AAMAS 2016 – TRANSET Workshop Abstracts

1. Multiagent cooperative routing: Aligning both infrastructure and vehicle agents

Authors: Madhavan Seshadri, Hongliang Guo, Jie Zhang, Dusit Niyato and Ulrich Fastenrath

Abstract

Traffic congestion is a menace for both traffic authorities and individual drivers causing frustration to millions of passengers every year. The financial cost is estimated to amount to an astounding $2200 billion each year in developed countries alone, worldwide. This paper proposes a novel node-pressure based multi-agent routing mechanism to alleviate traffic congestion. Different from traditional traffic jam alleviation techniques which either re-route vehicles alone or adjust the price of certain road link usage, this paper aligns the intentions of both, the vehicle agents and the infrastructure agents, allowing them to achieve the best global network state through a series of negotiations between the two. Through simple yet effective Q-learning algorithm for price update, we are able to balance the traffic load in the network and thus decrease the rate of traffic congestion occurrence and severity. Experiment results in realistic traffic simulation platforms show significant performance improvement in our approach against state-of-the-art solutions.

Speaker: Hongliang Guo

Hongliang Guo received his Bachelor of Engineering in Dynamic Engineering and a Master of Engineering in Dynamic Control at the Beijing Institute of Technology, China. He holds a PhD degree in Electrical and Computer Engineering from the Stevens Institute of Technology, USA. He later joined Almende in Rotterdam, the Netherlands as a postdoc research in 2011.

His research interests include selforganizing systems and agent-based technologies. In 2013, he joined NTU as a research fellow.

2. On the flexibility of using marginal distribution choice models in traffic equilibrium

Authors: Selin Damla Ahipaşaoğlu, Uğur Arıkan and Karthik Natarajan

Abstract

Traffic equilibrium models are fundamental to the analysis of transportation systems. The stochastic user equilibrium (SUE) model which relaxes the perfect information assumption of the deterministic user equilibrium is one such model. The aim of this paper is to develop a new user equilibrium model, namely the MDM-SUE model, that uses the marginal distribution model (MDM) as the underlying route choice model. In this choice model, the marginal distributions of the path utilities are specified but the joint distribution is not. By focusing on the joint distribution that maximizes expected utility, we show that MDM-SUE exists and is unique under mild assumptions on the marginal distributions. We develop a convex optimization formulation for the MDM-SUE. For specific choices of marginal distributions, the MDM-SUE model recreates the optimization formulation of logit SUE and weibit SUE. Moreover, the model is flexible since it can capture perception variance scaling at the route level and allows for modeling different user preferences by allowing for skewed distributions and heavy tailed distributions. The model can also be generalized to incorporate bounded support distributions and discrete distributions which allows to distinguish between used and unused routes within the SUE framework. We adapt the method of successive averages to develop an efficient approach to compute MDM-SUE traffic flows. In our numerical experiments, we test the ability of MDM-SUE to relax the assumption that the error terms are independently and identically distributed random variables as in the logit models and study the additional modeling flexibility that MDM-SUE provides on small-sized networks as well as on the large network of the city of Winnipeg. The results indicate that the model provides both modeling flexibility and computational tractability in traffic equilibrium.

Speaker: Uğur Arıkan

Uğur Arıkan received B.S., M.S. and Ph.D. degrees from the Industrial Engineering Department of Middle East Technical University, Turkey. Currently, he is a postdoc research fellow at the Engineering System Design pillar of Singapore University of Technology and Design. His primary research interests include transportation systems, discrete choice models, airline operations, disruption management and robust optimization.

3. A game theoretic view of electric vehicle charging station management

Authors: Yanhai Xiong, Jiarui Gan and Bo An

Abstract

The rapid development of Electric Vehicles (EVs) seen in recent years has been drawing increasing attentions from the public, markets, decision-makers, and academia. Notwithstanding the progress, issues still remain. Because of the widely complained disadvantages of limited battery capacity and long charging time, charging convenience has become a top concern that greatly hinders the adoption of EVs. Specialized EV charging station, which provides more than 10 times faster charging speed than domestic charging, is therefore a critical element for successful EV promotion.

While most existing researches focus on optimizing spatial placement of charging stations, they are inflexible and inefficient against rapidly changing urban structure and traffic pattern. Therefore, this paper approaches the management of EV charging stations from the pricing perspective as a more flexible and adaptive complement to established charging station placement. In this paper, we build a realistic pricing model in consideration of residential travel pattern and EV drivers' self-interested charging behavior, traffic congestion, and operating expense of charging stations. We formulate the pricing problem as a mixed integer non-convex optimization problem, and propose a scalable algorithm to solve it. Experiments on both mock and real data are also conducted, which show scalability of our algorithm as well as our solution's significant improvement over existing approaches.

Speaker: Yanhai Xiong

Yanhai Xiong received a B.S degree from University of Science and Technology of China. Currently, she is a PhD candidate at the Joint NTU-UBC Research Center of Excellence in Active Living for the Elderly (LILY), Interdisciplinary Graduate School, Nanyang Technological University. Her primary research interests include Game theory and its application on intelligent interactive systems.

