PersTour: A Personalized Tour Recommendation and Planning System

Kwan Hui Lim[*†], Xiaoting Wang[*†], Jeffrey Chan[‡*], Shanika Karunasekera[*],
Christopher Leckie[*†], Yehui Chen[‡], Cheong Loong Tan[‡], Fu Quan Gao[‡], Teh Ken Wee[‡]
[*]Department of Computing and Information Systems, The University of Melbourne, Australia
[†]Victoria Research Laboratory, NICTA / Data61, Australia
[‡]School of Computer Science and Information Technology, RMIT University, Australia
{limk2, wangx5}@student.unimelb.edu.au, jeffrey.chan@rmit.edu.au,
{karus, caleckie}@unimelb.edu.au, {s3189978, s3473500, s3230007, s3407931}@student.rmit.edu.au

ABSTRACT

Touring is a popular but time-consuming activity, due to the need to identify interesting attractions or Places-of-Interest (POIs) and structure these POIs in the form of a time-constrained tour itinerary. To solve this challenge, we propose the Personalized Tour Recommendation and Planning (PersTour) system. The PersTour system is able to plan for a customized tour itinerary where the recommended POIs and visit durations are personalized based on the tourist's interest preferences. In addition, tourists have the option to indicate their trip constraints (e.g., a preferred starting/ending location and a specific tour duration) to further customize their tour itinerary.

CCS Concepts

•**Information systems → Personalization; Recommender systems;** *Location based services; Data mining;* Web applications;

Keywords

Tour Recommendations; Trip Planning; Personalization; User Interests

1. INTRODUCTION

Tourism is a popular leisure activity with the main aim of visiting interesting attractions in foreign cities. For a tourist visiting an unfamiliar city, there are numerous challenges such as: (i) identifying attractions or Places-of-Interest (POIs) that appeal to his/her interest preferences, rather than simply visiting popular POIs; (ii) structuring these POIs as a tour itinerary that considers the tourist's preferences for starting/ending locations and time constraints for touring; and (iii) providing detailed directions on how to get from one POI to another, including recommendations for POI visit durations based on the tourist interest preferences.

To alleviate these challenges faced by tourists, we propose the Personalized Tour Recommendation and Planning (Per-
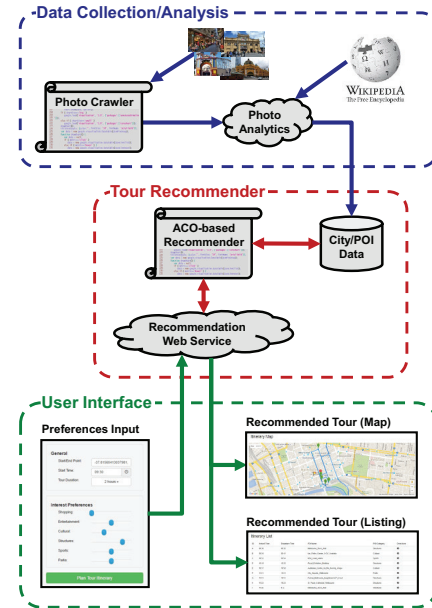
Figure 1: PersTour System Architecture.

sTour) System. While there exist various interesting tour planning applications [14, 4, 13, 11, 2, 10, 15], our PersTour system differs from them in one or more of the following ways: (i) tourists are able to select any starting/ending location (instead of a specific POI, which the tourist may be unfamiliar with) and PersTour will recommend an itinerary that starts/ends at a POI near that selected location; (ii) in addition to a personalized itinerary recommendation (comprising POIs of interest to the tourist), PersTour also personalizes the recommended visit duration at each POI based on the tourist's interest preferences; and (iii) PersTour uses publicly available geo-tagged photos and Wikipedia to determine POI-related statistics and information.

