CT-Planner2: More Flexible and Interactive Assistance for Day Tour Planning

Yohei Kurata

Department of Tourism Science, Tokyo Metropolitan University, Japan
ykurata@tmu.ac.jp

Abstract

Tourists often have a hard time making their tour plans, especially when they are visiting a large city on a tight schedule. To relieve tourists from such difficulty, a computer-aided interactive tour planning system, called *CT-Planner2*, was developed. This system models a tourist advisor who makes tour plans customized for individual tourists. Guided by an interactive agent, each user of this system can request when and where he starts/ends his tour, which tour criteria he wants to emphasize, and which attractions he especially wants to visit/avoid, as well as compare several plans that the system automatically generates. By repeating the revision of tour plans in an interactive manner, the user can eventually build a custom-made tour plan that fits his requests and preference. In our user test, the usability and potential of the system is evaluated positively by the participants.

Keywords: computer-aided tour planning; candidate/critique model; selective travelling salesman problem; user's preference; custom-made tour plan.

1 Introduction

Imagine that you are visiting Tokyo for a conference, after which you have a day off. Probably you want to visit several places for sightseeing. If so, which places do you visit? You may browse a guidebook or web site, or ask somebody, to find out what places in Tokyo will be interesting for you. However, even if you have found several interesting places, it is difficult to determine how many of them you can visit only in a day, since you do not know the time necessary for visiting each place, as well as the time necessary for travelling from one place to another. Your guidebook may kindly show some model plans, but it is not guaranteed that these plans include one that fits your interest and schedule. Alternatively, you can consult an expert, such as a staff in a tourist information office or a concierge in your hotel. However, in a foreign country you may experience difficulty in communicating with such experts.

To relieve tourists from such difficulty in tour planning, several researchers have developed the systems that support the user's tour planning. Some systems recommend attractive points-of-interest (*POIs*) in the target area, taking the user's tour preference into account (e.g., Ricci, *et al*., 2002; Schmidt-Belz, *et al*., 2002; Ardissono, *et al*., 2003). Some systems optimize the tour schedule complying with the user's request (Maruyama, *et al*., 2004; Seifert, 2008). Some systems score the POIs based on the user's preference and then generate a customized tour plan for each user (Kishimoto & Mizuno, 1997; Kurata, *et al*., 2000; Goy & Magro, 2004; Lee, *et al*., 2007). Typically, these systems are aimed at rather fully-automated generation of tour plans. *CT-Planner* (Kurata, 2010), on the other hand, emphasizes the concept of *interactive assistance*—it models the interaction between a tourist and a tour advisor, where the advisor shows several sample plans to the tourist, learns the tourist's preference and requests from the tourist's feedback, customizes the plans accordingly, and asks for the tourist's feedback again to refine the plans. Kurata (2010) asserted the potential of such interactive assistance, because the user can see the actual plans from the beginning, without thinking about his own tour interests which he is often not well aware of. However, he did not conduct an official user test to substantiate his claim. In addition, CT-Planner still had room for improvement of user-friendliness and interactivity. Thus, in this work, the revised version of CT-Planner, namely *CT-Planner2*, was developed and evaluated through a user test. This paper introduces CT-Planner2 and its mechanism, as well as reports the result of the user test. Note that CT-Planner stands for *Collaborative Tour Planner*, and also *City Tour Planner* as it mainly targets city-scale day tours. Currently, CT-Planner2 works on a Windows PC as a stand-alone application.

The major contribution of this work is, in an academic perspective, to introduce an alternative approach to computer-aided tour planning that emphasizes collaborative design of tour plans by the system and the user, and in an industry perspective, to demonstrate that this approach is highly potential as the users get high satisfaction through their active involvement in revising their tour plans.

The remainder of this paper is structured as follows: Section 2 reviews some key ideas of computer-aided tour planning. Section 3 describes the design concepts of CT-Planner2, while Section 4 explains its mechanism. Section 5 reports the result of our user test and identifies remaining problems. Finally, Section 6 concludes with a discussion of future work.

