Eliminatory Constraints in the User Interface of Bicycle Route Planners – Results of a Survey

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Introduction  
Current bicycle route planners widely neglect the decision maker’s demand to impose constraints on route alternatives: They either evaluate a single-attribute optimization function, such as shortest path (MAGWIEN 2004), or use a compensatory decision rule involving user-defined criteria and importance weights (Rad.RoutenPlaner 2003). This paper presents the results of an Internet survey that examines the constraint functionality in the user interfaces of bicycle route planners for urban environments.

The study is motivated by a previous survey where respondents stated a high number of “avoid” phrases and eliminatory constraints when asked for important bicycle route selection criteria in urban environments (Hochmair 2004a). We introduce the term “avoid criterion” as a general concept that describes a situation along a route that the decision maker tries to avoid. Within the multi-attribute decision making (MADM) framework, an avoid criterion can be conceptualized by the user either as a compensatory (cost) criterion or as a non-compensatory criterion, i.e., as an eliminatory constraint.

The Survey  
An Internet-based questionnaire was designed to gather bicyclists’ input on the need for avoid criteria in user interfaces of route planners (question 1 below), the necessary metadata for those criteria (question 2), and the preferred style of presenting those criteria (question 3). 34 volunteers participated in the survey, most of them students or university employees. 30 out of 34 participants stated to use their bike mainly in urban areas.

Question 1: Demand for Avoid Criteria in User Interfaces  
Respondents were asked to imagine that they could define their preferred route in a bicycle route planner using two different sets of compensatory benefit criteria, which were shown in random order as screenshots (Figure 1). The criteria used for each of the two sets were of different comprehensiveness (Hochmair 2004b) comprising higher-level or lower-level criteria. For each set, participants were asked to select from a list of 26 “avoid” criteria (Hochmair 2004a) those that they considered as substantial functionality complement to the compensatory benefit criteria. Results show that the number of selected avoid criteria is significantly different (p<0.01) between the two sets of
compensatory criteria (Figure 2), which indicates that the structure of the benefit criteria affects the demand for avoid criteria.

Figure 1: Sets of higher-level (a) and lower-level (b) compensatory route selection criteria presented to the participants in random order

Figure 2: Demand for avoid criteria in addition to two different sets of compensatory route selection criteria

Question 2: Need for Metadata
The second part of the questionnaire examined which metadata were requested to fully understand the semantics of an avoid criterion, such as the length of a steep slope. On average, participants suggested additional explanations for 38% of the requests for avoid criteria from question 1 (Figure 3). Such metadata should be included in the decision support process offered by bicycle route planners.
Question 3: Style of Avoid Criteria
Each avoid criterion selected by a participant for question 1 was presented again in the third part of the survey, both as a checkbox (denoting an eliminator constraint) and as a slider (denoting a compensatory criterion). Participants were asked to state their preferred style of functionality. The results show that the conceptualization of avoid criteria ranges from strictly eliminator to highly compensatory (Figure 4), which suggests that the functionality of avoid criteria in user interfaces has to be adapted to the individual decision situation.
Discussion and Outlook
The results demonstrate the general need for inclusion of avoid criteria (question 1) and their corresponding metadata (question 2) in addition to compensatory benefit criteria in bicycle route planning tools. The demand for avoid criteria was shown to depend on the comprehensiveness of the benefit criteria provided. As we expect the “natural” process of route selection to be an iterative approach, the use of avoid criteria in the user interface may have to be adapted to each refinement stage accordingly. The fact that a certain demand for compensatory functionality has been stated for almost all avoid criteria (question 3) may be interpreted as the user’s fear of eliminating too many acceptable route alternatives when applying eliminatory functionality. To overcome such uncertainty, the user interface should always provide an overview of the characteristics of the route alternatives at hand. Then, using eliminatory functionality may in fact help to speed up the refinement process.

The following open questions could be addressed in future research:
- What is the “natural” approach of human route selection? (e.g., roughly sketching best route on map vs. stating preferred attributes; comprehensive single preference statement vs. consecutive refinement steps)
- Which parameters do determine the need for avoid criteria in the actual decision situation? (e.g., topography, cycling experience)
- How much preference information does the user want to enter to the system within a single refinement step? How does this depend on the user’s familiarity with the environment?
- Which information should be displayed with route alternatives at hand when being presented to the user to provide him/her with a good overview of the situation (e.g., number of dangerous intersections)?

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