Developing parameters for agent-based models using choice experiments

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Introduction

Outdoor activities are increasing as a balance to a stressful business life and urban habitation. Especially in sensitive areas in the Alps the resulting pressure on nature and wildlife is increasing (Lamprecht et al., 2008). To avoid serious damages to nature and wildlife new planning instruments are needed. Agent-based models (ABM) are regarded as one such planning tool, to simulate the behavior of artificial recreationists or wildlife on a platform of infrastructures such as topography, land cover, trail network, etc. Such recreationists and wildlife are programmed as self-acting agents who behave according to certain rules. Thus ABMs serve as tools to study spatial behavior of recreationists and to estimate changes in recreation-wildlife-systems in anticipated future scenarios (Hunt et al., 2010). The challenge of "how to detect parameters for human agents" remains. This article is based on a case study of mountain bikers.

Framework mafreina

In the summer framework of the mafreina project – management-toolkit recreation and wildlife – the focus is on hiking and mountain biking in mountainous regions in the Swiss Alps. (First results of winter situation were published by Rupf et al. (2011).) Skov-Petersen (2005) suggests to develop rules for human agents based on a combination of revealed preference data (e.g. GPS-tracking) and stated preference data (e.g. choice experiments). Choice experiments (CE) are based on a theory of human behavior (i.e. random utility theory). In a CE at least two situations are provided to respondents who must choose the prefered one (see Figure 1). Hunt et al. (2007) applied an ABM based on a choice model of revealed preference data. With the integration of animal agents in the mafreina framework shortcomings of Hunts model could be improved.

Developing rules of mountain biker agents

In general, mountain biking agents need two different sets of rules, first about the selection of geographic entry points into the system and suitable routes, and second about the agents' behavior on their trips. During a GPS-tracking campaign among 159 mountain bikers 247 different trips were recorded. The analysis with a geographical information system (GIS) of the tracking data delivered diverse information about trips: distance, duration, altitude, start and end positions, etc. That information constituted the main source of information for defining the range of attribute levels for the CE of tours (see Figure 1) as well as the "Trail choice at a junction".

The first choice experiment was designed to present tour choices to the respondents. Because the duration of the actually tracked mountain bike trips showed a bimodal distribution (peak 1 at 1 to 2 hours and peak 2 at 4 to 5 hours), the decision was made to develop two different tour choice experiments for short and long trips. From the mountain biking literature (e.g. Morey et al., 2002) and interviews with experts, a total of 14 attributes for mountain bikers were integrated in the choice experiment which presented a challenge for succinct presentation; therefore nine variables were visualized in a route profile. With the additional five attributes (excluding "estimated time", which was calculated as a function of distance and altitude) the response task was feasible and quite enjoyable.

The second choice experiment dealt with the situation at a trail junction, once biking along the route. Here, for each hypothetical situation the respondent had to choose between two hypothetical trail sections, which were characterized with eight attributes, such as trail surface, slope, forest cover or crowding. Together with the answers to the other survey questions, e.g. about their habits, trip planning, and environmental interests, the results of the two choice experiments allowed the definition of the different agent types of mountain bikers.

Each CE was based on an orthogonal fractional factorial designs with 64 choice sets. In the visualization process of the tour choice experiment few corrections were needed. Consequently the statistical designs of the two tour choice experiments had to be adapted slightly and the analysis of short and long tour choice had to be done separately.

After data cleaning 126 short tour bikers and 191 long tour bikers remained for analysis. For the simple analysis we assumed that beside trip distance, time and altitude, the overall interests of the short and long tour bikers are quite similar. The crowding issue seems to be a major concern, especially the encounters with hiking groups. More tolerance is shown to other bikers. Another attribute of great importance is a good view, and the bikers like to be in higher altitude. But cable cars are refused by most bikers.

