CT-Planner4: Toward a More User-Friendly Interactive Day-Tour Planner

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Abstract

It is often difficult for novice people to make a tour plan for a tight schedule. Hence, we have developed a computer-aided tour planner, which enables the user to design a tour plan with the system in a collaborative manner. This paper introduces its latest version, *CT-Planner4*, which becomes accessible via Internet and is improved to achieve more user-friendliness. CT-Planner4 mainly targets foreigners and is expected to stimulate their hidden/unattended needs of plan consultation. Our two user tests with international students and foreigners living abroad, and another interviews with tourist advisors substantiates the practicality of CT-Planner4. Finally, we propose the application of its user log to marketing analysis.

Keywords: computer-aided tour planning; personalization; cold start problem; user evaluation

1 Introduction

Thanks to the widespread use of ICT in tourism, people can travel the world much more casually. On the other hand, it is still difficult for novice people to make a tour plan for a tight schedule, especially when they are visiting an unfamiliar area with various attractions. Of course, many people still enjoy tour planning, but at the same time some people feel anxious about it, wondering whether their plan is reasonable, without wasting or lacking for time. In addition, when in a foreign country, it is not always easy to ask for somebody's advice.

In order to relieve people from such difficulty in tour planning, researchers have proposed several systems that can make personalized tour plans, (e.g., Ardissono *et al.*, 2003; Goy & Magro, 2004; Maruyama *et al.*, 2004; Kramer *et al.*, 2006; Lee, *et al.*, 2007; Castillo *et al.*, 2008). However, many systems aim primarily at the automation of tour planning and, as a result, tended to exclude the user's participation in the process of planning (Seifert 2008). To overcome this problem, some systems introduced a customization phase, in which people can *modify* recommended plans (i.e., insert/remove/replace/reorder the POIs in the plans) (Garcia *et al.*, 2010; Schaller, 2011). Moreover, Kurata (2010) developed *CT-Planner*, which enables the user to design a tour plan with the system in a collaborative manner. CT-Planner stands for Collaborative Tour Planner, and also City Tour Planner as it mainly targets city-scale day trips. Its interaction model is similar to that of *critiquing*-based recommender systems (Linden *et al.*, 1997; Chen and Pu, 2009) in the sense that the users are required to gives certain feedbacks about the system's recommendations, but

the users' feedback in CT-Planner is not evaluations of recommended plans, but additional requests which come up to the users' mind, inspired by those plans.

In this paper we introduce the latest version of CT-Planner, namely *CT-Planner4*. CT-Planner4 is a web-based application written in JavaScript and accessible from various devices (PCs, tablets, etc.) via Internet (http://ctplanner.jp), although special support for smartphones' tiny screen is not yet implemented. CT-Planner4 succeeds several essential features from its previous version: i) collaborative planning ii) web-based accessibility, and iii) a genetic algorithm which allows high-speed plan calculation. In addition, to realize more user-friendliness, it newly achieves: i) introduction of a hot-start mechanism, ii) improvement of user profile specification, and iii) support of open/close hours and walking preference. Through an overview of CT-Planner4 and its evaluation result, this paper demonstrates the practicality of computer-aided collaborative tour planning. Note that in this paper, tour plans refer to the plans that visit some of many POIs distributed in a city-scale area in a few hours or a day. This means that transportation to/from the destination and lodging in it are out of our scope.

The remainder of this paper is structured as follows: Section 2 reviews key ideas of computer-aided tour planning. Section 3 describes the user interface of CT-Planner4, while Section 4 explains the underlying mechanism. Sections 5-6 report the result of our user tests and that of our interview with experts, respectively. Finally, Section 7 concludes with a discussion of future work.

