problem of online users feeling overwhelmed by excessive and messy information [3–5]. Ricci and Werthner showed that recommendation systems can provide some suggestions to customers, facilitating customer decision-making [6]. Recommendation systems are also a tool for screening information and providing personalization services [7–9]. The filtering methods used by recommendation systems comprise three categories: The content filtering, collaborative filtering and hybrid filtering method.

Recommendations provided by content filtering method are primarily based on content and related profiles [10]. This method builds on methods within information retrieval that emphasize item analysis. By analyzing the item attribute features and the correlation between items and the user based on the user's preference file, items that may interest the user are identified and recommended. Lee et al. developed a recommendation system based on using an agent system and a content filtering method to suggest products commonly provided in online shops, such as movies and notebook computers [4].

The collaborative filtering method locates groups of users with common interests to form a community. That is, by gathering members with certain common characteristics and analyzing their common interests and preferences, related items are recommended to users with relevant demands based on common characteristics. However, this method compares similarities among user evaluations of a recommended product as the basis for understanding personal preferences. For example, Smart Radio is a music recommendation system that employs this method [11].

The hybrid filtering method combines the content filtering and collaborative filtering method, simultaneously resolving the problems addressed by these two methods and providing superior predictions and recommendations. This method maintains excellent user descriptions during content analysis, and a direct comparison of these descriptions facilitates using the collaborative filtering method to determine recommendations for similar users. Users can receive self-conducted product evaluations or evaluations from similar users.

Initial travel recommendation systems primarily employ content filtering. However, the hybrid filtering method is more flexible because of its ability to avoid the limitations of the content filtering and collaborative filtering methods. Thus, hybrid filtering can include various methods/tools in the data filtering and recommendation processes, such as data processing techniques, statistical probabilities, data mining, and artificial intelligence. The integration of various methods effectively increases the overall quality and effectiveness of the recommendations. Therefore, recent TRSs have employed the hybrid filtering method.

### 2.2. Travel recommendation techniques

The core recommendation modules of recommendation systems typically use classification techniques from various fields [12,13]. However, the use of these techniques frequently influences the recommendation effectiveness of the system [14]. Numerous factors influence the recommendation effectiveness during the system development. Among the crucial factors are the classification technique and the recommendation framework design. A superior classification technique or framework design must effectively address problems that occur during the recommendation process, including attribute selection, data attribute dimension processing, the data type consistency, identifying user preferences, and establishing a feedback learning mechanism, thereby providing accurate recommendation results that satisfy users.

Most TRSs use the strategy of establishing user schema to increase recommendation accuracy. Machine learning methods effectively obtain and integrate travel data from various sources to establish user schema without being limited to a single data source [15]. Therefore, machine-learning methods frequently help establish TRSs.

### 2.3. Travel recommendation systems

In recent years, the topic of travel recommendations has gradually been recognized and emphasized. Numerous studies have developed corresponding recommendation systems or frameworks by combining various techniques to provide personalized travel routes and attraction recommendations that satisfy users' requirements [16–18]. However, the Internet has increased the convenience of information acquisition and travel experience sharing, stimulating the expansion of the free or independent travel population. The necessity of independently planning travel schedules has caused travel planning costs and freedom to become critical factors that influence users' travel willingness. To simultaneously address travel freedom and travel quality and to reduce users' search and travel planning costs, a TRS that only provides personalized travel attractions or route recommendations cannot satisfy users' requirements. Extant studies on personalized TRSs have seldom employed or provided recommendations for users who con-