e-Turist: An Intelligent Personalized Trip Guide

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Abstract. We present a personalized mobile trip guide that allows users to plan their single or multiple day trip based on their preferences and constraints. It is composed of a trip planning module and a tour guidance module. The trip planning module consist of: (i) a hybrid recommender system, which rates the points of interest according to the user profile, (ii) a route planning system, which filters out and selects the optimal points of interest according to the time and the location and thus creates a route to be used by the tour guidance module. The tour guidance module routes the user according to the trip plan and gives textual and audio descriptions of the visited point of interest. The e-Turist application is available for four smartphone platforms and as a web application (https://www.e-turist.si).

1 INTRODUCTION

Tourism, as one of the fastest developing industries globally, has seen a robust growth through last decades, with only a small setback during the recent economic recession. In 2014, the number of international tourists per year has exceeded a billion [1] and the number of domestic tourists is estimated to be above 5 billion.

While organized groups typically focus on most popular attractions and employ the services of a tourist guide, individual tourists or small groups are more flexible in choosing the attractions and usually plan their trip themselves.

In recent years, many mobile applications have been developed to assist them. For example, TripAdvisor [2] contains extensive lists of points of interest (POI) with user reviews from which the user can choose, Triposo [3] includes a ranked list of POIs by chosen category, Roadtrippers [4] is used by car travelers, to see POIs close to the route, and Route Perfect [5] includes recommendations based on explicit user preferences and a route planning component, but lacks day-to-day sightseeing itineraries in individual cities.

In this paper, we present e-Turist [6], an intelligent trip guide platform, which provides a complete sightseeing itinerary adapted to the time available for the trip, and beside the explicit users' wishes and ratings of attractions, it also uses a recommendation system that learns the users' preferences automatically.

The e-Turist platform consists of two modules, the trip planning module and trip guidance module. The trip planning module is composed of a hybrid recommendation system, to create a list of high rated POIs based on the user's profile and the user-defined constraints, and route planning system, to choose the POIs from the recommended list according to the time needed to visit them, and creates the most suitable route. The trip guidance module is a mobile application which guides the user along the route, suggests nearby attractions and offers text and speech synthesized audio descriptions (including a home-developed synthesizer for Slovenian language) of the POIs.

The descriptive architecture of the e-Turist system with the corresponding views from the application are presented in Figure 1.

2 TRIP PLANNING

The trip planning is performed on a server and consists of hybrid recommender system and route planning system. Each entry in the POI database that represents either place, event or a restaurant is enriched with meta information, e.g., location, type of attraction (cultural heritage, sports venue, restaurant, etc.), opening hours, accessibility for people with physical or motoric limitation, expert rating, the ratings of e-Turist users, etc.

The hybrid recommendation system utilizes the constraint-filtering sub-module which uses "hard" constraints to remove the POIs that do not meet user requirements or limitations. The hard limitations are entered by the user through application (top left in Figure 1). These are: (i) the location, (ii) the purpose of the trip (active tourism, cultural heritage, entertainment, and gastronomy), (iii) the opening hours with respect to the time intended for the trip, and (iv) mobility limitations for physically impaired users. The result of the constraints filtering is a list (List A in Figure 1) which is fed into the rating component which assigns rates using the simple recommendation system. The final rate is a combination of three rates produced by the following sub-modules:

- *The expert rate* of each POI is set by experts when the POI is entered into the database.
- *The knowledge-based rate* produced by a sub-module which employs expert knowledge that defines how a certain POI meets the needs of the current user according to user stereotypes.
- *The collaborative filtering rate* produced by collaborative filtering sub-module.

For the knowledge based rate we consider four stereotypes (defined by experts): age group, education, country of residence, and budget of the user. Stereotypes have two (country), three (budget, education) or five (age group) discrete values. One or more values of each stereotype are assigned to each POI. The user profile contains the same stereotype values, so we can compute the distance between the current user and each POI for each stereotype, and average it over all the stereotypes. The attractiveness of a POI for the current user is the reverse of this average distance.

The collaborative filtering sub-module estimates the rate of the POI utilizing users profile and ratings from other users. The feature vector of the current user is composed of his/her ratings of filtered POIs. The missing rates are estimated using a *k*-nearest neighbor algorithm which is applied to find *k* users most similar to the current one. The attractiveness of a POI for the current user is the average rating of that POI by the user's *k* nearest neighbors.

The final result of the recommender system is a dynamically weighted average of the expert rating and the attractiveness returned by the knowledge-based and collaborative-filtering sub-modules, with weights depending on the availability of individual values. The evaluation of the final rate was performed on 24 users who rated 90 POIs each. The result in terms of mean absolute error was 0.86 stars [7]. The result of the recommender system is a list of rated POIs (List B in Figure 1) which is fed into route planning system.