2 Issues of Computer-Aided Tour Planning

There are at least three major issues discussed in the previous studies of computer-aided tour planning: user profiling, POI evaluation, and user participation. User profiling is the process to obtain the user's data necessary for estimating the personalized value of POIs/plans. The obtained data is, for instance, his/her favourite POI categories (e.g., Kramer *et al.*, 2006), tour purposes (e.g., Kurata, 2010), and even demographic properties (e.g., Lee *et al*., 2007). Early recommender systems tended to force the user to input his/her profile manually at the beginning of use. Kurata (2000) criticized the difficulty of such manual input and proposed the use of AHP to deduce the user's preference from the answer to the questions comparing tour motivations. Similarly, Kurata (2010) used AHP to deduce the user's preference, asking him/her the preference over pairs of actual plans with different features. In Kurata (2011)'s user test, however, most users preferred manual input of preference when both options were available. This implies that the essential problem of user profiling is not manual input, but rather so-called *cold start*—the user is forced to spend long time to report his/her profile before getting recommendation. To prevent this problem, CT-Planner4 asks only two questions at the beginning and from the answer it roughly determines the initial value of user profile (Section 3).

POI evaluation is the process to estimate the personalized value of each POI. Previous systems adopted several techniques for this, such as matching of feature vectors (e.g., Lee *et al*. 2007; Kurata, 2011), content-based matching using an ontology (e.g., Kramer *et al.*, 2006), collaborative filtering (e.g., Castillo *et al.*, 2008), and direct input by the user (Maruyama *et al.*, 2004). In the process of POI evaluation, we should be careful about the context-dependency of POIs' value (Baltrunas *et al*. 2010;

Kurata, 2011)—the same tourist may give different evaluations to the same POI depending on his companion, weather, and season. Thus, it is desirable that the system allows the user to customize the POI evaluations in a certain way (e.g., accepting the request of must-see POIs).

User participation is a critical issue that many computer-aided tour planning systems have left behind (Seifert 2008). Lee *et al*. (2007) insists that the user-system interaction should be minimized in tour planning systems, but this claim is questionable. Kramer *et al*. (2006) insists that most people are not always aware of their preference and thus need to get reminded of it. We believe that many people cannot tell their preference/interest before seeing sample choices, especially when the target is not what they often buy, such as tourism products. CT-Planner (Kurata, 2010), therefore, adopted a cyclic approach where the system proposes a sample plan, the user examines it and gives feedback, and then the system revises the plan accordingly. The merit of this approach is that the user is not forced to specify their request/interests all at once in the early stage of use. This approach is welcomed by its test users (Kurata, 2011) and thus succeeded to CT-Planner4.

3 User Interface of CT-Planner4

CT-Planner4 starts from the screen in Fig. 1. Here you are asked only two questions: your destination and favourite travel style. Currently we are listing six destinations in/near Tokyo and five travel styles: *Enjoy Various Attractions*, *City Walking*, *Stroll in Relaxing Places*, *Learn Localities*, *and Walk with Children*. These travel styles are derived from the result of a GPS-based activity survey on foreign tourists visiting Tokyo (Aratani *et al.*, 2012).

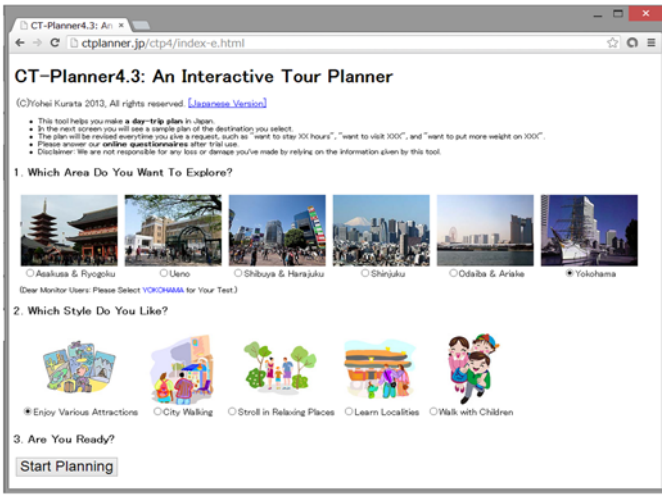

Fig. 1. Initial screen of CT-Planner4

If you select "*Yokohama*" and "*Walk with Children*", for example, you will see the main screen in Fig. 2. It shows the route of a sample tour plan on the central map,

which strolls across the central Yokohama in three hours. Its agenda is also shown on the right end of the screen. The map is illustrated with the aid of Google Maps API and accordingly, you can zoom/scroll the map and even see the corresponding satellite image to check the detail of the tour route.

