International Post-Conference (HKSTS) Workshop on "Advances in Supernetwork Modeling and Mobility Pattern Analysis"

11 December 2018 (Tuesday)
8:30 am – 12:30 pm

Rooms Y301 and Y302, 3/F, Block Y
The Hong Kong Polytechnic University
Hong Kong

Co-organizers
Prof. William H.K. Lam, CEE, The Hong Kong Polytechnic University
Dr. Feixiong Liao, Urban Planning Group, Eindhoven University of Technology

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**Special Issue of Transportmetrica-A: Transport Science on
"Advances in Supernetwork Modeling and Mobility Pattern Analysis"**

Biographies of Keynote Speakers

(In alphabetical order):

Prof. Chandra R. Bhat is the Director of the Data-Supported Transportation Operations and Planning (D-STOP) Tier 1 USDOT University Transportation Center and the Joe J. King Chair in Engineering at The University of Texas at Austin, U.S.A. Prof. Bhat is a world-renowned expert in the area of transportation and urban policy design, with far-reaching implications for public health, energy dependence, greenhouse gas emissions, and societal quality of life. Methodologically, he has been a pioneer in the formulation and use of statistical and econometric methods to analyze human choice behavior. His current research includes the social and environmental aspects of transportation, planning implications of connected and automated smart transportation systems (CASTS), and data science and predictive analytics. He is a top-cited transportation researcher in the world and his students have won many national and international awards for their MS theses and dissertations. Last year, he received the 2017 Lifetime Achievement in Transportation Research and Education Award from the Council of University Transportation Centers (CUTC).

Prof. Eric J. Miller is Director of the University of Toronto Transportation Research Institute, Canada. He is also Research Director of the University's Data Management Group, which is responsible for the largest travel survey data collection and management program in Canada, and the Travel Modelling Group, which works closely with transportation agencies in the Toronto region in improving the operational state of travel demand modeling practice in the region. Prof. Miller is the recipient of the Institute of Transportation Engineers 2009 Wilbur S. Smith Distinguished Educator Award, the inaugural winner of the University of British Columbia Margolese National Design for Living Award (2012), and the IATBR Lifetime Achievement Award (2018). Prof. Miller is the developer of GTAModel, a state-of-the-art activity-based microsimulation regional travel demand modeling system used in the Toronto region to forecast travel demand. He is co-author of the textbook Urban Transportation Planning: A Decision-Oriented Approach.

Prof. Tao Zhou obtained Ph.D. from the University of Fribourg, Switzerland in 2010, and now is a Full Professor of the University of Electronic Science and Technology of China, China and the Director of the Big Data Research Center. His main research interests include data mining, network science, and collective mobility dynamics. He has published many research articles in prestigious journals (e.g., Physics Reports, PNAS, Nature Communication), which received >20000 citations from the Google Scholar (H-index=68). His works have been reported by several academic media as Nature News, PNAS News, MIT Technology Review, PhysOrg.com, My Science, TG Daily, Dutch Science Magazine, Chinese Science News, etc.

# Workshop Programme on 11 December 2018 (Tuesday)

| Time	Event	Pages
08:30 – 09:00	**Registration** (Foyer, 3/F, Block Y, The Hong Kong Polytechnic University)	
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09:30 – 10:00	**A Multi-decade Longitudinal Analysis of Transportation and Land Use Co-evolution in the Greater Toronto-Hamilton Area** Prof. Eric J. Miller	7
10:00 – 10:30	**Predicting Human Mobility Fluxes between Any Two Locations** Prof. Tao Zhou	8
10:30 – 10:45	**Coffee Break** (Foyer, 3/F, Block Y)	
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10:45 – 12:15 (90 minutes)	**Maximizing Space-time Accessibility in Multi-modal Transit Networks with Uncertainties: An Activity-based Approach** Xiao Fu* and William H.K. Lam	9
	A Bi-level Model of Optimal Deployment of Shared Autonomous Vehicles Incorporating Vehicle Relocation and Traveler Daily Activity-travel Schedules Qing Li* and Feixiong Liao	9
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10:45 – 12:15 (90 minutes)	**Estimating Changes in Road Casualty Risk in Great Britain, 1995-2010** Benjamin Heydecker*	11
	Who is More Likely and Where is Easier to be a Passenger in Ride-sharing? Qiong Tian and Yue Yang*	11
	Improved Column Generation Algorithm for Dynamic Activity-travel Assignment Model Inclusive of Mobility Services Dong Wang*, Feixiong Liao and Ziyou Gao	12
	Modeling Bus Operation in a Multi-Modal and Multi-Directional Transportation System with Doubly Traffic Dynamics Fangni Zhang* and Wei Liu	12
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(*: presenter)