2 Computer-Aided Tour Planning

People have a large variety of tour interests. In addition, there are a large variety of tourist attractions, especially in huge cities which attract many tourists. Hence, user-adaptation techniques for filtering, sorting, and refabricating tourist information for individual tourists have been long discussed and implemented in many tourist information systems. Such techniques are especially important for tourist information services on mobile devices, because the users have to process the tourist information in a short time during their tour on a tiny screen.

A key question in such user-adaptation techniques is how to estimate the value of each POI for each user. In early systems, the user was asked to set several preference parameters manually, for instance, by sliders (e.g., Kishimoto & Mizuno, 1997; Maruyama, *et al*., 2004; Hochmair & Rinner, 2005). Then, the value of each POI in the target area is estimated, considering the matching between the POI's character and the user's preference. To achieve more natural interactions, the system by Kurata *et al*. (2000) adopted an on-lime questionnaire, in which the user is asked to compare several pairs of tour purposes. Then, from the user's answers the system calculates the user's preference parameters. Alternatively, CT-Planner (Kurata, 2010) asks the user to compare tour plans; the system provides several plans of different characters, calculates the user's preference from the selection of his favourite plan, and again the system shows a set of adapted tour plans to the user to ask his feedback. With this interface, the user no longer has to specify his tour interests explicitly before seeing actual plans. This technique, called *candidate/critique model*, was proposed by Linden *et al*. (1997) who applied it to on-line airplane ticket sales.

The controversial issue of such preference-based approaches is the validity of measurement of users' tour preference. To skip this problem, some systems adopted *collaborative filtering* (Rensnick, *et al*., 1994), which is now used practically in many recommender systems (Bachrach, *et al*., 2009). In this approach, the evaluation of each POI by previous visitors is used for the estimation of its value for each user, assuming that tourists with similar profiles (gender, age, travel history, etc.) give similar evaluations to the same POI (Ricci, *et al*., 2002; Lee, *et al*., 2007). Even though this approach imposes fewer burdens on the users, the validity of the above assumption needs to be carefully examined. In addition, this approach requires a large amount of evaluation data by tourists.

Seifert (2008) pointed out that the main disadvantage of computer-aided tour planning systems is that they exclude the user's participation in the process of planning. Indeed, according to the user test by Kurata *et al*. (2000), users complained about the inability to customize the recommended tour plans by adding or removing POIs that they want to visit/avoid. The same problem is also seen in other tour planning systems. Exceptionally, P-Tour (Maruyama, *et al*., 2004) allows the user to indicate where he wants to visit/avoid, although indirectly, by assigning high/low scores to the POIs. However, P-Tour forces the user to evaluate all POIs in the target area, which requires a lot of time and effort. From this lesson, CT-Planner (Kurata, 2010) allows the users both to specify their requests on some POIs and to leave the evaluation of the remaining POIs to the system.

3 System Design

Following the former version, CT-Planner2 models a tour advisor who makes tour plans customized for individual tourists. It emulates the following roles of the tour advisor:

- To propose sample tour plans to the tourist, based on the advisor's knowledge about the tourist's profile
- To handle the tourist's request about the overall character of his tour plan, as well as his special request to include certain POIs in the plan or to remove them from the plan
- To judge the tourist's preference from his feedback

The idea of modelling a tour advisor's role to realize user-friendly interactions is also seen in Garcia *et al*. (2010), but they do not adopt a repetitive process like ours where the tour plans are refined gradually as the user's preference and requests become clearer.

Currently CT-Planner2 targets Yokohama, a portside city near Tokyo, which attracts more than forty million tourists in a year. The number of POIs we consider is 28, which looks relatively fewer than the studies that target European cities where historic attractions are distributed densely (for instance, the system by Garcia *et al*. (2010) targets 50 POIs in San Sebastian, Spain).

Fig. 1 shows the main screen of CT-Planner2. A tour plan, recommended by the system, is shown on the map of central Yokohama. This plan visits eight POIs in five hours (from 10:00 to 15:00). On the right side the itinerary of this plan is shown, together with a photo, a short description, and a rating (one to three stars) of each POI visited during the tour. The user can see more detailed information about each POI by clicking it in the map or itinerary (Figs. 2a-b).