The left end of the screen shows three items from the top: tour condition, user profile, and command bottoms. The tour condition consists of five items: *duration*, *start time*, *day of the week*, *walking speed*, and *reluctance to walk*. If you modify the tour condition, your plan is revised promptly. For instance, if you set the *start time* to 5:00pm, your plan will skip most museums because they are already closed. Similarly, if you set *the reluctance to walk* to *yes*, the walking distance of your plan will become shorter. The user profile consists of *focus* and *taste* parts, each represented by a five-axial radar chart and a set of four sliders. The values of your profile is pre-determined based on your initial selection of favourite travel styles, but they are adjustable if you want. For instance, if you put more weight on *culture* by clicking the right-upper part of the radar chart, your plan will visit more museums. If you slide the top slider to the right end (i.e., to *Well-known* side), your plan will visit famous POIs more likely.

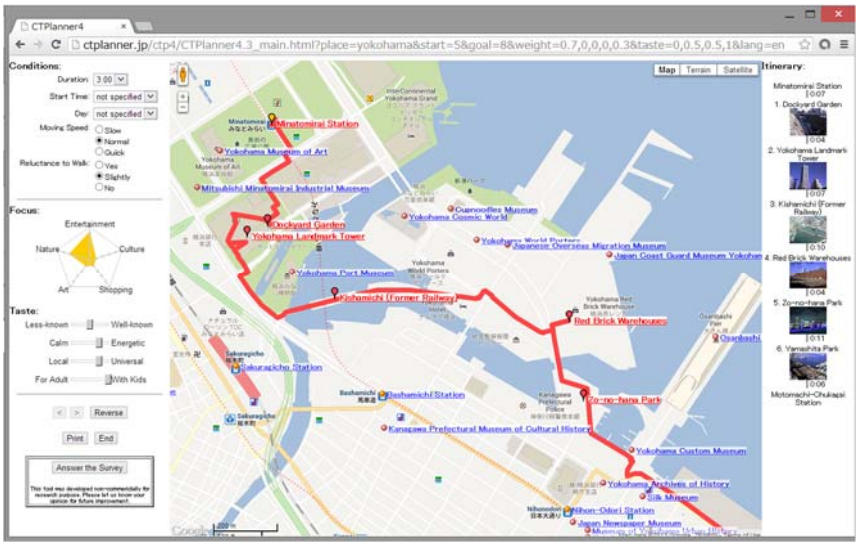

Fig. 2. Main screen of CT-Planner4

If you click a POI's name on the map or the agenda, a small info-window appears at its location (Fig. 3). This window shows the POI's basic information (name, estimated value represented by 1- to 5-stars, description, estimated staying time, and hyperlinks to the related websites). The window also shows several buttons. Once you click *Visit* button, the system generates the plans which visit this POI as long as possible. Conversely, once you click *Avoid* button, the system no longer shows the plans that visit this POI. *Start*/*Goal* button allows you to set this POI as the start/goal location of your tour. Finally, *+10*/*-10* button allows you to adjust the staying time. Note that you can request POIs to visit/avoid, but the system does not force you to do so. In other words, you can let the system select other unrequested POIs to visit if you have time.

CT-Planner4 expects the following interaction cycle: (i) you look at a sample plan and POIs shown on the map, (ii) you provide a certain response (specify a POI to visit/avoid, changes your tour condition, or modify your profile) and (iii) the system revises the displayed plan accordingly and displays it. This cycle is repeated until you get satisfied with the plan. You can also use *undo*/*redo* commands. After finishing, you can print out your plan and bring it to your destination.

