EDITORIAL: Special Issue on Dynamic Modeling for Intelligent Transportation System Applications

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This special issue is based on articles both chosen from an open call for papers and selected from the 16th International Conference of Hong Kong Society for Transportation Studies. The conference was held on December 17-20, 2011 in Hong Kong and jointly organized by the Hong Kong Society for Transportation Studies, the Institute of Transport Studies and the Department of Civil Engineering at the University of Hong Kong. It aimed to foster excellence in transportation research and practice, stimulate professional interaction and provide a forum for exchanging ideas on transportation developments. The presentations covered numerous aspects of transportation research, including the theme of the conference, "Transportdynamics".

Transportdynamics is the discipline in which transportation system dynamics are studied, covering many aspects of classical transportation system engineering such as transportation planning, design, control, operation, management, policy and travel behavior. It emphasizes capturing the time-varying nature of transportation systems from both the demand and supply perspectives. The discipline includes many traditional research topics, such as dynamic traffic assignment (e.g., Long et al., 2011; Szeto et al., 2011), schedule-based transit assignment (e.g., Hamdouch et al., 2011), dynamic traffic signal control (e.g., Li, 2011), dynamic tolls (e.g., Lo and Szeto, 2005), traffic flow forecasting (e.g., Chiou et al., 2013; Anand et al., 2013; Wei and Liu, 2013; Yuan et al., 2013), activity-based modeling (e.g., Oh et al., 2012), vehicle routing and scheduling (e.g., Rancourt et al., 2013), incident detection and management (e.g., Ghosh and Smith, 2013), time-dependent shortest path problems (e.g., Chen et al., 2013), dynamic transportation network design (e.g., Wismans et al., 2014) and time-dependent delay estimation (e.g., Abbas et al., 2013). The time scales captured vary from one study to another, and further range from second to second (e.g., Lo and Szeto, 2002), day to day (e.g., Parry and Hazelton, 2013) and year to year (e.g., Szeto and Lo, 2005a, 2008; Lo and Szeto, 2009; Szeto et al., 2010) depending on the application. Capturing this time-varying nature is particularly important when modeling and examining transportation-related problems such as congestion and vehicle emissions in many cities, regions and countries. Moreover, its consideration allows for a more accurate description of these problems, leading to better predictions or estimations of system performance and better engineering of transportation systems. Without considering the time-varying nature, as in the static modeling paradigm, the congestion problem could be ill represented and the transportation policies determined could worsen the problem (Lo and Szeto, 2005).

Although transportdynamics is not a new discipline, it is growing. Szeto and Wong (2012) showed that more than 800 publications on one transportdynamics topic, i.e., dynamic traffic assignment and its applications, were published from 1971 to mid-2012, and that the number of publications is increasing. New studies on this discipline are always arriving and new dynamic models are being developed, probably due to the new intelligent transportation system (ITS) applications (e.g., Siripirote et al., 2013), new insights into current dynamic problems (e.g., Long et al., 2011), new design methods (e.g., Wismans et al., 2014) and new formulation approaches (e.g., Friesz and Meimanda, 2014) to addressing the limitations of current dynamic models.

Dynamic models are among the key components of an ITS. They have been used to simulate transportation system operations (e.g., Szeto, 2008; Sumalee et al., 2011), evaluate system performance (e.g., Szeto and Lo, 2005b), forecast traffic flow conditions (e.g., Szeto et al., 2009; Ye et al., 2012; Chiou et al., 2013; Anand et al., 2013; Wei and Liu, 2013; Yuan et al., 2013), estimate dynamic origin-destination demand (e.g., Kim et al., 2013; Flötteröd and Liu, 2013; Frederix et al., 2013), provide route guidance (e.g., Guo et al., 2013) and determine traffic control or management strategies for the movement of goods and people (e.g., Espinosa-Aranda and García-Ródenas, 2012; Ghosh and Smith, 2013; Bifulco et al., 2013; Wismans et al., 2013). For over half a century, much effort has been put into developing more realistic, practical and computationally efficient models for ITS applications. This special issue focuses on the recent advances in dynamic modeling, including the new models, algorithms, methodologies, strategies and ITS applications.

