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Preliminary Analysis on Choice Set and Its Change in the Context of Route Choice Decision During a Trip

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Abstract

In this research, route choice behavior is treated as a two-stage process consisting of a choice set generation stage and a choice making stage. In the choice set generation stage, drivers include the routes which satisfy their spatiotemporal constraints into an individual choice set. In the choice making stage, drivers are assumed to choose the route with maximum utility. The data used in this research is 2011 probe vehicle data collected in Toyota city, Japan. The applied model can be estimated simultaneously for two stages with only the information in choice making stage, and multiple constraints can be used in the choice set generation stage, furthermore, the applied model overcomes the choice-set explosion, therefore, it can be applied even the number of alternatives are big in the master set. Estimation results indicate that routes with less turns have the higher probabilities to be put into drivers' considerations. Furthermore, when drivers are close to destinations, probabilities for consideration of routes with relatively more turns will significantly increase. Estimation results also show that the two-stage model fit the better than multinomial logit model which does not have the choice set generation stage.

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Keywords: Route choice; Consideration set; Two-stage choice model; En-route Choice; Choice set generation.

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1. Introduction

Route choice is the process of travelers choosing routes. It can be applied to appraise travelers' perceptions of route characteristics, to predict future traffic conditions on transportation networks and to understand travelers' reactions and adaptations to sources of information (Prato, 2009). However, modeling route choice behavior is not as easy as it seems. In a route choice situation, there may be a dense network of roads, especially in a city, and even if the distance from origin to destination (OD) is only several kilometers, there could exist thousands of routes for drivers to choose from. Obviously, it is unreasonable to assume that drivers will choose their route from a choice set that includes all routes connecting one OD pair. However, researchers are always lack of travelers' knowledge about the network composition, uncertain about travelers' perceptions of route characteristics and unavailable to exact information about travelers' preferences (Prato, 2009), therefore, how to properly define the choice set for drivers in route choice modeling is always an issue.

As already noted, the universal set of feasible routes between an OD pair might be very numerous; human limitations mean that no driver is likely to know all of them. But a driver may know some of the routes as a result of past driving experience and information from maps and navigation systems. This set of routes is called the awareness set, also called master set. However, a driver might not be choosing from this set of known routes on a particular trip because of certain spatiotemporal constraints that apply, such as a time budget, driving habits and so on. These constraints eliminate the availability of some of the known routes. The remaining known routes constitute a set known as the viable set, also called consideration set from which the driver ultimately makes a choice (Kaplan, 2012).

Early researchers (McFadden, 1980) always assumed that all choice-makers choose from the same choice set. Gaudry and Dagenais (1979) proposed the Dogit model, where an individual is either captive to one alternative or is free to choose from the full choice set. Manski (1977) proposed the probabilistic choice set (PCS) model in which the choice decision process is divided into two parts: the choice set generation stage and the choice making stage. Some choice set generation models have been proposed in the past and incorporated into the PCS model in some choice modeling investigations (Swait and Ben-akiva, 1986; Morikawa, 1996; Kaplan, 2012; Rashidi, 2012 ; Sasic 2013), however defining choice set formation in a probabilistic way is complex and has never been done in a full-size application (Frejinger, 2009)

The objective of this research is to model drivers' route choice behavior more accurately. The crucial part of the procedure in this analysis is the step in which the awareness set is reduced to the viable set. Since choice set generation is treated separately, the PCS model is applied. A constraint-based choice set generation model is used to model a driver's choice set generation procedure. Additionally, in the en-route route choice situation, constraints should be varied with the stage of the trip. An en-route variable is introduced to the choice set generation model to see the difference. On the other hand, in the choice making stage, the conventional discrete choice model is used. There is one problem with this approach that should be mentioned: if the number of alternatives is n, then the number of all non-empty subsets would be 2^n-1. With a large n, 2^n-1would increase exponentially to an enormous number. In order to solve the computational problem resulting from this total number of non-empty subsets, a pairwise comparison of alternative methods proposed by Morikawa (1996) is used.

The data used in this research is probe-vehicle data collected in Toyota city, Japan between Feb 2011 and Dec 2011. The two model stages are estimated simultaneously using information about drivers' actual chosen routes only, as provided by the probe data.

2. Models

2.1. Random Utility Models

Under the utility theory, choice makers are assumed to be rationally, and they will choose the goods with the highest utility among the available alternatives. However, we cannot measure the utility to individual directly. Therefore, in random utility models, we suppose that the utility U_{in} of alternative i to individual n is composed by a deterministic component V_{in} and a stochastic error component ε_{in}, as shown in equation (1).