1.1 Contributions

Our main contribution is in developing the PersTour system (Fig. 1) that is able to recommend POIs that are interesting to the tourist and plan these POIs in the form of a tour itinerary. The key features of this system are as follows:

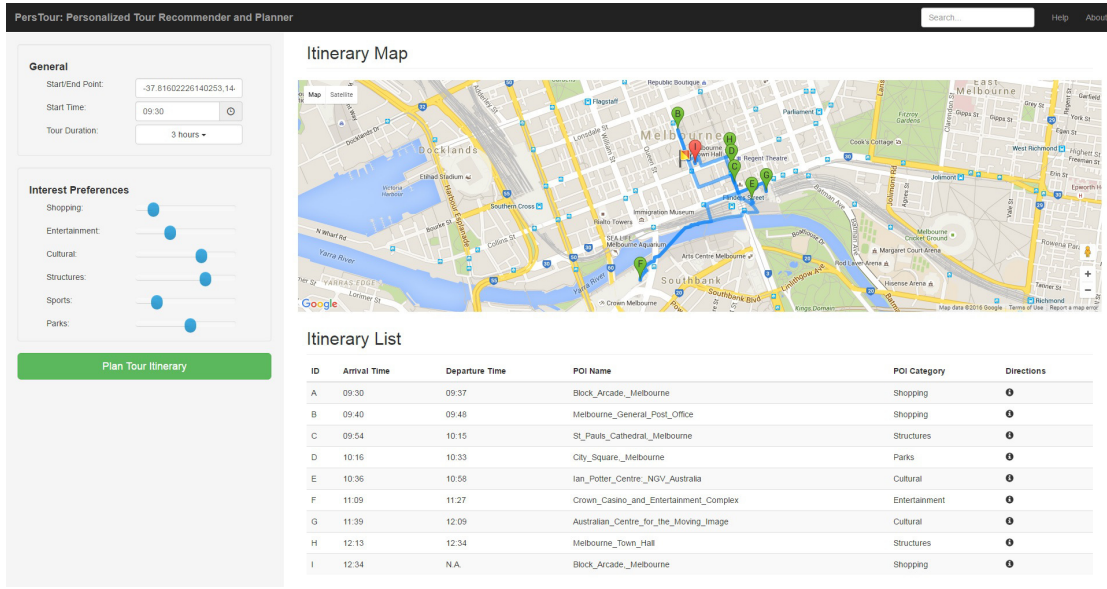- Able to consider tourist trip constraints such as start-

Figure 2: User Interface of the PersTour System.

ing and ending at specific locations (e.g., near the tourist's hotel) and having limited time for touring.

- Utilizes geo-tagged photos and Wikipedia to: (i) determine the popularity of POIs; (ii) derive the average time tourists spend at each POIs; and (iii) classify POIs into distinct categories.

- Able to recommend tours based on either POI popularity or tourist interest preferences. In addition, recommended POI visit durations are tailored based on the interest levels of the tourist, i.e., a longer visit duration for POIs that are interesting to the tourist.

- Adapted the Ant Colony Optimization algorithm for the purpose of tour recommendation, with considerations for trip constraints and interest preferences.

- Recommendation results are displayed in an intuitive graphical and textual form (Fig. 2). The graphical form allows for a quick overview of the tour itinerary on a map, while the textual form provides detailed information about getting from one POI to another.

2. SYSTEM ARCHITECTURE

Our PersTour system was developed as a web-based application with a responsive interface that allows for viewing on desktops, tablets or mobile phones. The front-end component was developed using HTML, PHP, jQuery and the Google Maps API [6], while the back-end was developed using Python, Java and PHP. Our PersTour system comprises three main components, namely:

- **Data Collection and Analysis Component**. This back-end component is mainly responsible for the retrieval of geo-tagged photos and analyzing these photos to infer POI popularity, average POI visit durations and POI categories.

- **Tour Recommendation Component**. This back-end component uses the processed POI data (from the Data Collection and Analysis component) for recommending and planning personalized tour itineraries that are then passed to the User Interface component.

- **User Interface Component**. This front-end component solicits the trip constraints and interest preferences from the tourist, then communicates with the Tour Recommendation component to obtain a personalized tour itinerary, which is then displayed to the tourist.

In the following sections, we will describe each component in greater detail.

2.1 Data Collection and Analysis Component

The Data Collection and Analysis component performs two main tasks, which are: (i) the crawling of geo-tagged photos from the Flickr photo sharing website; and (ii) the analysis of these photos to infer the popularity of POIs, average POI visit duration and the interest categories associated with each POI.