Fig. 3. An example of a POI's info-window

4 Underlying Mechanisms

4.1 Deriving the Best Plan

The problem to find out the best tour plan under given constraints can be formalized as follows (Kurata, 2010):

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* $v_{a_1},\cdots,v_{a_k}$ $(v_{a_i} \in V)$ *that maximizes the sum of utilities* $\sum_{i=1}^{k} u_{a_i}$ *under the following three constraints*:

$$\sum_{i=1}^{k} t^{visit}{}_{a_i} + \sum_{i=0}^{k+1} t^{travel}{}_{a_i a_j} \le T,\ v_{a_0} = v_{ori},\ v_{a_{k+1}} = v_{des}$$

This problem is essentially Selective Traveling Salesman Problem (STSP), which is proved to be NP-hard (Laporte & Martello, 1990). Thus, to compute semi-optimal solutions of this problem, CT-Planner 4 uses the following genetic algorithm:

Step 1. Initialization: We generate *n* initial plans, which starts at the given start location, visits an appropriate number of randomly-selected POIs, and ends at the given goal location.

Step 2. Evolution: The following process is repeated *N* times:

Crossover: We select two plans P_A and P_B, randomly from the n existent plans, and create their hybrid plan (i.e., the plan that combines the random length of P_A's fast part and that of P_B's last part and then removes redundancy of POIs). This is repeated cn times (c: crossover rate). As a result, we have $(1+c)n$ plans.

Mutation: We select a plan P_C from the $(1+c)n$ existent plans and replace a POI visited in P_C by another randomly-selected POI. This is repeated $(1+c)mn$ times (m: mutation rate).

Survival Competition: We select two plans randomly from the $(1+c)n$ existent plans and remove the one with a lower score. This is repeated cn times.

Step 3. Selection of the best plan: From the n existent plans, we select the one with the highest utility score.

This algorithm has four parameters: number of generations N, number of surviving plans in each generation n, crossover rate c, and mutation rate m. As N and n increase, the solution becomes better, but the computation time increases. We tuned up the parameters such that the computation usually finishes within a second. For powerless devices, CT-Planner4 has another option with which the above computation is conducted on our server.

The above algorithm allows us to handle POIs' closing days/hours, simply by reducing the score of *violating* plans (i.e., the plans that require to visit a POI during its closing hours/days) to zero. In a similar way, the above algorithm will allow us to handle various extensions, such as POIs' time-dependent values, budget limitation, and reciprocal effects of POIs (Section 4.2), although they are not implemented yet.

4.2 Evaluating Plans

In the above algorithm, we have to score the plans for comparison. Basically, a plan's score is calculated as the total of the *expected utility* of POIs to be visited in this plan. Then, certain penalty is imposed on the score when the plan requires long-distance walk, depending on the user's setting on *reluctance to walk* (Fig. 2).

This scoring method may have a room for improvement, because in reality the plan's value may be affected by the order of POIs. For instance, people may prefer the plan that visits the highlight POI at the end rather than at the beginning. In addition, we should also consider reciprocal effects— if people visit similar POIs repeatedly, they may get bored, or conversely, they may get more understanding and satisfaction. Ideally, tour plans should be designed carefully, like fabricating a story, imagining the temporal transitions of tourists' emotions. How to realize such tour design in computers is left as a future question.

4.3 Evaluating POIs

The expected utility of a POI is estimated based on the vector matching of the POI's characteristics and the user's profile (Kurata, 2010). The POI's characteristics are evaluated in advance by the data author (Section 4.4), while the user's profile is determined at the time of use (Section 3).

CT-Planner4 supports two types of user profile: *focus* and *taste*. *Focus* refers to the tour's functional feature demanded by the user. It is represented by the assignment of weight to the five categories: *culture*, *entertainment*, *nature*, *art*, and *shopping*. *Taste* refers to the tour's emotional characteristics demanded by the user. We considered four types of taste, each represented by its two poles; *less-known* or *well-known*, *calm* or *energetic*, *local* or *universal*, *for adult* or *with kids*. Taste is newly added in this version to enrich the representation of user preference. We expect that the taste is relatively stable and consistent, while the focus often changes depending on the destination and context.

Each POI is evaluated from the nine criteria corresponding to the parameters of focus and taste. For instance, a typical zoological park has high scores for *entertainment* and *nature*, and it is positioned at *energetic*, *universal*, and *with kids* sides, respectively. In order to assure the reliability of such evaluation, a scoring manual was prepared.

