Demand Estimation and Bottleneck Management Using Heterogeneous Traffic Data

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Abstract

Congestion on urban and freeway networks has become a major problem, leading to increased travel times and reduced traffic safety. In order to suggest traffic management solutions to improve the transport system efficiency, it is important to capture the travel demand patterns, expressed as origin-destination (OD) matrices, and understand the mechanisms of traffic bottlenecks. The increasing availability of traffic data offers significant opportunities to effectively address these issues. The thesis uses heterogeneous traffic data to improve three important problems.

The first problem relates to the dynamic OD estimation problem, which entails significant challenges due to its complexity. The Simultaneous Perturbation Stochastic Approximation (SPSA) algorithm has been commonly used to solve the problem, which can handle any available data that can improve the estimation accuracy. However, it encounters stability and convergence issues. The thesis proposes a general modification of SPSA, called cluster-wise SPSA (c-SPSA), that has more robust performance and finds better solutions. Its efficiency is demonstrated through simulation experiments for a network from Stockholm.

The second problem focuses on the development of methods for utilizing heterogeneous traffic data for the analysis and management of freeway work zone and tunnel bottlenecks. Simulation is used as the means to evaluate and optimize various mitigation strategies for each case.

The third problem analyzes multimodal impacts due to network disruptions for the case of tunnel bottlenecks, using a data-driven approach. Tunnel congestion is often dealt with temporary closures, which may cause significant disruptions. It is crucial to identify the potential multimodal impacts of such interventions so as to design efficient and proactive mitigation strategies. The thesis shows the benefits of combining multiple data sources to analyze the impacts of temporary tunnel closures for a freeway tunnel in Stockholm.