Data collection. For the first task, we are interested in all photos taken within a specific city of interest, particularly the associated meta-data such as the latitude/longitude coordinates, photo time taken and photo owner/taker.[1] The usefulness of geo-tagged photos for tour recommendation purposes has also been demonstrated in many recent research works [3, 8, 12]. A future enhancement would involve the use of computer vision techniques to analyze the photos themselves to determine the number of humans in each photos (i.e., travelling alone, in pairs or larger groups) and demographic details (e.g., age group, gender, etc).

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[1] While we use Flickr geo-tagged photos for the purpose of this system demonstration, our PersTour system can be easily generalized to other photo sharing sites (e.g., Instagram) or any social media that is tagged with geo-location information (e.g., geo-tagged tweets).

Data analysis. For the second task, we analyze the meta-information of each photo to determine the popularity of each POI based on the number of photos taken at each POI, i.e., a proxy for real-life POI visits as the user has to visit the POI to take a photo.[2] We are also able to determine the amount of time spent visiting each POI based on the time difference between the first and last photo taken at a POI. Lastly, we utilize Wikipedia to derive the category (e.g., Shopping, Entertainment, Cultural, Structures, Sports and Parks) that each POI belongs to, based on the Wikipedia article describing the POIs in each city.

These two tasks (data collection and data analysis) can then be conducted for each city of interest. Upon completion, the results of the analysis are provided to the Tour Recommendation component, which utilizes the computed POI popularity, POI categories, distance between POIs, and average POI visit duration for recommending and planing tour itineraries. We next discuss the details of the Tour Recommendation component.

2.2 Tour Recommendation Component

Using the POI-related information provided by the Data Collection and Analysis component, the Tour Recommendation component recommends and plans a tour itinerary according to the interest preferences and trip constraints of the tourist. The interest preferences corresponds to the POI categories in the city, while trip constraints are in terms of the tourist's preferred starting/ending location and available touring time.

The back-end tour recommendation algorithm is based on a modified version of the Ant Colony Optimization algorithm [5]. We first discuss the basic Ant Colony Optimization algorithm before describing our proposed modifications to adapt it for our purpose of personalized tour recommendation and planning. The basic Ant Colony Optimization algorithm utilizes a number of agents (ants) that start from a specific POI with the aim to finding the best path to a desired destination. This algorithm works in the following main steps:

1. At the start of the algorithm, all agents initially select the next POI to visit (based on the utility of visiting that POI), until they reach the destination.

2. At the end of Step 1, the best path taken among all agents is selected and remembered for a period of time, before being gradually forgotten.

3. Steps 1 and 2 are then repeated for a fixed number of iterations. The main difference is that the selection of the next POI to visit (i.e., Step 1) will be biased towards paths that have been taken recently.

The intuition behind the Ant Colony Optimization algorithm is that agents are more likely to follow a path that is "better" and has been taken recently. This preference subsequently leads to the positive reinforcement of choosing a single path over time, resulting in that path being selected as the best solution. Our modifications to the Ant Colony Optimization algorithm are largely based on our earlier work [7] and include the following: (i) the utility of each POI is based on a combined POI popularity score and tourist interest

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alignment; and (ii) the cost of travelling from one POI to another is based on a fixed travelling cost and dynamic POI visit duration (personalized based on tourist interest levels). As we currently focus on city tours, we compute travelling costs based on the transport mode of walking but this can be extended to other transport modes such as cycling and cars by changing the appropriate travelling speeds. In most cases, this algorithm takes less than 0.5 seconds to recommend and plan a personalized tour.

2.3 User Interface Component

The User Interface component serves three main responsibilities, namely: (i) obtaining user inputs in the form of the tourist's trip constraints (starting/ending location and available touring time) and their interest preferences; (ii) communicating with the Tour Recommendation component by providing the tourist's trip constraints and interest preferences, and retrieving the recommended tour itinerary; (iii) displaying the recommended tour itinerary in an easy to understand visual and textual format.

Obtaining user input. For the first task, a tourist can pick a preferred starting and ending location by simply clicking on any point on the map. Similarly, the tourist can enter a desired tour start time and select a preferred tour duration. For a more personalized tour, the tourist is also able to indicate their interest preferences via slider bars that represent their interest level in the six POI categories (Shopping, Entertainment, Cultural, Structures, Sports and Parks). The slider bars allow tourists to state their interest level at varying levels, ranging from "not interested" to "very interested", which is represented by values of 1 and 100, respectively. By default, all interest levels are set to a neutral "neither interested nor uninterested", i.e., a value of 50.