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Location Maps to Workshop Venue

Map 1: Way from The Mira Hong Kong Hotel to The Hong Kong Polytechnic University (PolyU)
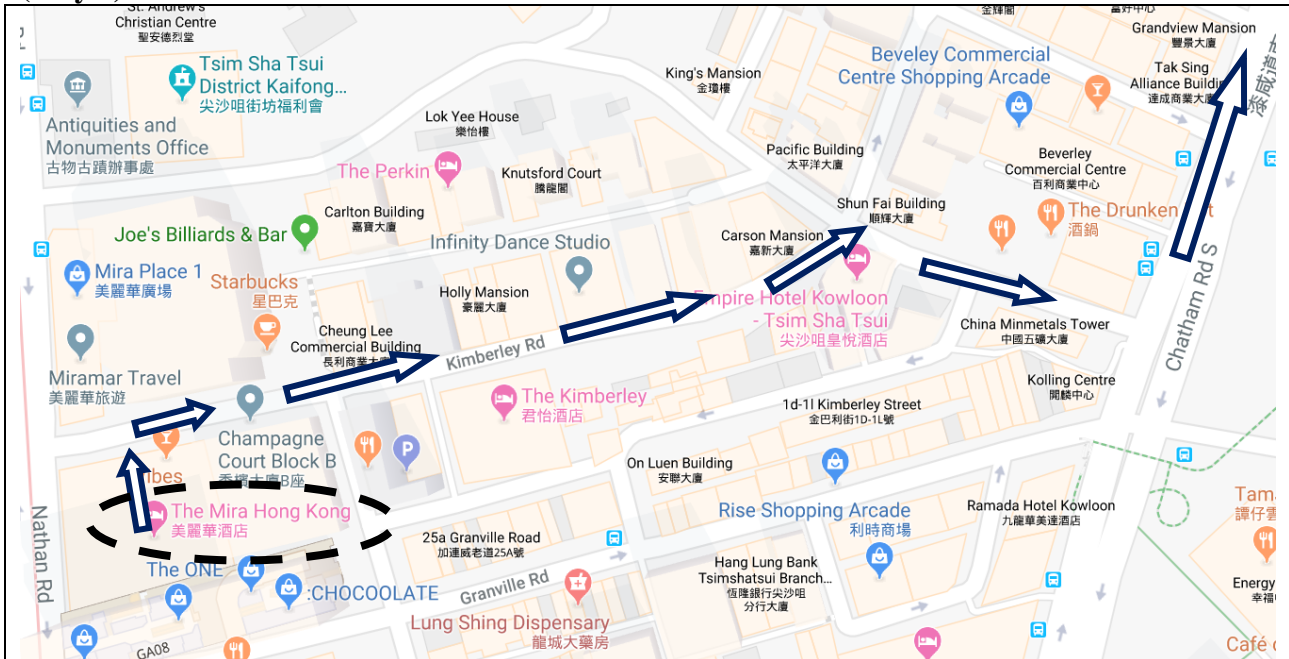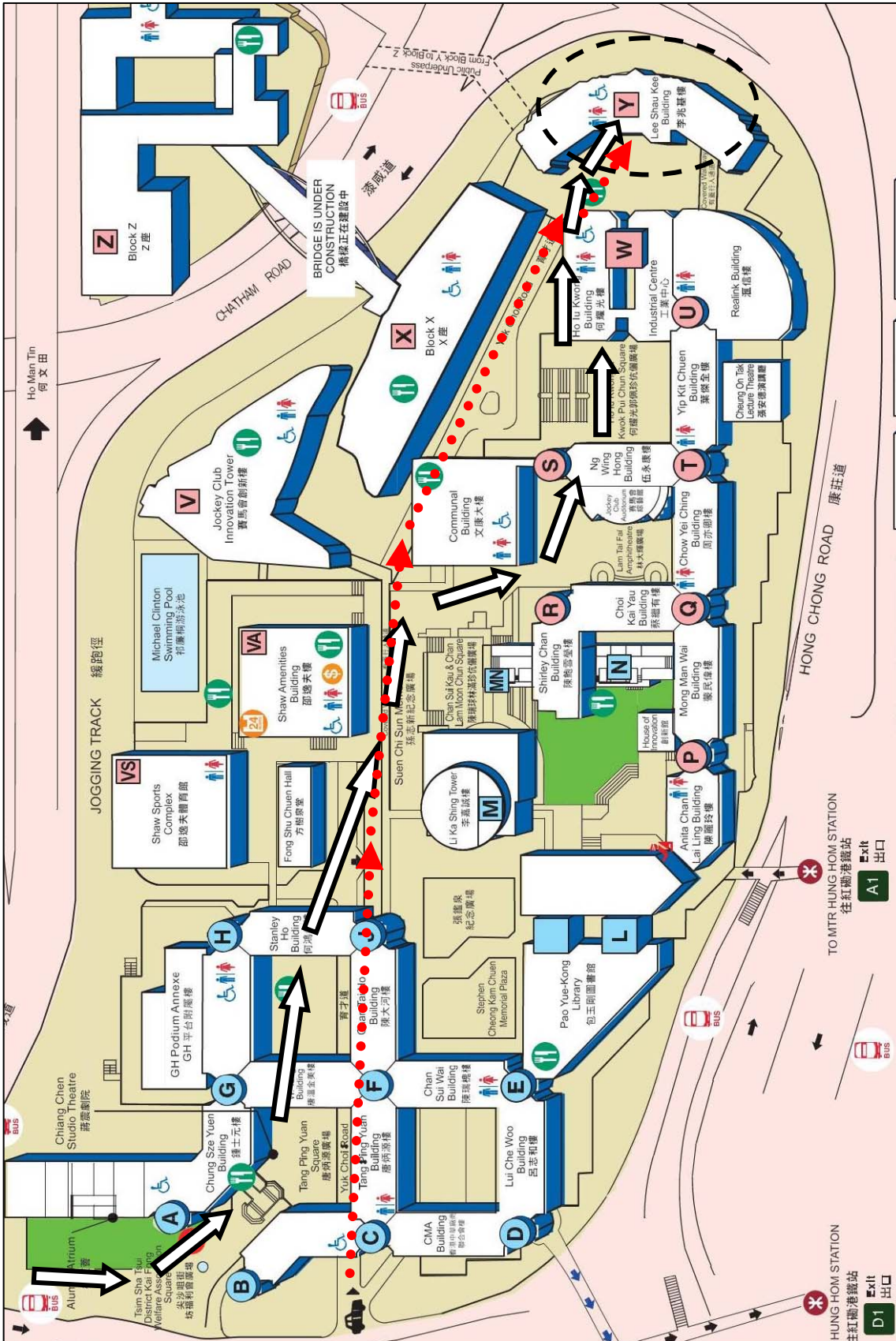