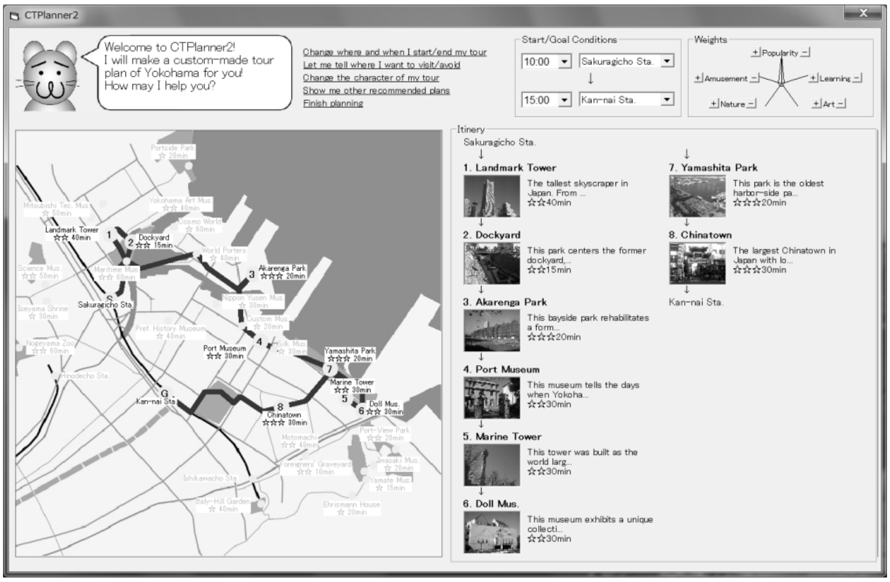
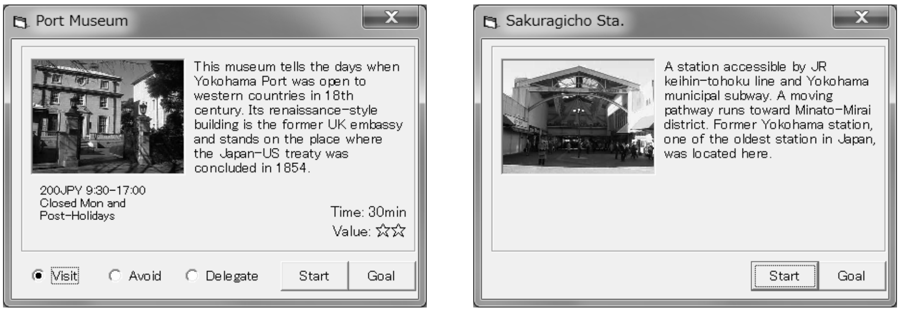


Fig. 1. The main window of CT-Planner2



(a) (b)

Fig. 2. Two small windows that show the property of (a) a POI and (b) a transportation facility, respectively

In the upper right of the main screen, there are two frames: the left one, namely *Start/Goal Conditions* frame, shows when and where the tour starts/ends, and the right one, named *Weights* frame, shows a radar chart that visualizes the weights on five tour criteria—*popularity*, *learning*, *art*, *nature*, and *amusement*—under which the POIs are evaluated and the recommended plan is generated. The radar chart essentially represents the user's preference.

In the upper left of the main screen is a cartoon character who guides the user. The user can interact with this character simply by selecting one of the options shown to the right of the character's message. Basically, the user has five options:

1. To change where and when the tour starts/ends;
2. To specify which POIs the user wants to visit/avoid;
3. To change the character of the tour;
4. To see other plans for comparison; and
5. To finish tour planning

If option 1 is selected, the user is guided to manipulate the four components in the *Start/Goal Conditions* frame (Fig. 1). The start/goal locations can be changed also by clicking a node in the map and then clicking the *Start*/*Goal* buttons in its property window (Figs. 2a-b). Similarly, if option 2 is selected, the user is guided to click a POI in the map or itinerary and then to click the *Visit*/*Avoid* button in its property window (Fig. 2a), and if option 3 is selected, the user is led to manipulate the radar chart in the *Weights* frame. As soon as the user manipulates any element, the tour plan shown on the screen is revised accordingly. For instance, when the user clicks the + button to the left of *Learning* in the *Weights* frame repeatedly, the tour plan is revised to visit more and more museums.