Communication between components. The second task commences when the tourist clicks on the "Plan Tour Itinerary" button. Upon clicking, the User Interface component makes a web service call to the Tour Recommendation component, along with the various trip constraints and interest preferences provided. In turn, the Tour Recommendation component invokes its recommendation algorithm to plan a personalized tour based on the provided parameters. This personalized tour is then returned to the User Interface component in the form of a JSON response, containing the recommended POIs and the time to spend at each POI.

Displaying recommendation results. For the third task, the User Interface component parses the returned JSON response for display in a visual and textual format. Utilizing the Google Maps API, the visual representation is in the form of waypoints (POIs) that are plotted on a map and connected lines that indicate the route to take between POIs. The textual representation provides more information on the recommended tour, indicating the time to arrive at and depart each POI, along with the name and category of each POI. In addition, the tourist is also able to click on the "information" icon to the right of each POI for more detailed step-by-step directions, i.e., which road to take, how far to travel and which road junctions to turn at.

3. USE CASE SCENARIOS

As part of our system demonstration, we highlight two scenarios where a tourist might use PersTour to obtain a popularity-based and interest-based tour recommendations.

3.1 Popularity-based Tours

Consider a tourist Alice who is staying at The Sebel Melbourne Flinders Lane and is planning for a tour that starts near her hotel. Using our PersTour system, she can simply click on the location of her hotel (or anywhere on the map) as her desired starting/ending point. Furthermore, Alice selects a starting time of 10am, a tour duration of 3 hours and then clicks on the "Plan Tour Itinerary" button to get a customized tour itinerary recommendation. Based on the selected starting/ending location, tour start time and preferred tour duration, PersTour recommends a set of popular POIs to visit within Alice's preferred tour duration. This recommendation is displayed as a graphical tour itinerary on the map as well as in textual form with detailed information about the POI visit sequence with the appropriate time to arrive at and depart from each POI. If Alice requires more detailed directions, clicking on the "information" icon beside each POI listing will display a set of detailed instructions for directions.

3.2 Interest-based Tours

Consider another tourist Bob who prefers a more personalized tour based on his specific interest preferences. Similar to what Alice has done, Bob also selects his preferred starting/ending point, tour start time and preferred tour duration. In addition, Bob can indicate his interested preferences via a set of slider bars that correspond to each POI interest categories. For example, Bob is very interested in Sports and Parks, moderately interested in Shopping and Entertainment, and less interested in Structures and Cultural. As such, Bob adjusts the slider bars for each POI interest category accordingly before clicking on the "Plan Tour Itinerary" button. In this case, PersTour takes into account Bob's interest preferences and recommends a personalized tour itinerary comprising POIs that are more likely to include POIs of the Sports and Parks categories and less of the Structures and Cultural categories. Similarly, PersTour recommends a longer duration to spend at POIs of the Sports and Parks categories and a shorter duration at POIs of the Structures and Cultural categories, given Bob's interest preferences.

4. CONCLUSION AND FUTURE WORK

In this paper, we proposed the PersTour system for recommending and planning personalized tour itineraries. This system comprises three main components that perform the following functions, namely: (i) a Data Collection and Analysis component that uses geo-tagged photos and Wikipedia to derive POI-related statistics and information; (ii) a Tour Recommendation component that uses a modified Ant Colony Optimization algorithm to recommend tour itineraries, which adhere to trip constraints and consider interest preferences; and (iii) a User Interface component that uses an intuitive graphical and textual interface to solicit user input and display recommendation results. In addition, the PersTour system is able to recommend a suitable starting/ending POI based on a tourist-selected location and also personalizes the recommended POI and visit duration based on tourist interest preferences.

Some future work to enhance the PersTour system includes the following: (i) incorporate restaurant visits (e.g., breakfast, lunch and dinner) and consider POI visiting costs (e.g., entrance fees) as part of tour recommendation; (ii) cater for tour recommendations to groups of tourists with diverse interest preferences, in the same spirit as that of [8]; (iii) automatically build a tourist interest profile, possibly by analyzing a tourist's social media posts such as in [1]; and (iv) apart from POI popularity and tourist interest, also consider the beauty, peacefulness and enjoyability of routes taken in a tour [9].

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