⬅ Walk from the Hotel to Chatham Road South
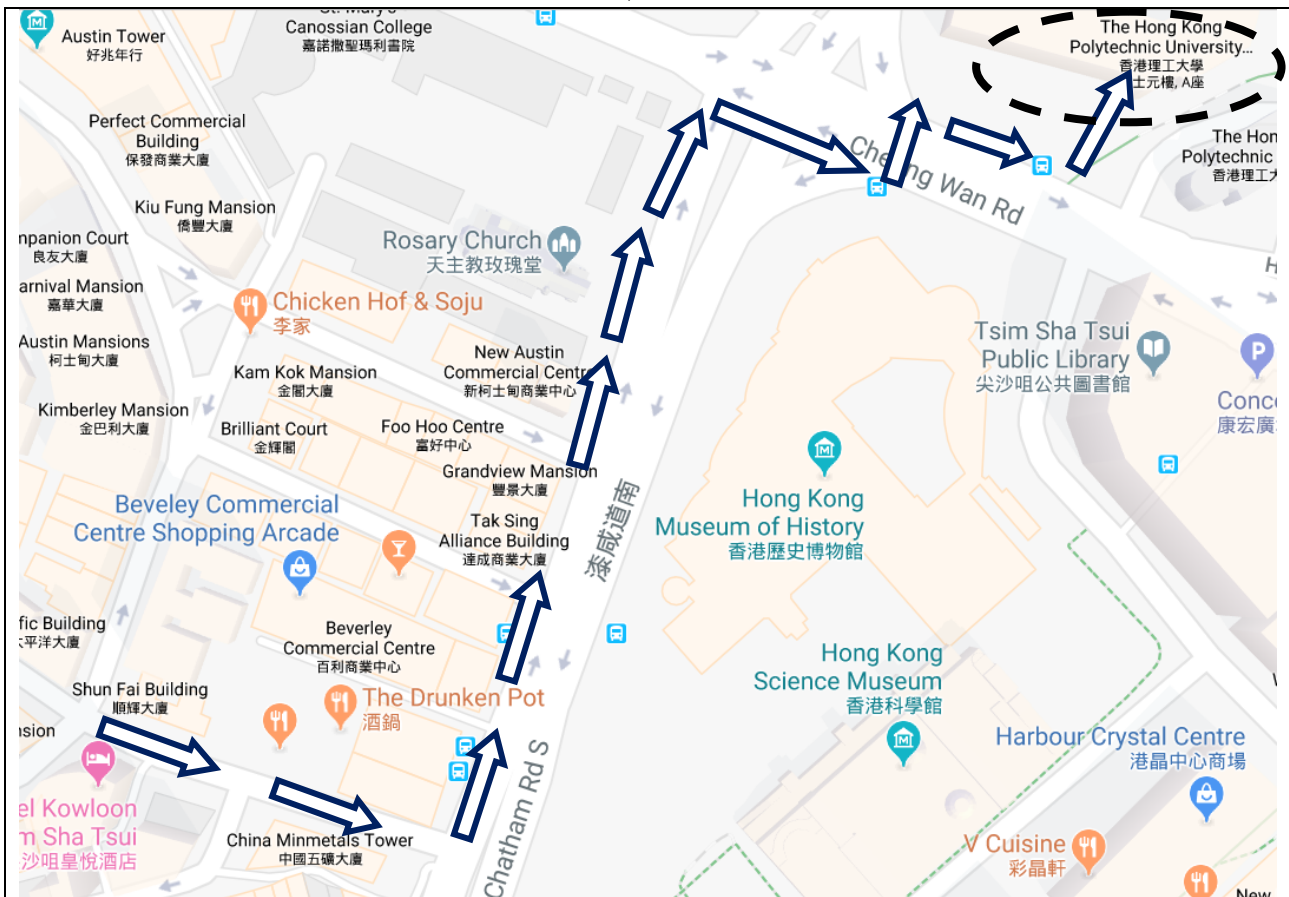
⬅ Walk from Chatham Road South to Block A of PolyU *(please see Map 2 on next page)*

Location Maps to Workshop Venue

Map 2: (PolyU Campus) Way from Block A to Rooms Y301 and Y302, 3/F, Block Y

⇨ Walk from Block A, upstairs/take lift in block A to 2/F (i.e. podium), go towards block Y, take lift in block Y to 3/F and then go to rooms Y301 and Y302

