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Information provision strategies eliminating deluded equilibrium caused by travellers' misperception

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Abstract

Providing travel time information may be effective at reducing travel costs. However, this information does not always match the actual travel time that travellers will experience. Furthermore, the information is often asymmetrically provided within the network, owing to the limitations of observation devices, prediction model calibration, and uncertainty about road conditions. The purpose of this study is to investigate the effects of predictive travel time information that is asymmetrically provided to travellers. This study formulated a dynamic traffic assignment model in origin-destination (OD) pair with two parallel routes, while considering travellers' learning processes and within-day and day-to-day dynamics. In this study, it is assumed that different information will be provided to each traveller, according to within-day traffic dynamics. Furthermore, the information is provided for only one of two possible routes, because of observation limitations. The effects of information accuracy are also discussed in this study. The results of numerical analysis indicated that information provisions possibly reduced the negative effects of deluded equilibrium state, even when the information was only provided for one of the routes. Different effects of the travel time information and its variation were illustrated according to the allocation of the bottleneck capacities of two routes.

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Keywords:deluded euilibrium; bounded rational choice; advanced travel information systems; dynamic assignement

1. Introduction

Providing travel time information may be effective at reducing travel costs. By using this information, travellers can attempt to change their routes according to current conditions. It is apparent that accurate, real-time information is

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required to choose the most efficient routes. Many conventional studies have attempted to improve the accuracy of travel time information, and to evaluate the benefits of an advanced travel information systems (ATIS). Ettema & Timmermans (2006) classified the travel time information in three categories: Retrospective, Descriptive and Predictive information. "Retrospective" information is obtained from the historical data. The second category "Descriptive" describes a current situation. The third category "Predictive" describes a situation after starting a trip.

When the predictive travel time information is very accurate, travellers seem to be able to choose appropriate routes to minimise their travel costs. However, the travel time information does not always match the revealed travel time that travellers will experience. Furthermore, the information is often asymmetrically provided within the network, owing to conditions of observation and information provision. For example, information accuracy varies from one road section to the next; occasionally, information is not available for some sections because of observation device limitations, model calibration, and road condition uncertainty. Therefore, travellers may learn possible travel times through their daily commuting experiences, and incorporate that knowledge with the travel time information; based on these observations, they might adjust their route choice behaviour. Thus, as investigated in Chen & Mahmassani (2004 and 2009), mutual dependence of the learning process and road network performance is significant to know day-to-day evolution of traffic flow. Also as shown in Chorus et al. (2006), interactions between perception of travel time and information service's reliability is significant factor to know the effect of the information services.

To understand the role of the information, the effects on bounded rational choices and deluded equilibrium that are caused by false travel time perception must be considered, because of their significance. Nakayama et al., 1999 indicated the deluded equilibrium as a state where "drivers are locked in delusions and do not believe their perceived travel times can be improved by changing routes." In this state, travellers may be still capable of improving perceived travel time of unchosen routes. This state may stabilise the system before converging to an actual equilibrium state. Several studies have investigated the properties of bounded rational assignment in transportation systems (e.g., Mahmassani & Chang, 1987, Nakayama et al., 1999). Many studies that used a behavioural survey and a laboratory experimental approach were conducted to reveal relationships between travel time information provision and travel choice behaviour (Iida et al., 1994, Khattak et al., 1996, Mahmassani & Liu, 1999, and Avineri et al., 2006). Simulation approaches, including day-to-day evolution, were used to show the relationships between travel time information and network-wide performance (Emmertink et al., 1995; Jha et al., 1998). The information may help or hinder travellers' memories, as well as their trial-and-error based route choice behaviour processes. The reliability of the real-time information is a significant variable that influences commuters' pre-trip departure time and route-switching decisions (Mahmassani & Liu, 1999). Notably, when some elements of the network are disrupted or newly added, the role of the information may be more significant, because travellers do not have sufficient experience on the changed network (Guo & liu, 2011).

Travellers adjust their route choice behaviour based on daily experiences when the information is not perfectly accurate. Many conventional studies analysed dynamical traffic evolution. These studies mainly focused on flow evolution (e.g. Smith, 1984, Friesz et al., 1994) and network equilibrium stability (e.g. Horowitz, 1984, Watling, 1999, Bie & Lo, 2010). These dynamical traffic evolution studies assumed that traffic flow systems were static. Within-day dynamics are also an important factor in evaluating the effects of information accuracy. This is because the effects caused by information (such as congestion information) can only affect travellers who enter the network later. To describe within-day dynamics, the dynamic flow model is required in place of the static flow model; in the latter, travel costs affect travellers homogeneously.

The purpose of this study is to investigate the effects of predictive traffic time information that is asymmetrically provided to travellers. In this study, we focus on the interactions between the day-to-day learning, information, and dynamic traffic flow system. We investigate the deluded equilibrium state in the proposed framework to examine the effects of the information. This study assumes that predictive travel time information, according to the evolution of within-day traffic, will be provided to each traveller. Furthermore, the information is provided for only one of two available routes, because of observation limitations. In addition, the effects of information accuracy are discussed. In order to analyse the information's effects on the day-to-day dynamics of route choices, a day-to-day dynamic traffic assignment model with a dynamic traffic flow system is proposed in Section 2. Section 3 describes the analysis of the proposed model, using a Monte Carlo simulation. Section 4 concludes this paper.