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# CRITIQUING-BASED MAP INFORMATION SEEKING

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**ABSTRACT**

We present an on-going work on the application of critiquing aids in a geographical visualization. Particularly, it has been oriented to the Web 2.0 environment with the goal of facilitating users to easily seek out information and make confident and accurate decisions among overwhelming social data. We concretely illustrate our novel ideas through a web-based interactive travel map, where recommended items are visualized in an informative way and an example-critiquing agent (with both system suggested critiques and user-initiated critiquing support) is integrated to allow for effective product comparison and tradeoff navigation.

**KEYWORDS**

Travel map, preference elicitation, example critiquing, information visualization, Web 2.0, recommender systems.

## 1. INTRODUCTION

The electronic Map, such as Google Map, has been increasingly adopted by users when they search for location-aware items. Many websites (e.g. Yahoo travel) also combine it with the list view of retrieval results (e.g. hotels, apartments, and restaurants) so as to support users to obtain a direct impression of these items' location properties in addition to their descriptive features as listed in the blocks of text. However, most maps purely follow a traditional query-search interaction model. That is, users first input their queries (e.g. desired hotel's price/class ranges) and the map will display a set of items that completely satisfy the user's preferences. Three crucial issues have nevertheless been overlooked: 1) according to adaptive decision theory (Payne et al. 1993), people are usually uncertain about their preferences initially, while likely constructing and refining them in the specific decision environment. Thus, purely based on users' stated preferences to show items may be limited to augment their decision accuracy; 2) when there are conflicting preferences (meaning that no available item satisfies all of them), such interaction model will return "zero" message which however is helpless for the user to revise her criteria; 3) with the increasing popularity of social websites, more and more people reply on the social information to make their decisions. For example, when she is looking for a hotel to reserve, rather than simply considering the hotel's own features (e.g. price, location, amenities), she would likely consult with other travelers' opinions so as to judge the hotel's true quality. Due to this reason, TripAdvisor.com has become a prevalent social website with over 20 millions traveler reviews at present.

Recent years, recommender systems have been broadly studied with the purpose of suggesting products that may interest the user so that the user can save her effort in locating these items by herself (Adomavicius and Tuzhilin 2005). They may be ideally useful for compensating the above mentioned limitations of existing map interfaces, while most of related work have mainly emphasized on their applications in list interfaces (e.g. presenting recommendations in a ranked list). Few attentions have been actually paid to how to improve the map interaction with advanced recommendation technologies, although the e-map has been broadly applicable and regarded as particularly handy in mobile devices like handset, PDA and GPS (Meng et al. 2008).

In this paper, we report our research work aimed to fill the vacancy and improve the user interaction experience with e-maps. Specifically, we have been engaged in integrating a preference revision support, which is called the critiquing-based recommender agent, into the map interface. Two novelties have been

attempted to achieve: 1) computation of recommendations based on social data (e.g. users' rates on hotel features) and visualization of the recommended items onto the map; 2) support of preference revision/refinement through both system-suggested critiques and user-initiated critique specification interface. In the following, we first briefly introduce the critiquing approaches and then present how we have attempted to realize them in a prototype map system.

## 2. CRITIQUING SUPPORTS

The critiquing-based recommender system has been proposed mainly as an effective preference construction and feedback mechanism, to expose domain knowledge and guide users to make the product comparison. More specifically, it uses a user's current preferences to first recommend some items as options, and then elicits the user's feedback in the form of critiques such as "I would like something cheaper" on one near-target item. These critiques help the recommender refine the user's preference model and accordingly improve the recommendation accuracy in the next cycle.

In essence, the critiquing support is to assist users in executing tradeoff navigation, which is a process shown to improve users' decision accuracy and confidence (Pu and Chen 2005). The tradeoff navigation involves finding products having more optimal values on one or several attributes that are important for the user, while accepting compromised values for other less important attributes. With the critiquing interface, the user can conveniently start the tradeoff navigation from one item (called the reference product), specify her tradeoff criteria in terms of improvements and compromises regarding the product's features, and see a new set of products more nearly approaching to her target choice.

In recent years, the critiquing-based system has evolved into two principal branches. One has been aiming to pro-actively generate a set of knowledge-based critiques that users may be prepared to accept as ways to improve the current recommendation (termed *system-suggested critiques*). This approach has been adopted in FindMe systems (Burke et al. 1997) and the more recently proposed dynamic-critiquing agents to create compound critiques (McCarthy et al. 2005). An alternative approach has focused on showing examples and stimulating users to freely compose critiques on their own (termed *user-initiated critiquing*) (Pu and Kumar 2004).

