Hindawi
Journal of Advanced Transportation
Volume 2019, Article ID 6964943, 4 pages
https://doi.org/10.1155/2019/6964943

Editorial

Models and Technologies for Transport System Flow Analysis

Zhiyuan Liu,[1] **Lele Zhang**,[2] **and David Z. W. Wang**[3]

[1] *Jiangsu Key Laboratory of Urban ITS, Jiangsu Collaborative Innovation Center of Modern Urban Traffic Technologies, School of Transportation, Southeast University, China*
[2] *School of Mathematics and Statistics, The University of Melbourne, Melbourne, Australia*
[3] *School of Civil and Environmental Engineering, Nanyang Technological University, Singapore*

Correspondence should be addressed to Zhiyuan Liu; zhiyuanl@seu.edu.cn

Received 28 November 2018; Accepted 28 November 2018; Published 10 January 2019

Flow analysis is the core of many well-recognized technologies for the evaluation and improvement of transport systems, including the analytical methods and simulation software packages for transport system planning and design, traffic control, traffic safety analysis, and demand management. Urban and regional transport systems belong to a highly complex sector that involves the intricate activities of millions of commuters each day, which makes it highly challenging to accurately analyze and predict the flows. Herein, these flows also cover the dynamics in different subsystems, including the urban road networks and public transport systems; thus how to reasonably address the interactions and correlations between these subsystems is still a difficult and prevailing problem in the transport engineering and science area. In addition, new emerging sharing mobilities (such as ride-sharing, car sharing, and bike sharing) have provided new dimensions to travelers for the trip choices, which have introduced new challenges to the studies of transport system flows. To this end, this special issue aims to address the cutting-edge ideas, knowledge, methodologies, techniques, and practices in the broad areas of transport system flow analysis. There were 70 papers submitted to this special issue, 20 of which were accepted for publication. As the guest editors of this special issue, we would like to summarize the accepted papers as follows.

"Analysis on Port and Maritime Transport System Researches" by L. Chen et al.

Container port and maritime transportation has grown as a unique academic field in recent decades. In this study, rigorous bibliometric analysis methods are employed to review the literature of container port and maritime logistics research to illustrate the evolution of this field. A four-step method is designed to collect and process data. The authors rank the most active researchers, affiliations, and countries/regions adopting two scoring criteria and identify overall research terms at the microlevel by the Term Frequency-Inverse Document Frequency (TF-IDF) algorithm, which provides a better understanding of how maritime transportation research has been undertaken in a quantitative manner.

" Application of Finite Mixture of Logistic Regression for Heterogeneous Merging Behavior Analysis" by G. Li

In this research, a two-component finite mixture of logistic regression model is applied to analyze the vehicle trajectory data collected on a highway segment and discovered two major merging behaviors of drivers: risk-rejecting and risk-taking.

" Characterizing Critical Transition State for Network Fundamental Diagram" by R. Hong et al.

This paper proposes a clustering method based on the Gaussian mixture model to classify the critical transition state (CTS) of traffic flow using the time series data of network aggregated density and flow. The findings of this research are helpful to understand the temporal evolution process of traffic flow.

" Empirical Approximation for the Stochastic Fundamental Diagram of Traffic Flow on Signalized Intersection" by N. Zhang et al.

In this study, a stochastic traffic flow model is designed, and a shockwave speed based stochastic fundamental diagram is studied for a road segment between two signalized intersections for capturing the density-flow data scattering. The distribution of shockwave speeds is obtained by the variational Bayesian learning method from the field data.

"The Impact of Aggressive Driving Behavior on Driver-Injury Severity at Highway-Rail Grade Crossings Accidents" by C. Ma et al.

In this research, the authors analyze the accident data at US highway-rail grade crossings to explore the determinants of driver-injury severity with and without aggressive driving behaviors. A mixed logit modelling approach with a likelihood ratio test is utilized to estimate the problem. Results show that young male drivers, bad weather, peak-hour conditions, and driving in open space areas were more likely to express aggressive driving behaviors outwardly with high level injury severity given a highway-rail grade crossing accident happened.

"Driving Risk Detection Model of Deceleration Zone in Expressway Based on Generalized Regression Neural Network" by W. Qi et al.