If the user selects option 4, the system shows two tour plans side-by-side, so that the user can compare the plans (Fig. 3). Both plans follow the same tour conditions (i.e., when and where to the tour should start/end and which POIs the tour should visit/avoid). The difference is that the left one follows the current weights shown on the screen, while the right one puts more weight on either learning, art, nature, or amusement more than now. If the user adopts the alternative plan, the window switches to the previous state (Fig. 1) but the plan is now replaced with the adopted one, and the weights are updated accordingly.

By repeating the above four types of operations, the user can make his own tour plan supported by the system. When the user gets satisfied with the plan, he is supposed to select option 5. Then, the map and itinerary of the current plan are printed out for the user, while the system is restarted for the next user.

CT-Planner2 implemented several new ideas that are not in the former version. First, CT-Planner2 adopted a cartoon character as a navigator, in order to enrich the sense of user-friendliness and interactivity. Second, CT-Planner2 shows the tour plan not only in a map, but also in an itinerary enriched with photos and short texts. Finally, CT-Planner2 shows the weights on the five tour criteria and allows its manual adjustment. The old version hides such weights and determines the weights from the user's repeated selection of alternative plans. However, some users complained that they could not directly decide the character of the tour plan. Hence, CT-Planner2 is designed to allow the user's direct manipulation on the weights on the five tour criteria. The evaluation of these new ideas is reported in Section 5.

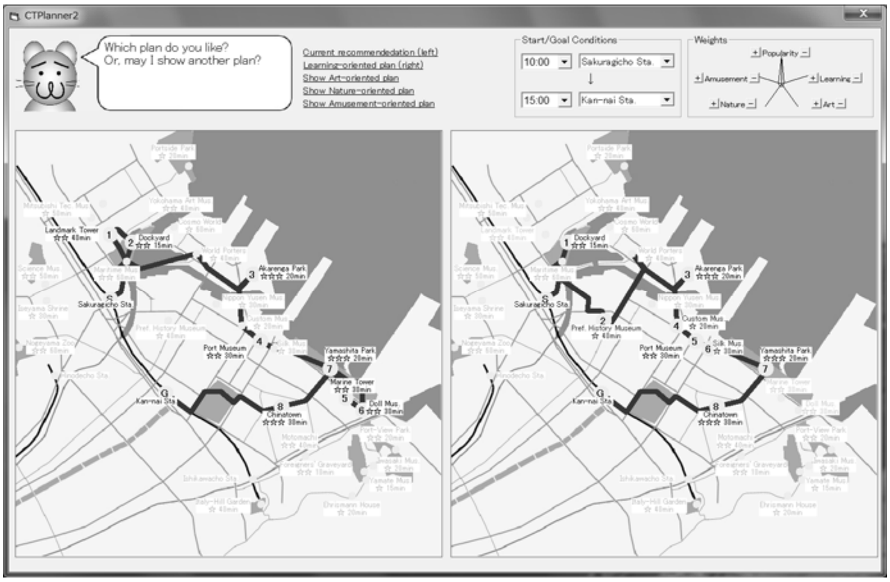


Fig. 3. CT-Planner2 shows two plans of different characters to seek the user's preference from his feedback

4 Underlying Mechanism

This section explains how CT-Planner2 generates custom-made tour plans for individual users. The underlying mechanism is almost the same as the former CT-Planner, although we redesigned the user interface.