••▶ By Taxi: Depart near Block Y, take lift in block Y to 3/F and go to rooms Y301 and Y302

Abstracts

Keynote Speeches

Activity-based Modeling: Recent Advances and Possible Application to Hong Kong

Prof. Chandra R. Bhat
The University of Texas at Austin, USA

Urban population explosion is a ubiquitous phenomenon across the globe, including middle-eastern cities and Asian cities. This population explosion has led to a substantial strain on the transportation infrastructure in the form of traffic congestion. The problems of traffic congestion and urban footprint expansion have, in turn, led to other associated problems of increased traffic crashes and fatalities, mobile-source emissions, greenhouse gas emissions, and global climate change. As a result, national and regional urban and transportation planning agencies have embarked on renewed master planning and strategic planning efforts to regulate development and manage growth. Such efforts need a shift in the focus of travel demand modeling from the statistical prediction of aggregate-level, long-term, travel demand to understanding disaggregate-level (i.e., individual-level) behavioral responses to short-term demand management policies. Individuals respond in complex ways to such changes in travel conditions. In this keynote presentation, the author will (1) Provide an overview of the many dimensions and features characterizing activity-travel behavior modeling, (2) Present the conceptual basis and the modeling architecture adopted in activity-based travel forecasting systems that have been developed in the recent past, (3) Identify important advances in the field within the past 2-3 years to accommodate emerging and future technologies, and (4) Summarize the benefits and pathways to develop and implement activity-based models for Hong Kong.

Abstracts

Keynote Speeches

A Multi-Decade Longitudinal Analysis of Transportation and Land Use Co-Evolution in the Greater Toronto-Hamilton Area

Prof. Eric J. Miller

University of Toronto Transportation Research Institute (UTTRI), Canada

It is a truism in urban studies that a two-way transportation – land use interaction exists, in which, on the one hand, the accessibility that the transportation system provides to points in space influences both the development of the built environment and the location decisions of households and firms within this built environment, while on the other hand, the distribution of people, jobs and activity locations drives the demand for transportation and the resulting evolution of the transportation system over time. These interactions, however, play out over long time periods, given that both the built form and the transportation network change slowly over time. This makes the empirical study of this two-way, co-evolution of transportation and land use difficult to observe given the multi-decade nature of the timeframes involved, as well as, often, the lack of appropriate, consistent, comprehensive, historical data to retrospectively study this process (the only practical means of investigation).

Building on the work of Kasraian, et al. (2016a,b), this presentation reports on preliminary results of such a multi-decade (45 years, 1971-2016) analysis of the joint evolution of built form and the road and transit networks within the Greater Toronto-Hamilton Area (GTHA), Canada's largest urban region, with a 2016 population of approximately 7.1 million people. To support this study, all available open source datasets concerning built form in the GTHA were assembled into as consistent a time-series database as possible. Historical road and transit networks for the region were obtained from the Emme network model maintained by UTTRI's Travel Modelling Group (TMG). A brief comparison of these findings with the Hong Kong case (based on the earlier work by Kasraian) will also be made.

The presentation concludes with implications of the findings for the development of next-generation integrated transportation – land use modelling, as well as for the workshop's mobility pattern analysis theme.

Abstracts

Keynote Speeches

Predicting Human Mobility Fluxes between Any Two Locations

Prof. Tao Zhou

University of Electronic Science and Technology of China, China

With remarkable significance in migration prediction, global disease mitigation, urban plan and many others, an arresting challenge is to predict human mobility fluxes between any two locations. A number of methods have been proposed against the above challenge, including the intervening opportunity model, the gravity model, the radiation model, the population-weighted opportunity model, and so on. In this talk, I will give a brief introduction to these well-known methods. Despite their theoretical elegance, all models above ignored an intuitive and important ingredient in individual decision about where to go, that is, the possible congestion on the way and the possible crowding in the destination. This talk will further show a microscopic mechanism underlying mobility decisions, named destination choice game (DCG), which takes into account the crowding effects resulted from spatial interactions among individuals. In comparison with the state-of-the-art models, the present model shows a more accurate prediction on mobility fluxes across wide scales from intracity trips to intercity travels, and further to internal migrations. The well-known gravity model happens to be the equilibrium solution of a degenerated DCG neglecting the crowding effects in the destinations.