Note that the estimated utility of some POIs may be replaced internally for the computation of tour plans. For instance, when you request to visit a POI p_x, very high utility is assigned to p_x, such that CT-Planner4 generates the plans that visit p_x as long as the time constraint allows. Conversely, when you request to avoid a POI p_y, its utility is set zero, such that the generated plans do not visit p_y.

4.4 Authoring Destination Data

We made an Excel-based data editor, with which people can easily make a destination data for CT-Planner4. In future, we will ask volunteers to author destination data, in order to expand the destinations that CT-Planner supports. In our editor, the user is asked to input in a table the basic data of each POI, including its evaluation and geo-coordinates. Then, in order to save the user's task, the editor automatically derives all inter-POI routes by walk with the aid of Google Directions API and records them in json format. Pre-computation of inter-POI routes is highly effective for the reduction of computation time in use (Joest and Stille, 2002), and also necessary to overcome the API's access limit per day.

5 Evaluation by Test Users

In order to evaluate CT-Planner4's practicality, we conducted two user test, one with international students and another with foreigners living abroad, because we wanted to examine whether our tool was useful for both people who were already in/near the destination (*on-destination users*) and those who were at home (*off-destination users*). The reason for targeting foreigners is that they tend to feel difficulty in tour planning due to language barrier and lack of geographical knowledge. As the first step of our test we employed international students instead of actual travellers because we could easily control their travel schedule.

The test with on-destination users was conducted on March, 2013. We advertised on a student mail magazine and employed 16 international students from 8 countries. We assembled them to Yokohama, a popular destination near Tokyo. At a meeting room, they were asked to make their tour plan with CT-Planner4 and then to answer a questionnaire. After that, they went sightseeing for six hours. After returning, we asked them to answer another questionnaire and conducted a short interview.

The test with off-destination users was conducted on August, 2013. We employed 56 English-speaking test users from 28 countries, introduced by an investigation firm. We asked them to use CT-Planner4 on their PCs for at least five minutes and then to answer an online questionnaire. They were not given any instruction about how to use CT-Planner4, so that we can examine the intuitiveness of the system.

5.1 Satisfaction and Impression

The participants of both tests were asked their satisfaction with and impression of CT-Planner4 (Table 1). Most users evaluated CT-Planner4 positively. Its easiness was

evaluated even by off-destination users who have no instructions (Q2). The use of CT-Planner4 gives a positive effect, although not dramatic, on their expectation (Q4). In addition, most users agreed the system's positive effect on learning destinations (Q5-6). Unfortunately, on-destination users show a bit lower satisfaction (Q1). This is probably because at the time of their test, *undo* and *reverse* functions was not implemented yet and some users strongly requested them.

We investigated the relations between overall satisfaction (Q1) and such personal features as travelling days per year, experience to visit Japan, interest in Japan, and self-evaluation of map reading skill, but no clear relation was found. In addition, the unsatisfied users did not have any remarkable features in their profile.

On-destination users were also asked to evaluate CT-Planner4 after their six-hour tour (Q7-8). Q7 (usefulness of tour plans) is agreed by most users, but interestingly, Q8 (usefulness of tour planning experience) gets more agreement. Indeed, some users reported in the interview that they could flexibly reschedule their plan during their tour thanks to their planning experience. This indicates a unique aspect of CT-Planner4 as an educational tool for tourists.

Table 1. Satisfaction and impression by users (average scores in five-grade scale).