We have previously experimentally compared the two types of critiquing systems and revealed their respective advantages (Chen and Pu 2006). That is, system-suggested critiques may likely accelerate users' decision process if they can exactly match to what users are prepared to make. On the other hand, user-initiated critiquing support allows for a high degree of user control and gives users the freedom of creating their truly intended criteria, which result in higher level of decision confidence. Motivated by these findings, we have developed a hybrid system in order to combine the respective strengths together (Chen and Pu 2007a). We have further proposed a new approach to generating critique suggestions (called preference-based organization) in such hybrid platform and demonstrated its superior performance in predicting users' needs relative to non user-preference focused suggestion methods (e.g. dynamic-critiquing) (Chen and Pu 2007b).

However, all of our previous works have been done on traditional list interfaces without any visualization. In order to understand whether the empirical results would be extendable and valid among other interaction environments, we have recently been engaged in investigating the critiquing support's role in map-based information seeking. We indeed believe that the combination of critiquing supports and map would provide a more effective and enjoyable user experience compared to either non-critiquing or non-map based interfaces (especially for location-aware items).

In this new application domain, the critiquing aid can be regarded as a visual preference revision tool, given that the user's critiquing action will immediately cause the change of visual representation of the map (the refreshing of displayed items and related features). In this regard, Zhang et al. also proposed a method called visual critiquing while they were to use icons (i.e. each icon is associated with a type of critique) to achieve the visualization effect (Zhang et al. 2008). Averjanova et al. (2008) has lately implemented a map-based mobile recommender system, but they only provide a simple critiquing panel (without detailed illustration in fact) and are purely based on static item features to generate recommendations without the involvement of dynamic social data.

## 3. MAP PROTOTYPE

The primary objective of our work has been to integrate the two types of critiquing supports (system-suggested critiques and user-initiated critiquing) in the map interface, to bring their respective advantages into play so as to maximally enhance users' interaction experience. Imagining that the user's task is to seek out an item on the map for her trip planning such as the need of hotel-reservation, system-suggested critiques are ideally applicable to expose available product space and recommend items with different tradeoff directions relative to the one that the user is currently near-satisfied. In addition, the user could refine her needs by specifying self-initiated critiquing criteria on one of displayed examples respecting its feature values (e.g. "I like this hotel's location, but are there ones cheaper or with higher user rates?"). In the following, we introduce the two core components in addition to how we elicit users' initial preferences and generate recommendations in the map.

a. Implementation of the interactive map

We have implemented the travel map with Google Map API. The map interface is mainly composed of three parts: 1) one is the left side that includes the initial preference specification panel and the list view of items that are currently shown on the map; 2) the map is in the central part. Any movement on the map (e.g. zoom in/out) will cause an update of items recommended in the restricted district. When a user clicks on an item on the map, a bubble will be popped up with three tabs: "Details" (the item's static/basic specifications), "Reviews" (list of user reviews) and"Refine" (to support preference revision by critiquing); 3) the third part is below the map to allow users to check whether additional items (such as good restaurants/shops nearby) can be added on the map along with the currently considered products.

b. Initial preference elicitation and recommendations

Besides the item's static features, we emphasize on the role of dynamic social data in the process of recommending. Therefore, more features are extracted from users' rates and reviews. For instance, as for the hotel, in addition its basic descriptions like price, class and location, the features that have been broadly commented, such as room size, cleanliness, service, are also contained and assigned values with other users' average rates (the rate ranges from 1 of the lowest level to 5 of the highest level). Thus, each item is structured into an array of pairs ($F_i$, $V_i$) where $F_i$ is the feature name and $V_i$ is its value. The user's preferences are accordingly elicited based on this structure, i.e. by asking the user to input explicit criterion on each feature (e.g. "service value is greater than 4"). A default preference model is included in case no preference is stated on one feature. Hence all of items can be ranked by their matching utilities according to user preferences. The calculation is formally conducted via Multiple-Attribute Utility Theory (MAUT) by which a weighted additive sum score is computed for each item (Keeney and Raiffa 1976). The top $k$ items are then located on the map during the first round of recommendations. In addition, we designed different icons assigned to items in order to represent their overall degrees of user popularity (e.g. full bar corresponds to the highest overall rate of 5, 4/5 bar is with rate of 4), so that users can obtain a direct visual overview of these items' reputations.