Abstracts

Session A1

Maximizing Space-Time Accessibility in Multi-Modal Transit Networks with Uncertainties: An Activity-based Approach

Xiao Fu [1] and William H.K. Lam [2]

[1] *School of Transportation, Southeast University, Nanjing, China*
[2] *Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University, Hong Kong*

As individuals conduct activities and travels under constraints of time and space, space-time accessibility is one of the key concerns in individuals' activity and travel choice behavior. The impact of space-time accessibility on the design of the multi-modal transit network with the use of activity-based approach is an important research area, as yet largely unexplored. In this paper, a reliability-based user equilibrium model is used to model individuals' activity and travel choice behavior. Considering the proposed network equilibrium results as reactions to the upper-level decision, a bi-level optimization model is developed with the objective of maximizing the space-time accessibility of activity locations in the study area. A reliability-based space-time accessibility is introduced for modeling the effects of travel time uncertainty on activity location choices and activity utility perceived by individuals. In the upper level, frequencies of transit lines for different transit modes are to be optimized so as to maximize the space-time accessibility. The proposed models and the solution algorithms are applied to a simple multi-modal transit network and a real-size transit network.

A Bi-Level Model of Optimal Deployment of Shared Autonomous Vehicles Incorporating Vehicle Relocation and Traveler Daily Activity-Travel Schedules

Qing Li [1] and Feixiong Liao [2]
[1] *School of Management Science and Engineering, Nanjing University of Information Sci & Tech, China*
[2] *Urban Planning Group, Eindhoven University of Technology, The Netherlands*

The combination of autonomous vehicles (AVs) and the free-floating car-sharing scheme is expected to deliver the full potentials of both through effective AV self-relocations. Existing studies have been rare to analyze the optimal deployment of shared AVs (SAVs) considering the interplay between SAV relocation and travelers' daily multi-modal multi-activity schedules. This study proposes an activity-based bi-level system optimal model inclusive of a hub-based relocation strategy to moderate the supply and demand of SAVs, in which the lower-level captures the travelers' activity-travel scheduling behavior by a tolerance-based dynamic activity-travel assignment (DATA) model and the upper-level determines the fleet size and initial distribution of SAVs. To solve the mixed network design problem, we develop an iterative heuristic algorithm based on Lagrangian relaxation. The numerical examples demonstrate that the relocation can significantly influence the distribution of SAVs and travelers' daily schedules and considerably increase the mobility efficiency of the multimodal transport system.

Abstracts

Session A1

Managing Congestion with Heterogeneous Commuters:
An Activity-Based Bottleneck Model Approach

Leilei Liang [1] and Meng Xu [1]

[1] State Key Lab of Rail Traffic Control and Safety, Beijing Jiaotong University, Beijing, China

In the trip-based bottleneck models, the interdependency of travel and activity in time and space is ignored. Influence of activity utility on the commuters' departure- time choices and time allocation among activities can be identified by modeling an activity-based bottleneck model. In this study, we allow heterogeneous commuters to travel along a corridor with bottleneck. We focus on a simple but typical activity chain consist of one trip and two activities (home and work activities). The iso-cost curves of commuters in various groups show that in an equilibrium state, commuters order themselves systematically in the departure sequence. Properties of solutions in the proposed model are analytically explored. The classical bottleneck model can be regarded as a special case of the model proposed in this study. In addition, a time-varying tradable credits scheme (TCS) is designed to eliminate queueing at the bottleneck. Welfare gains and social equality of commuters from different initial credit distribution schemes are explored. Numerical experiments are conducted to examine the feasibility and efficiency of TCS.