CT-Planner2 targets a city-size tourist area which contains multiple POIs. The tourist area is modelled as a graph. Each node represents either POI or transportation facility (TF), while each link represents a route between two POI/TFs. The routes are computed beforehand using Dijkstra's shortest path algorithm (Dijkstra, 1959). POI-nodes are assigned two parameters: *visitation time* that a tourist normally spends at the POI and *expected utility* (i.e., the amount of satisfaction) that the user will obtain by visiting it. TF-nodes are assigned zero visitation time and zero utility in order to deal with both POI-nodes and TF-nodes simultaneously in computation. Links are assigned a single parameter *travel time* that a tourist normally spends to travel the corresponding route.

4.1 Plan Generation

The system recommends the *best* tour plan that visits highly-evaluated POIs as much as possible under a given time constraint and current evaluations of POIs. The problem to find out the best plan is formalized as follows (Kurata, 2009):

Given a complete graph (V, E), *the expected utility of each node* u_i, *the visitation time* $t^{visit}{}_i$, *the travel time* $t^{travel}{}_{ij}$, *origin node* $v_{ori} \in V$, *goal node* $v_{goal} \in V$, *and time* *constraint* T *, find a series of nodes to be visited* $v_{a_1}, \cdots, v_{a_k}$ $\left(v_{a_i} \in V\right)$ *that maximizes the sum of utilities* $\sum_{i=1}^{k} u_{a_i}$ *under the following three constraint*s:

$$\sum_{i=1}^{k} t^{visit}{}_{a_i} + \sum_{i=0}^{k+1} t^{travel}{}_{a_i a_j} \le T$$

$$v_{a_0} = v_{ori}$$

$$v_{a_{k+1}} = v_{des}$$

Currently, the maximum tour time is restricted to less than or equal to 7 hours (i.e., $T \le 420\,\mathrm{min}$), since we target day-tour planning. Another reason of this restriction is that the above problem setting presumes that all POIs are always open and accessible (usually 10am to 5pm).

The above problem is essentially the *Selective Travelling Salesman Problem* (*STSP*), which is known to be an NP-hard combinatory optimization problem (Laporte & Martello, 1990). CT-Planner2 uses a heuristic high-speed algorithm for deriving semi-optimal solution, which was proposed by Kurata *et al.* (2000). This algorithm works in $O\left(nt^2\right)$, where *n* is the number of POIs in the target area and *t* is the length of tour time. Alternatively, a genetic algorithm (GA) used in STAR (Goy & Magro, 2004) or P-Tour (Maruyama, *et al.*, 2004) may also be applied to generate more optimal solutions. We, however, did not adopt a GA-based approach, because it may take a bit time to find a solution (Garcia *et al*. 2010) while quick feedback from the system is vital in our system to achieve smooth interactions.

4.2 Evaluation of POIs

To conduct the plan generation as explained in Section 4.1, we have to estimate the expected utilities of POIs in the target area beforehand. Each POI is given five-grade scores in five criteria—*popularity*, *satisfaction level of learning*, *satisfaction level of art*, *satisfaction level of nature*, and *satisfaction level of amusement*—determined by experts in advance. On the other hand, the weights on the corresponding five tour criteria—*popularity*, *learning*, *art*, *nature*, and *amusement*—are determined by every user (Section 4.4). The expected utility of each POI is calculated from the weighted total of its five scores.

We adopted the above four criteria for representing the user's tour preference, because people often express their preference by the categories of tourist attractions they like. We considered that *education*, *art*, *nature*, and *amusement* are four representative categories of tourist attractions. Of course there are other possible categorizations, but we should avoid detailed ones in order not to overwhelm the user. Note that we further added one item, *popularity*, because people typically prefer to visit popular POIs when they do not have any specific request.

The expected utility is transformed into star-based rating (one to three stars) and displayed on the screen (Figs. 1 and 2a), such that the user can easily judge whether the POI will be interesting to him or not.

4.3 Processing Visit/Avoid Requests

If the user requests the system to visit certain POIs, the system tentatively assigns very high utility to these POIs. Accordingly, the generated plans contain the requested POIs as many as possible under the given time constraint. This function is useful, for instance, if the user assigns a high weight on *learning* as she likes museum, but she also wants to visit an amusement park as it is famous.

