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An efficient solution algorithm for solving multi-class reliability-based traffic assignment problem

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ABSTRACT

The multi-class reliability-based user equilibrium (RUE) problem has been intensively studied in recent years, as it can capture the route choice behaviors of users with heterogeneous risk-aversion under demand and supply uncertainties. Few solution algorithms, however, are available for solving the RUE problems in large-scale road networks. This is mainly due to the non-additive property of the path finding sub-problem in the RUE model. An efficient traffic assignment solution algorithm for solving the multi-class RUE problems in large-scale road networks is proposed in this study. First, an effective shortest path algorithm is developed to explicitly overcome the non-additive difficulty. The algorithm is capable of finding optimal paths for all user classes in one search process and hence the repeated search process for each user class is avoided. This property can save not only computational time but also memory requirement. The proposed shortest path algorithm is then, further incorporated into a path-based traffic assignment algorithm using a column generation technique. Such traffic assignment algorithms can solve the multi-class RUE problem without the requirement of path enumeration. Experimental results show that the proposed solution algorithms can, even for large-scale networks with multi-user classes, efficiently achieve highly accurate RUE solutions within satisfactory computational time.

1. Introduction

1.1. Background

It is widely recognized that in urban road networks, travel times are highly stochastic due to random traffic demand fluctuations and link capacity degradations. Under travel time uncertainty, it is found from several empirical studies that road users (or travelers) make their route choices, not only dependent on travel time saving, but also on reduction of travel time variability [1–4]. This is because larger travel time variation may result in undesirable late arrival and impose a high penalty on road users such as missed important meetings. As a result, users may be more concerns of the travel time reliability for their travels. The travel time reliability is defined as the frequency (e.g. 19 out of 20 days) that a trip can be successfully made within a desirable time interval [5,6]. In this case, users tend to allow extra travel time, generally referred to as a buffer time (or safety margin) in the literature, to reduce their risk of late arrival.

The road users with heterogeneous degrees of risk-aversion are also recognized in many empirical studies [1–3], as users may value travel time reliability differently depending on their socio-economic characteristics and trip purposes. It was

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