Day-to-Day Need-based Activity-Travel Dynamics and Equilibria
in Multi-State Supernetworks

Peng Liu [1,2], Feixiong Liao [3], Qiong Tian [1], Haijun Huang [1] and Harry Timmermans [3]

[1] School of Economics and Management, Beihang University, Beijing, China
[2] Department of Civil and Environmental Engineering, National University of Singapore, Singapore
[3] Urban Planning Group, Eindhoven University of Technology, The Netherlands

This study proposes a new framework of dynamical activity-travel in multi-state supernetworks based on a need-based theory. The framework postulates that human dynamic needs are the source of generating dynamic activities, travel demand, and day-to-day traffic, which in turn exert the influences on the choice of day-to-day activity-travel patterns (DTD-ATPs). The needs will be updated on the next day, so will the utilities of fulfilling the ATP, which means conducting the same ATP on two continuous days is likely to derive different utilities. Thus, the choice of a daily ATP is determined not only by the inner needs built up based on the past choices of ATPs but also by the current conditions of traffic and the usages of facilities. We formulate these terms and the relationship in an activity-travel rational adjustment process. This formalism couples dynamic activity generation, activity-travel scheduling, and traffic flow evolution in a strong sense, and offers appealing explanations for day-to-day traffic dynamics and equilibria in the real world.

Abstracts

Session A2

Estimating Changes in Road Casualty Risk in Great Britain, 1995-2010

Benjamin Heydecker [1]

[1] Centre for Transport Studies, University College London, UK

During 1995-2010 the annual number of road fatalities in Great Britain roughly halved, corresponding to an annual reduction in risk per km of travel of about 5 percent. Concurrently, the amount of driving in the highest risk age group (young males) reduced whilst that in the lowest risk group (middle-aged females) increased: this change in exposure will in itself have reduced aggregate risk. We used travel and casualty data from national surveys during this period in negative binomial log-linear regression models to investigate this. We found that the reduction in risk applied approximately equally across all combinations of age and sex except for a greater reduction for those under 10 years old and a lesser reduction for those between 15-17 years. The reduction also applied across all modes except that risk per km remained largely constant for users of taxis but approximately doubled for motorcyclists.

Who is More Likely and Where is Easier to be a Passenger in Ride-Sharing?

Qiong Tian [1] and Yue Yang [1]

[1] School of Economics and Management, Beihang University, Beijing, China

The ubiquity of Internet and application of global positioning system (GPS) enabled cell phones provides new opportunities to enable dynamic ride-sharing, where rides are established on very short notice or even en-route. In this paper, the travelers are assumed homogeneous in terms of having the same attitude towards ride-sharing mode. When they confirm their random distributed travel demand, including the OD and time requirements, they firstly announce their request and the platform checks whether they can be picked up by any driver. If failed, they will drive by themselves and become a driver who would like to pick up other passengers en-route. The ride- matching problem is formulated as a set-partitioning problem and a reduction mechanism is proposed to reduce the size of the feasible routes existed in the system. Because the matching problem is NP-hard, we propose a heuristic method to solve the ride-sharing match problem and compare the results generated by CPLEX for cases with relatively small size. Consequently, several numerical experiments are conducted by using both simulating generated data and the real world taxi request data of Chengdu in China. Several interesting results are found, such as the "sharing ratio" exhibits a decreasing trend as increasing the distance from the center of region and the lower the mileage of OD trip, the higher "passenger ratio".

