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Dissertation Outline

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Chapter 1

Introduction

This chapter provides general idea on the research problem and emphasizes the novelty of the dissertation. There are substantial studies effort at calculating travel demand from datasets besides direct survey. Potential datasets include traffic counts, probe vehicle and mobile phone data. Despite the abundance of studies on novel datasets, there are still many issues unsettled when estimating OD demand from these datasets. This dissertation is dedicated to develop new methods for estimating static and dynamic OD demand from multiple data sources.

Chapter 2

Literature Review

This chapter reviews the evolution of OD estimation problem following the timeline of data, the macroscopic fundamental diagram for traffic dynamics, and the dynamic network loading model. Here is a brief discussion on the previous studies.

- There are several ways to classify the OD estimation method by their difference in: 1) whether directly estimate the OD demand, 2) whether the assignment map is endogenously or exogenously determined, 3) whether the path cost is endogenously or exogenously determined, 4) data sources, and 5) whether the departure time of OD demand is considered. Meanwhile, the requirement of SODE and DODE are different. The SODE problem requires innovation on data source so that reliable OD demand can be estimated from inexpensive, privacy free and ubiquitous data, while the computation and reliability issues are crucial to DODE problem.

- As a component of the DODE problem, DNL model is performed iteratives with the OD estimation problem. Though the point queue model is easy to implement, the spillback phenomenon can not be captured due the neglect of physical queue. Other macroscopic DNl models need discretization of links that thus pose challenge in developing fast numerical method. Introducing the macroscopic traffic characteristics to the DNL model will potentially improve the deficiency

- Though there exist a couple of studies on describing the traffic dynamics by macroscopic fundamental diagram. They are not perfect. For one thing, the relationship of vehicle accumulation-production uses gross information. Thus it can not track traffic dynamics in reservoir. For another thing, most studies focus on single reservoir problem and the flow propagation in network is neglect.

Chapter 3

Updating Origin-Destination Matrices with Aggregate Mobile Phone Data

Large-scale transportation surveys are time-consuming and costly for estimating the travel demands of work related trips. This was one of the driving reasons in this study for employing mobile-based data collectors. However, trip flow estimation methods with individual location data were also constrained by concerns about the invasion of privacy. This was the motivation in this study for new estimation methods with aggregated mobile datasets because it could preserve the advantageous aspects of mobile phone data while eliminating unfavorable aspects. This study proposed an approach to estimating trip flows with aggregated mobile phone datasets and low-cost surveys. This consists of two sequential entropy-maximization principle based sub-models. One is the trip attraction–production estimation model with inequity constraints on population change and rail capacity, and the other is an entropy maximization model on trip flow. A numerical example then showed this method performed well for synthetic data. This was the basis for the empirical study in 23 wards of Tokyo. The results of the case study showed that overall work related trips increased slightly in Tokyo between 2008 and 2012. It is consistent with our intuitions and the findings in previous studies.

However, this study is also constrained by the fact that only work-related trips can be derived from the dataset. Another limitation of this study is that modal split and route assignment problem are not integrated with the model. We have discussed how to formulate this problem when datasets such as path costs and link flow are available in Section 3.6. If we can have sufficient data, we will validate the proposed idea in the future.

Chapter 4

MRDNL: A Macroscopic Dynamic Network Loading Model for Multi-Reservoir System

Chapter 4 and 5 analyze the properties of macroscopic fundamental diagram and establish a dynamic network loading model that accounts for the macroscopic traffic dynamics.

Chapter 4 instigates a community detection method for identifying reservoir in network. With this method, a large scale network can be regarded as multi-reservoir system considering the inhomogeneity of network structure and link properties. Then the traffic dynamics in this system can be specified by the flow propagation in reservoirs and across the boundaries. The average density- speed relationship of each reservoir are adopted to build the link model while the flow at boundaries are controlled by the relation of supply in the downstream and demand in the upstream.

The MRDNL model is distinct from previous methods in that: (1) the MRDNL model extends Leclercq *et al*'s research on the heterogeneity within reservoirs by using the density/speed relationship instead of the vehicle accumulation/speed relation; (2) A novel numerical scheme describes traffic dynamics within the reservoirs. Introducing non-uniform cells and boundary conditions relieves the delay overestimation and underestimation problems; and (3) The traffic dynamics at the reservoir boundaries are treated by a generalized node model based on Nie *et al*(2008). The boundary model is extended to incorporate the control problem and priority of reservoirs.

Two numerical studies showed that the proposed model can accurately describe the traffic dynamics of networks. The macroscopic traffic flow characteristics estimated from the MRDNL model describe the change in the traffic conditions. Moreover, the computation speed of the MRDNL model is competitive even for mid-sized networks such as Sioux Falls.

For practical applications, it is important to note that the output of the proposed model is constrained by the fineness of the reservoirs. If the links in the reservoir have certain discrepancies, then the estimated results will be affected. The development of an effective clustering method for identifying the reservoirs with well-defined MFDs is an important issue for future studies.

Chapter 5

A Community Detection Method for Identifying Reservoirs in Large-scale Transportation Network

This chapter presents an application of community detection method to identifying neighborhood for MFD. In this settings, we modifies the definition of link weight, enabling the Louvain method to consider the similarity of link performance with the discretization of neighborhood.

The proposed method is test by simulation in Berlin. The results show this method is able to deal with large scale network and adjust the size of neighborhood automatically. The shape of MFDs for several neighborhoods shows that the a trip accumulation-production relationship exist.

However, further research is still needed to validate the proposed method on the performance on partitioning network. Unfortunately, there is no previous studies on using similar dataset for benchmark.

Chapter 6

A Unified Approach for Dynamic Path Flow Estimation

Chapter 6 presents proposes two new dynamic path flow estimators for estimating OD travel demand that incorporates observed link cost and link count. This two models are formulated by variational inequalities.

After proving the existence of solutions, this chapter also reviews solution algorithms for the proposed model.

Chapter 7

Conclusions and Future Works

Chapter 7 summarizes all results and discusses issues for future studies.