Evaluating different Cartographic Design Variants for visually communicating Route Efficiency

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Abstract

Among other traffic-related challenges, such as reducing air pollution or fuel consumption, congestion reduction is central to maintaining an effective and safe transport system. This work describes a cartographic approach for influencing a road user's route choice, by visually communicating routes that are efficient in terms of traffic density. This is particularly relevant, since, due to the increasing emergence of mobile navigation devices such as car navigation or phones for route planning, a large number of route decisions are made based on the information provided by routing applications.

We performed an online experiment, which investigates the potential of six different design variants of visual variables (*color hue*, *distortion*, *length distortion*, *size*, *spacing* and *symbols*) for influencing route choice using cartographic visualization methods, while recommending a longer, but less congested route. This recommended route is not necessarily always the faster one, but rather the route, which contributes best to a more even distribution of traffic; and therefore benefits the entire traffic system. For the study, we created a set of 36 route maps of areas within 18 different German major cities of comparable size. Half of the maps represent the route options without any modification (*baseline* maps), while the remaining maps represent the same routing scenarios by modifying the visualizations using different design variants (*modified* maps).

The visualizations for all design variants have been prepared in three different levels of intensity of modification (weak, medium and strong). The objective of this modification is to nudge users towards choosing the longer route. While the different design variants visualize the temporary change in traffic density in different ways, the temporarily more efficient route is always aimed to be recommended as a result of the modification. Although the input data (traffic density) is the same for all representation methods, the visual metaphors for communicating traffic density distributions differ among the six design variants.

The results of our user study showed that in most of the tested cases, the participants' route choice has been significantly influenced towards choosing the recommended route

– indicating that the modification of route visualizations does actually lead to a different route choice behavior. Results further revealed that for most of the variants, the willingness to decide for the recommended route increases with using a higher intensity of modification. While some of the design variants like using *symbols* or *length distortion* have been found efficient for communicating route efficiency at all three levels of intensity, other visual variables like *size* and *spacing* have been found less suitable. We further found that route decisions do not depend on the time needed for making the decision for most of the tested routing scenarios. A comparison between the route choices and estimated route characteristics suggested that there is a strong relation between the willingness to choose the recommended route and the characteristics, participants associate with a certain representation. We discuss that particularly route visualizations, which create an impression of a *faster, more convenient* or *more fluent* travel experience are more likely to influence route choice behavior.

In conclusion, our findings provide evidence that it is possible to influence a map-reader's route choice behavior towards a temporarily efficient route – based on visual communication using different cartographic design variants.

A manuscript with the research details of this study is currently under review for journal publication.