Abstracts

Session A2

Improved Column Generation Algorithm for Dynamic Activity-Travel Assignment Model Inclusive of Mobility Services

Dong Wang [1, 2], Feixiong Liao [2] and Ziyou Gao [1]

[1] *Institute of Transportation System Science and Engineering, Beijing Jiaotong University, China*
[2] *Urban Planning Group, Eindhoven University of Technology, The Netherlands*

Incorporating daily multi-modal multi-activity activity-travel patterns, this paper develops an improved column generation algorithm for dynamic activity-travel assignment (DATA) problem in large-scale transport networks. The algorithm adopts a varied temporal resolution scheme, combining exploration and exploitation strategies, to assign flows to narrow time regions rather than to the whole time horizon. Moreover, the complex supply-demand interactions and spatial-temporal interdependencies of shared mobility service (MS) are formulated analytically. Under the framework of multi-state supernetworks, the DATA model inclusive of MS is solved without activity-travel pattern enumeration. Using furtherly space-time supernetwork transformation, a critical MS resource allocation problem are addressed by path expansion, and the resulting side-effect, i.e., more computation burden, can be offset by the proposed column generation algorithm.

Modeling Bus Operation in a Multi-Modal and Multi-Directional Transportation System with Doubly Traffic Dynamics

Fangni Zhang [1] and Wei Liu [2, 3]

[1] *School of Aviation, University of New South Wales, Sydney, Australia*
[2] *School of Computer Science and Engineering, University of New South Wales, Sydney, Australia*
[3] *School of Civil and Environmental Engineering, University of New South Wales, Sydney, Australia*

This study examines the time-dependent bus dispatching problem in a multi-modal context. Traditional studies along this line often optimize the bus frequency or schedule. However, they may fail as the realized bus frequency or schedule is constrained by the time-varying traffic congestion on the road. Dispatching more buses (number of bus in service) does not necessarily increase the frequency. Given this, we look into the time-dependent bus dispatching problem when incorporating complex multi-modal and multi-directional flow interactions on the road. In particular, the traffic dynamics is modeled through an aggregate traffic representation with flow interactions between cars and buses, and those between traffic in opposite moving directions. Moreover, we propose an adaptive adjustment mechanism for dispatching buses where we have a target level of bus loading factor. Numerical studies show that the proposed approach can help bus operator to reduce operating cost and improve net benefit while maintaining comparable user costs for passengers.

Call for Papers
Special Issue of Transportmetrica-A: Transport Science on "Advances in Supernetwork Modeling and Mobility Pattern Analysis"

Guest Editors:
   Dr. Feixiong Liao, Eindhoven University of Technology, The Netherlands
   Prof. William H.K. Lam, The Hong Kong Polytechnic University, Hong Kong
   Prof. Zhi-Chun Li, Huazhong University of Science and Technology, China

Number of papers: about 5~8
Number of pages: in total about 150

This special issue solicits novel contributions on methodological advances and empirical analyses of activity-travel choices and mobility patterns using supernetwork-related approaches. We hope to receive submissions addressing the following aspects, but not limited to:

- Supernetwork representation and design;
- Methodological advances in activity-travel scheduling and equilibrium analyses;
- Modeling of supply dynamics and uncertainties;
- Enhanced behavioral realism on choice facets and mechanisms;
- Parameter estimations and calibrations of activity-travel choices;
- Analyses of mobility patterns with BIG DATA technologies;
- Analyses of mobility patterns with the inclusion of emerging transport modes and services;
- Analyses of the effects of policies on mobility patterns and transport externalities.

Submission Guidelines

This special issue relates to the post-conference (HKSTS) workshop on "Advances in Supernetwork Modelling and Mobility Pattern Analysis", 11 Dec. 2018, Hong Kong, China. However, submissions are welcome from a broader audience. The length of each manuscript, including the abstract and references, should not exceed 10,000 words. It should be noted that each table, figure, or photograph accompanying the text counts as 250 words. Interested authors may read the full instructions for authors before submitting online. Please mention the special issue title in the cover letter when submitting. All submissions will be processed upon receipt and go through the journal's standard peer-review process.

Important Dates

Submission website opens:	1 January 2019
First submission deadline:	1 April 2019
Notification of first decision:	1 July 2019
Revision submission deadline:	1 September 2019
Notification of final decision:	1 November 2019
Final manuscripts deadline:	1 January 2020
Issue of publication (expected):	Spring 2020