c. Preference-based critique suggestions

Our recommender mechanism (i.e. the MAUT-based computation) determines that a set of examples will be returned to assist users whenever their initial preferences are incomplete or having conflicts. The critique suggestions are further provided for the user to articulate more needs or revise her criteria to eliminate conflicts. Specifically, the suggestions are generated by involving user preferences into an association-rule mining algorithm, in order to discover the most prominent associative features that may interest the user. The algorithm steps can be referred to (Chen and Pu 2007b). Here we mainly describe how it acts on the map interface. Intuitively, it is invoked once a user is interested in one item, while she would like to see more similar ones and compare with them. Through clicking the button "Show Similar Ones" under the "Refine" tab, she could obtain such items which are categorized into different categories according to their tradeoff directions. For instance, given that the user initially stated that she wants a cheaper hotel with higher degree of service review, the map will show a category of hotels with better properties on these features (compared to the currently critiqued one), while they may compromise on some aspects like location. Besides, the map will also return a set of hotels that are superior on some features (e.g. cleanliness) that although the user has not stated any preference on them, may stimulate the user to consider when she sees concrete examples. In order to differentiate these different categories on the map, they are given different colors (e.g. one category of hotels is with green color, another is with yellow color) and users can associate the color's semantic

meaning with the help of left panel where these hotels are listed under these categories and each category is with a title (depicting its tradeoff properties) and the corresponding color as the background (see Figure 1).

d. User-initiated critiquing

In the case that the user is willing to refine search on her own, she could specify concrete improvement criteria under the "Refine" tab (Figure 1). The critiques can be made on any features used to describe the item (i.e. static and social ones). For example, if the user likes this hotel except its location, she could critique on this feature with the purpose of obtaining some similar hotels but being closer to the city center. Concretely, in such critiquing panel, the user can specify which features she wants to improve (to make them more important) and which ones she can sacrifice (less important) in order to guarantee the intended gains. Once she made all of critiques and clicked the "Show Results" button, the map system will automatically update her preference model (i.e. increasing the weights of improved features and decreasing the ones of sacrificed ones) and then compute a new set of best matching items to be presented on the map. These items will be also organized into the categories (when no item meets all critiques) like the interface design in part *c*, while at this time, the tradeoff directions are determined according to the user's self-specified tradeoff criteria (in terms of which improvements/compromises are satisfied).

When a critiquing action is invoked, the currently critiqued item (also called the compared item) appears encircled as in Figure 1, for the user to easily navigate from it to its similar options and compare among them. Thus, invoking system-suggested critiques or creating critiques by users themselves completes one interaction cycle, and it continues as long as the user wants to refine her preferences and seek out more items closer to her ideal target.

We have been implementing the map prototype system to support all of the above functions. Location-aware items, such as hotels, restaurants, shops and sights, are periodically extracted from social websites (e.g. TripAdvisor and Yahoo travel). At present, we determine the social features by manually analyzing users' reviews. Some websites also provide relevant information, like TripAdvisor allows users to input separate rates on multiple aspects. Based on these features, our map interface requests for the user's initial preferences and shows recommended items accordingly. It then aids the user in efficiently locating her best choice through the interactive and critiquing platform.


Figure 1. Critiquing-based map interface (the currently shown hotels are system-suggested ones similar to the critiqued hotel, which are organized into categories and depicted on the left panel. Users can also specify specific critiquing criteria under the "Refine" tab).

## 4. EXPECTED RESULTS

To our knowledge, we are one of few beginners who have emphasized the potential role of critiquing supports in enhancing user experiences with e-maps. The map's visualization characteristic makes it broadly accepted as a more effective method to aid users' understanding and exploration of location-aware product space. In order to further alleviate information overload (given the increasing amount of social data in current web) and accelerating users' information seeking process, we have been developing the map system that particularly integrates two types of critiquing aids: *system-suggested critiques* to expose available recommendation opportunities and stimulate preference refinement, and *user-initiated critiquing support* to allow for high level of user control and precise searching revision.

For the next step, user studies will be designed and conducted to identify our interface's practical benefits by comparing it respectively to the map without critiquing supports and to the list-based critiquing interface without the map element. The objective is therefore to understand the respective impacts of critiquing supports and map in our combined version. Three crucial criteria will be concretely measured in our user evaluations: decision accuracy, interaction effort and subjective perceptions. Ideally, we expect that the critiquing-based map information seeking tool will significantly improve users' decision accuracy, confidence and trust-related subjective constructs (like intention to return), while demanding a low level of objective and cognitive effort, so that it can become a more useful tool embedded in both of online social websites and mobile devices to replace the traditional map interface.

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