Similarly, if the user requests the system to avoid certain POIs, the system tentatively assigns zero utility to these POIs, such that the generated tour plans no longer contain these POIs. Again, this function is useful, for instance, if the user has been to the target area before and she does not want to visit the same POIs again.

4.4 Changing Weights

To estimate the utility of POIs for each user (Section 4.2), the user has to specify the weights on the five tour criteria. Initially, the weight is assigned only to *popularity*. Accordingly, the initial recommended plan emphasizes the POIs that are popular to everyone. The user can adjust the weights on the five tour criteria by clicking the respective + and buttons in the *Weights* frame (Fig. 1). Let the current weights on *popularity*, *learning*, *art*, *nature*, and *amusement* be $(w_p, w_l, w_a, w_n, w_e)$ and suppose that the user clicks the + button to the left of *Amusement*. Then, the weights are modified to $(aw_p, aw_l, aw_a, aw_n, w_e + \alpha)$, where $a = (1 - w_e - \alpha)/(1 - w_e)$ in order to keep the sum of weights 1. In the current version, the parameter α is assigned 0.1, or $(1 - w_e)$ if it is smaller than 0.1, such that the weight on each criterion is kept less or equal to one. Note that the + button to the left of *Amusement* is enabled only when $w_e < 1$.

The weights can be modified also by the user's selection of alternative plans (Fig. 3). The alternative plans are generated using tentatively modified weights. For instance, when the current weights are $(w_p, w_l, w_a, w_n, w_e)$, the *nature-oriented plan* is generated under the weight $(bw_p, bw_l, bw_a, w_n + \beta, bw_e)$ where $b = (1 - w_n - \beta)/(1 - w_n)$. β is $\min(0.1, 1 - w_n)$. If the user adopts this plan, the weights are modified to $(bw_p, bw_l, bw_a, w_n + \beta, bw_e)$.

Once the weights on the five tour criteria are changed, the system promptly revises the expected utility of each POI, as well as the tour plan shown on the screen. Accordingly, the user can see the result of weight adjustment dynamically.

5 Evaluation

In order to evaluate CT-Planner2, a user test was conducted from August to September 2010. Twenty people participated in the test as volunteers. The participants were seventeen students and three faculty members in the department of Tourism Science, Tokyo Metropolitan University. Sixteen were males and four were females. Their average age was 25.4. All subjects had been to Yokohama before, as it is a very popular tourist destination near Tokyo.

In this test, the participants were asked to play with the system freely for about five to ten minutes and then to make his favourite day-trip plan eventually. They were not given any instruction about how to operate the system, so that we can examine the intuitiveness of the system for naïve users. The participants were left alone and given no advice during their trial, but their actions were recorded by the system. After the trial, the participants were asked to fill in a questionnaire.

On average, the participants spent 9.7 minutes (σ=3.4) for the trial. Three major types of users were found from the user log:

- Goal-oriented users, who made their final plan in fewer steps without trying various tour conditions;
- Experimenting users, who tried various tour conditions and eventually found the best plan; and
- DIY-type users, who specified their requests as many as possible and did not leave the system to propose which POIs to visit.

Naturally, the first group finished tour planning relatively quickly, while the latter two groups spent longer time.

In the first part of the questionnaire, the participants were asked six questions about their satisfaction with and impression of the system. The results, as summarized in Table 1, show that the system is evaluated positively by the users. Especially, most users evaluated the system as easy to understand (Q2). However, some participants did not feel that they had successfully made their favourite plan (Q4). Two complaints were heard from them: one is that CT-Planner2 does not allow them to specify *when* they visit a POI and *how long* they spend there, and another is that the current sample data misses the information about restaurants and shops. Many participants answered that they would like to use the system on the Web (Q5), while some participants were not willing to use it in a tourist information office (Q6). This indicates that the sales point of CT-Planner2 is that it enables the users to consult the system about their plans at any time at any place.