Drivers' mistakes may cause some traffic accidents, and such accidents can be avoided if prompt advices could be given to drivers. So, how to detect driving risk is the key factor. Firstly, the selected parameters of vehicle movement are reaction time, acceleration, initial speed, final speed, and velocity difference. The ANOVA results show that the velocity difference is not significant on different driving state, and the other four parameters can be used as input variables of neural network models in deceleration zone of expressway, which have fifteen different combinations. Then, the detection model results indicate that the prediction accuracy rate of testing set is up to 86.4%. An interesting finding is that the number of input variables is positively correlated with the prediction accuracy rate.

"Modelling Rail-Based Park and Ride with Environmental Constraints in a Multimodal Transport Network" by X. Chen and I. Kim

This paper proposes a rail based Park-and-Ride (RPR) scheme to promote public transport in the multimodal transport network. To remedy the heterogeneous distribution of vehicle pollutants in the network, regulations in environmental sensitive districts are required and studied in this paper. To quantitatively evaluate and analyze this joint RPR and environmental regulation strategy in multimodal transport systems, this paper develops an environmental constrained combined modal split and traffic assignment (EC-CMSTA) model. The proposed formulation adopts the concept of fixpoint to reformulate the nonlinear complementarity conditions associated with the combined modal split and user equilibrium conditions, which is subsequently incorporated into a VI formulated nonlinear complementarity conditions associated with environmental constraints. A customized projection based self-adaptive gradient projection (SAGP) algorithm is then developed to solve the problem.

"Predicting and Visualizing the Uncertainty Propagations in Traffic Assignments Model Using Monte Carlo Simulation Method" by M. Seger and L. Kisgyörgy

In this research, the authors develop a five stages model based on Monte Carlo (MC) simulation to predict and visualize traffic flow and its uncertainty in traffic assignment models. After generating origin-destination (OD) matrices using MC simulations and simulating the traffic assignment with VISUM, the predicted traffic flow on each link is categorized based on the bias and variability.

"Enhancing Freeway Safety through Intervening in Traffic Flow Dynamics Based on Variable Speed Limit Control" by J. You et al.

This paper proposes an innovative Variable Speed Limit (VSL) based approach to manage crash risks by intervening in traffic flow dynamics on freeways using High Definition Monitoring System (HDMS) data. A binary logistic regression model is built to estimate crash risk. Microsimulations have been conducted to verify the proposed method with the AIMSUN simulation software and some insights are obtained.

"Bike-Sharing Static Rebalancing by Considering the Collection of Bicycles in Need of Repair" by S. Zhang et al.

In this study, the authors present an investigation of the net flow of each bike-sharing station to quantify the station state. Then a bike-sharing demand prediction method based on autoregressive integrated moving average models is proposed. With a view of bicycles that need repair, an extended Vehicle Routing Problem with Simultaneous Picked and Delivery (VRPSPD) program is developed to model the bike-sharing static rebalancing problem. A hybrid Discrete Particle Swarm Optimization-Variable Neighborhood Search (DPSO-VNS) algorithm is employed to solve the proposed model.

"Impact of a New Metro Line: Analysis of Metro Passenger Flow and Travel Time Based on Smart Card Data" by X. Fu and Y. Gu

In this study, smart card data of metro system from Nanjing, China, are used to study the changes of metro passenger flow and travel time due to the operation of a new metro line. The impacts of the new metro line on passenger flow distribution, travel time in the metro network, and commuters' trips are analyzed.

"Improving Traffic State Prediction Model for Variable Speed Limit Control by Introducing Stochastic Supply and Demand" by Y. Bie et al.

This paper investigates how to eliminate this prediction error within a VSL environment. In this study, the traffic state prediction model is a second-order traffic flow model named METANET, while the VSL control is model predictive control (MPC) based, and the VSL decision is discrete

optimized choice. A simplified version of the switching mode stochastic cell transmission model (SCTM) is integrated with the METANET model to eliminate the prediction error. The performance of the proposed method is assessed using field data from a VSL pilot test in Edmonton, Canada, and is compared with the prediction results of the baseline METANET model during the road test.

"A Two-Layer Network Dynamic Congestion Pricing Based on Macroscopic Fundamental Diagram" by B. Wei and D. (J.) Sun

This paper proposes a bilevel programming toll model, incorporating MFD to solve the unbalanced flow distribution problem within the two-layer transportation networks. The upper-level model aims at minimizing the total travel time, while the lower level focuses on the MFD-based traffic assignment, which extends the link-based traffic assignment to network wide level. Genetic algorithm (GA) and the method of successive average were adopted for solving the proposed model, on which an online experimental platform was established using VISSIM, MATLAB, and Visual Studio software packages. The results of numerical studies demonstrate that the total travel time is decreased by imposing the dynamic toll, while the total travel time savings significantly outweigh the toll paid.