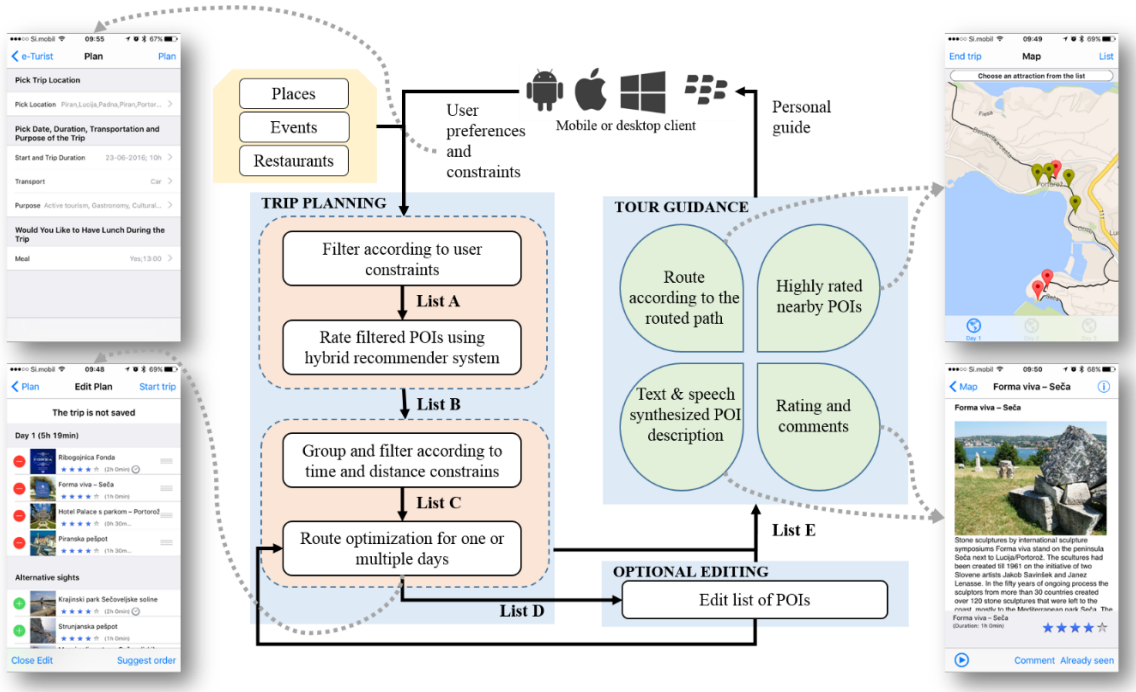

Figure 1. Descriptive architecture of the e-Turist system. Left side of the figure shows the trip planning module and the right side of the figure shows the tour guidance module, both with corresponding views from the application.

The route planning system chooses the most relevant POIs from the list provided by the recommendation system and then finds the shortest route to visit these POIs. It utilizes the knapsack problem [8] where each POI is assigned two features, the visit duration time (W_i) and the attractiveness, rated on the scale from 1 to 5 (V_i). Therefore, the task is to find the best set of items with weights W_i and values V_i, so that the overall weight does not exceed the limit and that the total value is maximal. Because the knapsack problem does not include the time required to travel between the POIs, the algorithm uses a travelling salesman problem (TSP) solver for this task [9]. This way, an augmented POI attractiveness value (V^*) is calculated as a weighted sum of the: POI rating (V), visit duration, and reachability duration. The aim here is to "punish" the destinations that are far from the others (outliers). More detailed information and mathematical definitions are available in [10].

Next, the POIs are ordered by the attractiveness value V^* and the knapsack is filled until the limit is reached. Once the combination of POIs is found (List C in Figure 1), the algorithm checks if the user prefers to start from the nearest POI. If this is the case, the order of the POIs is recalculated with a modified version of the original TSP which creates a path using a fixed start POI. In the case of multiple days, the POIs are segmented into groups, each group corresponding to one day of the trip. Finally, if the user plans a meal at a particular hour, the algorithm considers the restaurant-POIs in the list of POIs, and the best is chosen (according to the evaluation value). That day's route is modified in such a way that the tourist is near the restaurant during the previously chosen meal-time.

The result of the route planning system is a list of POIs which are presented to the user for optional modification as seen in bottom left in Figure 1 (List D) or an accepted list of POIs (List E). The accepted list is fed into the tour guidance module to be used by the mobile trip guide.

3 TOUR GUIDANCE

The tour guidance is performed through the mobile application and is enabled in two languages: Slovene and English. Once the user starts the trip, the tour guidance tracks the route and notifies the user about the high rated nearby POIs (radius of 300 meters) which did not get to the final list for the current tour (top right in Figure 1).

The POI visit (either being on the recommended list or one of the nearby POIs) includes text description for each site which is also converted into audio with speech synthesizer (bottom right in Figure 1). For Slovenian, we use the eBralec [11] service and for English, Microsoft synthesizer. For each POI, the user is encouraged to give rate with purpose to improve further recommendations.

4 DEMO

The e-Turist demo consists of the mobile application and the web application. For the purpose of this demo, we will include the itinerary from the Hague area, the conference venue. The participant of the conference will be encouraged to download the application from the relevant application market, create their own personalized trip, and use it to go sightseeing.

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