So far in general no differences between short and long tour bikers could be detected in their stated behavior at a junction. Significant trail attributes for bikers (Latent Gold, Wald-Test, $\alpha = 0.05$) were:

- Trail type (highest ratings: single trails)
- Steepness (highest ratings: moderate)
- Numbers of hiking groups
- Rest infrastructure (highest ratings: hut selling alp products)
- Trail signalization (as good as possible)
- Closed trails

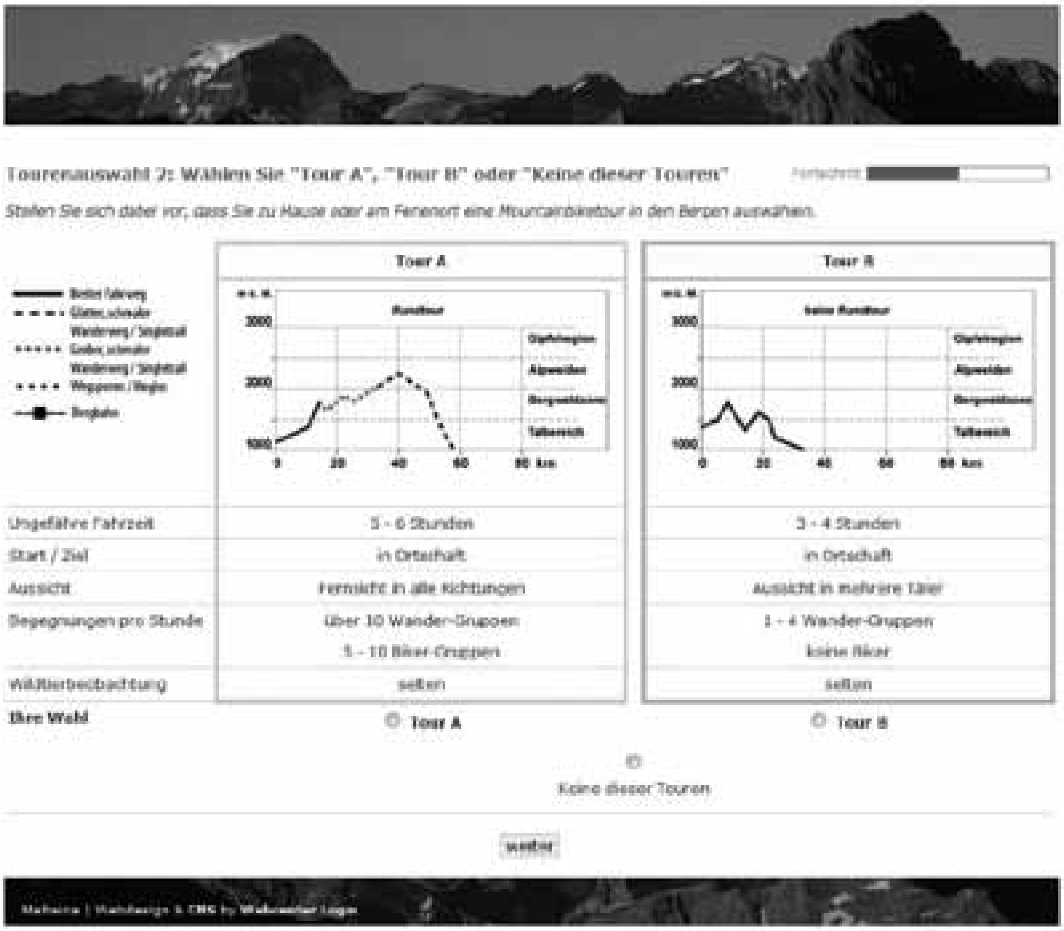

Figure 1. Choice experiment for a mountain biking tour – respondents had to choose "Tour A", "Tour B" or "None of those tours". The presented attributes described the tour as profile, roundtrip or not, its estimated duration, start/end in a village, view, encounters per hour (hiking groups and mountain biking groups) and chance to watch wildlife.

No significance occurred for time difference (little bit longer or shorter), proportion of forest and number of other mountain bike groups.

Conclusion

So far the first experiences and findings with the process GPS-tracking and GIS-analysis as base for the CE are positive as it guided the design of the CE into the right direction. It will provide a suitable rule set for the ABM. Further analysis will lead to the identification of additional subgroups and agents (Morey et al., 2002) which will be the next steps in the project mafreina.

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