"Automatic Estimation Method for Intersection Saturation Flow Rate Based on Video Detector Data" by L. Wang et al.

In this research, an automatic estimation method is proposed for the Saturation Flow Rate (SFR) based on video detector data in order to overcome the limitation of the field measurement method. The actual vehicle headway is treated as time series and an auxiliary regression equation is built up wherein the parameters are estimated through the ordinary least square method. The SFR is eventually calculated using the average value of saturation headways. A case study is conducted to demonstrate the validity of the proposed model by using data from an intersection with three approaches in Qujing, China.

"Optimal Bus-Bridging Service under a Metro Station Disruption" by H. Yin et al.

This paper aims to solve the metro station disruption problem. The authors propose an integrated optimization model by providing additional bus-bridging services. The model includes an optimization part and a three-layer nested-logit passenger behavior model part for analyzing the dynamic passenger flow demand. A genetic algorithm and a simulation based method are integrated to solve the proposed model.

"A Crash Surrogate Metric Considering Traffic Flow Dynamics in a Motorway Corridor" by X. Wang and K. Liu

In this study, the authors propose a new concept of traffic state vulnerability to develop a simplified crash surrogate metric (SCSM) with a closed form in consideration of traffic flow dynamics. A simulation model is developed using VISSIM to effectively generate dynamic vehicle behavior and a case study is conducted to compare the performance of the proposed metric with time to collision (TTC) and aggregated crash index (ACI). The result show that SCSM and ACI have similar performance which is superior to TTC, and SCSM is more applicable to practical engineering issues since it is less computational demanding.

"Optimal Design of Transportation Networks with Automated Vehicle Links and Congestion Pricing" by Y. Ye and H. Wang

This paper is focused on transportation network design problem (NDP) with congestion pricing involving both automated vehicles (AV) and conventional vehicles (CV) modes. This problem is formulated as a bilevel programming model. The upper-level optimizes the network design for AV links and congestion pricing while lower level describes a user equilibrium problem. The effectiveness of the proposed model and solution method are evaluated through numerical examples and some insights are obtained.

"Minimizing the Average Delay at Intersections via Presignals and Speed Control" by M. Ghanbarikarekani et al.

This paper aims to propose a model to improve presignals by reducing the vehicles' number of stops behind the presignals. By applying the method, vehicles would be able to adjust their speed based on traffic conditions as well as buses' speed and approach. Numerical analyses have been conducted to determine the conditions required for implementing this method.

"An Association Rule Based Method to Integrate Metro-Public Bicycle Smart Card Data for Trip Chain Analysis" by D. Zhao et al.

This research is focused on matching metro and public bicycle smart cards of the same commuters. To this end, a novel method with association rules to match the data derived from the two systems is proposed. The matching result helps to identify the spatial pattern of public bicycle demands, and the total journey and transit times of the metro-bicycle trip chain.

"On the Effects of Various Measures of Performance Selections on Simulation Model Calibration Performance" by C. Wang and C. Xu

In this study, the authors investigate how different performance measures affect the calibration of traffic simulation models at an intersection. In terms of reflecting traffic conditions and vehicle conflicts, they found calibrations on the basis of efficiency measures such as travel times and headway distribution performs better than those of safety measures and also a multimeasures based calibration performs better.

Collectively, these 20 papers illustrate the diverse range of the topics on transport system flow analysis and provide an insightful compilation recently being investigated in this

field. The papers included in this special issue are representatives of the current research challenges in advanced understanding, modelling, and algorithmic techniques for transport system flow analysis, which are capable of solving a variety of problems. It is expected that these papers can provide researchers with valuable inspiration and guidance to work on studies involving macroscopic fundamental diagram and its applications, disruptions to transport system flow, data-driven approaches for improving transport system planning, multimodal transport network flow, and so on.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Acknowledgments

As guest editors, we would like to take this opportunity to thank all the authors for their contributions to this special issue and the reviewers for their expert review comments. We hope the readers will share our joy and find this special issue very helpful.

Zhiyuan Liu
Lele Zhang
David Z.W. Wang