	Question	On-destination users	Off-destination users
Q1	How satisfied are you with CT-Planner4 overall? (5: very satisfied – 1: very dissatisfied)	3.81	3.96
Q2	Was it easy to use? (5: very easy – 1: very hard)	4.13	3.96
Q3	Were you able to draw up a travel plan to your taste? (5: strongly agree – 1: strongly disagree)	4.00	3.93
Q4	Did use of this tool heighten your expectations of sightseeing in Yokohama / Japan? (5: very much – 1: lowered very much)	3.73	3.88
Q5	Do you feel clearer than before what you'd like to do at the destination? (5: strongly agree – 1: strongly disagree)	3.94	3.89
Q6	Did use of this tool hep you notice tourist spots which you would not consider in your usual planning? (5: very much – 1: not at all)	4.19	4.13
Q7	Was the tour plan you made with CT-Planner4 useful for your trip? (5: strongly agree – 1: strongly disagree)	4.19	–
Q8	Was your experience of computer-aided tour planning useful for your trip? (5: strongly agree – 1: strongly disagree)	4.38	–

5.2 Demand by Situations

We proposed six situations where CT-Planner4 can be used, and asked the test users the level of their demand on CT-Planner4 in each situation. We found that CT-Planner4 is welcomed in most situations except the earliest phase (S1). This means that people start to want CT-Planner4 after deciding their destination. Thus, the availability of CT-Planner4's service may not give high impact on the selection of destinations. Interestingly, on-destination users had lower demand for on-site mobile use (S6). Some users said that they had no time to consult on their trip plan once they

started travelling. Another finding is that in most situations (S1-5) on-destination users had higher demand than off-destination users. This may indicate that the actual practice of tour plans made with CT-Planner4 increases their evaluation of it.

Table 2. How much people want to use CT-Planner4 in each situation (average scores in five-grad scale, where 5: very much – 1: not at all)

	Situation	On-destination users	Off-destination users
S1	At home, when selecting a destination from several candidates	3.81	3.61
S2	At home, when planning activities at the selected destination	4.50	3.80
S3	In the hotel at the destination, on the previous night of strolling	4.50	3.80
S4	On board a transportation medium headed for the destination	4.06	3.96
S5	From a device at a local tourist-information agency	4.13	3.75
S6	While strolling around the city (using a mobile device)	3.88	4.07

5.3 Comparison with Usual Planning

We asked the off-destination users to compare tour planning with CT-Planner4 and their usual planning (i.e., the planning style they normally use, maybe manual or computer-aided). The result shows that the highest strength of CT-Planner4 is its time-saving capability, followed by plan's novelty and reliability (Table 3). On the other hand, the plan's quality is not highly evaluated. Actually, 30% of the test users answered that their usual planning is superior to CT-Planner4 with regard to plan's quality. This implies that there is still room for improvement in our current plan generation method.

Table 3. Evaluation of CT-Planner4 in comparison with usual tour planning (+2: Planning with CT-Planner is much better – -2: Usual planning is much better)

Criteria	Off-destination users
Plan's quality	+0.14
Plan's reliability	+0.65
Plan's novelty	+0.79
Time spent to make plans	+1.09

5.4 User Requests

We asked the off-destination users to write any request to CT-Planner4. The popular requests were (i) to display more information and/or pictures about POIs, (ii) to provide a user instruction, and (iii) to add restaurant/café/food information. In addition, we got several useful requests, such as (i) to simplify the map with icons with automatic pop-ups, (ii) to show other user's comments on POIs (possibly using an outer service like Trip Advisor), and (iii) to consider weather forecast for planning.

The request for restaurant/café/food information is also often heard in the interviews with the on-destination users. CT-Planner4 did not support restaurants/cafés yet, because the current method required us to pre-compute the routes between all pairs of POIs (Section 4.4) and thus it is difficult to add a number of restaurants/cafés to the POIs. However, as food is an important content of tourism, we are seeking an alternative technique which can treat restaurants/cafés differently from other POIs.

Some users proposed the use of public transportation during tours. Actually, we can derive the routes using public transportation making use of Google Maps API. However, it often shows the route that uses local low-frequent buses, which is probably difficult for novice tourists and thus, the current version did not consider the use of public transportation. In future, we are going to calculate inter-POI routes by different transportation modes, and we may adopt the one by public transportation if it is found much time-saving, high-frequent, and easy for novice tourists.