The issue consists of eight articles selected through a rigorous review process. The selected articles are representative of recent advances in dynamic modeling for ITS applications. The first article, by Mesa-Arango and Ukkusuri, develops a cell-based dynamic system optimal traffic assignment model that considers the interactions between trucks and cars. This model is derived from hydrodynamic theory and is formulated as a linear program. It offers a benchmark result for advanced traffic management system (ATMS) applications and insights into the decisions made in truck-only lanes. Its traffic flow sub-model will be used for the further development of cell-based, multiclass dynamic user equilibrium models for advanced traveler information system (ATIS) applications.

The second article, by Tian and Chiu, proposes and examines two time-discretization strategies for forming dynamic shortest path algorithms as the core algorithms for solving simulation-based dynamic user equilibrium models. Its results show that the proposed discretization strategies can flexibly and scalably balance the memory use and runtime of simulation-based dynamic traffic assignment models without degrading convergence. This property is rather important when dealing with large, realistic networks with lengthy analysis periods.

The third and fourth articles are related to traffic condition forecasting. The third article, by Chiou, Lan and Tseng, proposes a novel, multi-step time-series forecasting model for predicting traffic features such as traffic flow, travel time, speed and occupancy in a long freeway corridor. Based on rolling self-structured traffic patterns, the model adopts the growing hierarchical self-organizing map model to form a number of traffic pattern clusters, and predicts the traffic features of the clusters by developing a genetic programming model for each of the clusters. The results show that the model performs better than ARIMA, SARIMA and naïve models. It is my belief that their proposed model will be widely applied in various short-term traffic forecasting applications. The fourth article, by Anand, Ramadurai and Vanajakshi, develops a data fusion model for predicting traffic density in traffic conditions that are heterogeneous and lack lane-following behavior. The model relies on the Kalman filter to fuse flow and travel time data and thereby estimates traffic density. According to its calibration and validation, the model predicts density more accurately. The model is expected to be particularly suitable for forecasting traffic density in cites with similar traffic conditions and driving behavior in India.

The fifth article, by Liu and Lam, proposes a time-dependent model to determine mode choice over time under the provision of ATIS. The prospect theory is used to develop this model, which can be used to evaluate the performance of multimodal transportation corridors under ATIS provision. The article's insights into the effect of population density on mode choice will help governments establish transportation policies on mass transit rail development.

The sixth article, by Siripirote, Sumalee, Watling and Shao, proposes a maximum likelihood problem for simultaneously updating activity-based travel behavior model parameters and estimating vehicle trip chains based on information obtained from plate scanning, including vehicle passing times and scanned vehicle sequences along a series of plate scanning locations. The authors adopt a nested logit model to depict the travel behavior in this problem, in which the upper tier considers trip chains and the activity patterns of individuals, and the lower tier considers destinations and route choices. The problem is solved using the expectation-maximization algorithm. The test results demonstrate that the algorithm is able to effectively update the model parameters when the travel time variation level is low or the mean activity duration is high. This article significantly contributes to the literature by providing a new methodology that jointly updates travel behavior model parameters and estimates vehicle trip chains.

The seventh article, by Yushimito, Ban and Holguín-Veras, develops a two-stage optimization model for implementing staggered work hours that can be implemented effectively with the help of ITS. The first stage considers the problem of a firm aiming to reassign its workers to different schedules to minimize costs. The second stage considers the problem of workers aiming to determine the departure times and routes necessary to reach their workplaces on time. The article gives two examples to illustrate how the model could be applied to study the effects of external incentives on a firm and the firm's response, and to determine the type of starting-time arrangements that would achieve a social optimum. These examples are implicative of decision makers who want to implement staggered work hours.

The final article, by Ghosh and Smith, establishes a new and simple strategy that allows the use of current freeway-based automatic incident detection algorithms (AIDA) in signalized urban arterial transportation networks without significantly affecting incident detection effectiveness. This strategy relies on adjusting the traffic information obtained from the arterials to mitigate the effect of traffic signals before inputting the information to existing AIDA. Its performance is tested in three different scenarios using four AIDA. The advantage of the strategy is that the AIDA can be used to detect incidents on urban arterials with higher accuracy and without any instrumentation or operational cost.

In summary, the eight articles published in this special issue provide different, novel methods of building larger models for general ITS applications, along with various methodologies for and insights into specific ITS applications. I hope it will inspire and stimulate researchers, practitioners, transportation authorities and policymakers to arrive at new modeling approaches, methodologies, ideas and insights addressing transportdynamics problems.

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