Table 1. User evaluation of CT-Planner2 (Five-grade scale where yes=5 and no=1)

	Question	Average Rating	Standard Deviation
Q1	Are you satisfied with your tour planning experience supported by CT-Planner2?	3.95	0.51
Q2	Was CT-Planner2 easy to understand?	4.40	0.68
Q3	Was CT-Planner2 user-friendly?	3.95	0.76
Q4	Did you successfully make your favourite plan with CT-Planner2?	3.65	0.99
Q5	Will you use CT-Planner2 if you can access it on the Web?	4.20	0.83
Q6	Will you use CT-Planner2 if you can access it at a tourist information office in your destination?	3.80	1.20

In the second part of the questionnaire, the participants were asked to evaluate five features of CT-Planner2. The results, as summarized in Table 2, show that visualization of a tour plan and support of user's visit/avoid requests were highly evaluated, while presence of a guiding character was not well. Some participants told that the character was not lively, as his image was fixed and his messages were very limited. Display of multiple plans for comparison, which was the key feature of the former CT-Planner, did not attract many participants. According to the user log, the participants rather preferred to adjust the weights on the five tour criteria by themselves, in order to see the tour plans of different characters.

Table 2. User evaluation of CT-Planner2's five features (Five-grade scale where good=5 and bad=1)

Function	Average Score	Standard Deviation
Visualization of a tour plan by the combination of a map and an itinerary	4.55	0.60
Presence of a guiding character	3.65	1.09
Display of multiple plans of different characters for user's comparison	3.68	0.95
Support of user's request about where to visit/avoid	4.45	0.69
Support of user's manual setting of weights on tour criteria	3.9	1.04

The last part of the questionnaire asked the participants to write their comments and ideas freely. There some participants mentioned the system's restriction on tour time (10:00 to 17:00). This restriction arises from the problem of the current algorithm which presumes that all POIs are open and accessible. This problem can be avoided by the use of an approximate algorithm by Matsuda *et al*. (2004) for *FORPS* (Fuzzy Optimal Routing Problem for Sightseeing), which supports temporal fluctuation of POI values—we should simply assign zero utility to POIs when they are in closed hours.

Some participants wanted the system to support not only point-like tourist attractions, but also attractive paths. If the value of paths is taken into account, the problem becomes *EPTP* (*Enhanced Profitable Tour Problem*). A heuristic algorithm for deriving semi-optimal solutions of this problem is already available (Joset & Stille, 2002). Thus, the remaining question is how we should evaluate the attractiveness of paths in a reasonable way. Further possible extensions of the tour planning problem are reviewed in Souriau and Vansteenwegen (2010).

Some participants wished if they could edit multiple plans simultaneously, such that they could keep candidates and compare them afterwards. Some participants requested an *undo* function as well. The implementation of these ideas is left for future work.

6 Conclusions and Future Work

Tourist information is essential for tourists who visit unfamiliar places, but their decision making becomes rather difficult if they are given an overwhelming amount of information. Thus, the question of how to refine and customize the information for individual tourists is important for intelligent tourist information systems. This paper introduced CT-Planner2, with which people can create custom-made tour plans interactively, as if they are assisted by a human advisor. Compared with the former version, CT-Planner2 increased the user-friendliness and interactivity thanks to the employment of the guiding character, the visually-enriched itinerary, and the radar chart that shows the weights on different tour criteria and allows their adjustment. The system was evaluated positively by the participants of our user test. At the same time, the user test revealed several remaining issues, such as limitation of tour hours and inability to request the time and duration for visiting POIs. How to overcome these issues is left for future work.

A great advantage of computer-aided tour planning systems is that a user can consult a system at any time, as much as he wants, using his own language even in foreign countries. To make the most of this advantage, an online multi-language version of our system for serving tourists visiting Japanese cities is now under preparation. Of course, the system itself is applicable to non-Japanese cities if their data are provided.

In addition, the development of a mobile version of our system is also on our road map. A key question is how to provide a service tailored to mobile devices. Real-time monitoring of the user's location and schedule (Shiraishi, *et al*., 2005) and subsequent real-time rescheduling are potential services of mobile-oriented tour planning systems.

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