5.5 Analysis of User Log

CT-Planner4 records the user's commands and the resulting plans, and uploads them to our server if possible. Through the above two tests, we obtained eight complete logs by on-destination users and thirty-five by off-destination users. These logs show that on average the on- and off-destination users have spent 20 min. 50 sec. and 6 min. 42 sec. on CT-Planner4, respectively. The on-destination users spent much longer time because they carefully designed their plan for their immediate use, while the off-destination users simply tried this tool to see what they can do with it. Fig. 4 shows the detail of the users' commands. On average the on- and off-destination users gave 70.1 and 31.6 commands, respectively. The difference arises mainly from the frequency of opening POI info-windows and the following visit/avoid request. This is, again, because the on-destination users carefully designed their plan for that day. Interestingly, the numbers of commands gave by both user groups for the setting of tour condition setting and for that of user profile are almost the same.

Our more detailed analysis revealed the following typical pattern of the use of CT-Planner4: (i) at the beginning phase the user often use the commands for setting tour conditions and user profile, (ii) in the middle phase the user often open POIs' info-windows and give visit/avoid requests and (iii) at the last phase the commands are used less frequently, but some users experimentally re-adjust their profile to see what happens then.

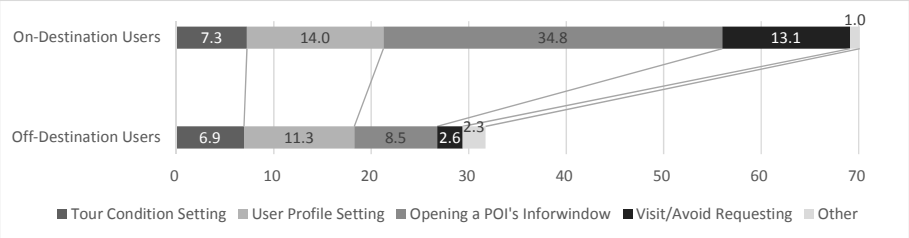

Fig 4. Frequency of commands gave by test users

6 Evaluation by Experts

In addition to the two user tests in Section 5, we had an interview with four staffs at Yokohama's tourist information office on July, 2013. All of them welcomed CT-Planner4, saying that it would support unattended or hidden consultation needs. They regretted that many tourists stayed their office only for a short time, often without asking any question, especially when the staffs looked busy. In addition, they said that the staffs could attend only visitors who came to the office on their office hours, while tourists often had consultation needs in the previous night of sightseeing. As for the plan's quality, they said that CT-Planner4 apparently generated reasonable plans, although it would be much better if it supports the use of subways and *Akai Kutsu Buses* (bus service specialized for tourists).

One of the staffs pointed out that CT-Planner4 would be very useful when they were asked about *other* cities. They have abundant and up-to-date knowledge about Yokohama, but not so much about other cities, such as Tokyo and Kyoto, whereas tourists' questions often go beyond their speciality. Another staff suggested to provide CT-Planner4 to taxi drivers and hotel staffs, who often got questions from foreign tourists but had not received any special training for advising them. Those ideas are worth considering when promoting CT-Planner4 to the business world.

7 Conclusions and Future Work

This paper reported the latest version of our computer-aided tour planner, CT-Planner4. Our goal is to provide tour planning aids to novice tourists via the Web. With CT-Planner, people can consult on their tour plan from anywhere at any time, as much as they want, without worrying about asking people in foreign languages. Its practicality is substantiated by the result of our user tests and expert interview. In addition, we observed that CT-Planner4 stimulated its users' expectation to the destination. We hope that in future CT-Planner4 will contribute to its destinations by bringing more tourists to there.

Although we have not explicitly claimed, we have another future goal—to collect a large volume of user log data and make use of it for marketing analysis. The user log of tour planning service is an invaluable source to know users' travel needs and preferences (Not & Venturini, 2011). For instance, our user log shows that *Yamashita Park* and *Red Brick Warehouse* are popular for both on- and off-destination users (i.e., most of their plans visit these two POIs), but *Chinatown* is popular only for on-destination users. As the number of users increase, we can derive more reliable insights, as well as we can analyse the difference of tourist groups (e.g., Asians and Europeans), without paying a survey cost. We expect that such findings will help destination management offices to consider their promotion strategies, as well as travel agencies to improve their package tours (Hara, *et al.*, 2012).

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