4. Sparsely observed agent-based systems: a generative model for instantaneous crowd modeling

Authors: Nathan De Lara and Sébastien Blandin

Abstract

Real-time estimation of dynamical phenomena involving large number of agents is critical for Smarter Cities applications. However, for systems with many degrees of freedom, including crowds, the availability of timely structured and usable data remains a challenge. Given the high-dimensionality of the state-space, crowd systems are not fully observable for most applications. In this work, we consider the problem of model design for crowd estimation in a one dimensional space, given limitations on data stream availability. Our focus is on the model performance for estimation purposes, rather than comprehensive modeling capabilities. Starting from a classical cellular automaton model, we design a provably equivalent analytical instantaneous model, and we highlight modeling discrepancies between the modeling approaches.

Speaker: Sébastien Blandin

Sebastien is a Research Scientist at the IBM Research Collaboratory -- Singapore (IRC-S). His interests lie in the design and implementation of algorithms for modeling, estimation and control of urban networks.

5. Online agent-based pedestrian simulation for complex environments: A hybrid simulation-video analytics approach

Authors: Karthik Nandakumar, Jitendra Singh and Laura Wynter

Abstract

Modeling pedestrian movement in real-time is a capability that has become increasingly important in the effective management of public spaces. With the increasing availability of real-time sensor data, online pedestrian simulation models have become realizable. The models permit rapid prediction of pedestrian movement as well as facilitate real-time decision support such as what measures to take in the case of unusually large crowds. Typically used in planning studies, pedestrian simulators have been calibrated off-line using either "fundamental" diagrams of people movement or historical data. However, the real-time operational use case requires a new paradigm and an effective means for online, quasi-continual calibration. In this work, we propose such a framework that makes use of measurements from real-time sensor data, namely video, in conjunction with a microscopic simulation platform, for the continuous online calibration of a pedestrian simulator.

Speaker: Karthik Nandakumar

*Karthik Nandakumar is a Research Staff Member at IBM Research, Singapore. Prior to joining IBM in 2014, he was a Scientist at Institute for Infocomm Research, A*STAR, Singapore for more than six years. He received his B.E. degree (2002) from Anna University, Chennai, India, M.S. degrees in Computer Science (2005) and Statistics (2007), and Ph.D. degree in Computer Science (2008) from Michigan State University, and M.Sc. degree in Management of Technology (2012) from National University of Singapore. His research interests include computer vision, statistical pattern recognition, biometric authentication, and machine learning. He has worked extensively on human video analytics for several applications, with particular emphasis on information fusion. Some of these applications include recognition of age, gender, and emotions from facial images, gesture recognition, person re-identification, and face/biometric recognition. He has co-authored two books titled Introduction to Biometrics (Springer, 2011) and Handbook of Multibiometrics (Springer, 2006). He has received a number of awards including the 2008 Fitch H. Beach Outstanding Graduate Research Award from the College of Engineering at Michigan State University, the Best Paper award from the Pattern Recognition journal (2005), the Best Scientific Paper Award (Biometrics Track) at ICPR 2008, the 2010 IEEE Signal Processing Society Young Author Best Paper Award, and the 5-year Highest Impact Paper Award at BTAS 2013.*

6. Stochastic congestion games

Authors: Pradeep Varakantham and Shih-Fen Cheng

Abstract

This research is motivated by large scale problems in urban transportation and labor mobility where there is congestion for resources and uncertainty in movement. In such domains, even though the individual agents do not have an identity of their own and do not explicitly interact with other agents, they effect other agents. While there has been much research in handling such implicit effects, it has primarily assumed deterministic movements of agents. We address the issue of decision support for individual agents that are identical and have involuntary movements in dynamic environments. For instance, in a taxi fleet serving a city, when a taxi is hired by a customer, its movements are uncontrolled and depend on (a) the customers' requirement; and (b) the location of other taxis in the fleet. Towards addressing decision support in such problems, we make two key contributions: (a) A framework to represent the decision problem for selfish individuals in a dynamic population, where there is transitional uncertainty (involuntary movements); and (b) Two techniques (Fictitious Play for Symmetric Agent Populations, FP-SAP and Soft-max based Flow Update, SMFU) that converge to equilibrium solutions. We show that our techniques (apart from providing equilibrium strategies) outperform \driver" strategies with respect to overall availability of taxis and the revenue obtained by the taxi drivers. We demonstrate this on a real world data set with 8,000 taxis and 83 zones (representing the entire area of Singapore).

Speaker: Pradeep Varakantham

Pradeep Varakantham received his Ph.D. degree in Computer Science from the University of Southern California and he was a post-doctoral fellow at Carnegie Mellon University. Currently, he serves as assistant professor at Singapore Management University. His research is focussed on developing agent and multi-agent systems for urban environments.

He is an author or co-author of more than 50 international publications at top tier journals (JAAMAS, JAIR) and conferences (AAAI, IJCAI, NIPS, UAI, AAMAS, ICAPS) in AI. He has been invited to give the "Early Career Spotlight" talk at IJCAI-16. He was nominated for best senior program committee member at AAMAS'13 and one of his papers was nominated for best student paper at AAMAS'09. He is the local organization chair for AAMAS 2016 and organised/co-chaired multiple workshops on planning under uncertainty, multi-agent coordination and game theory for security. He served as the student abstract chair for AAAI-16 and serves on the program committee of most top tier conferences (AAMAS, AAAI, ICAPS, IJCAI) and reviews for most top tier journals (JAIR, AIJ, JAAMAS) in Artificial Intelligence.

7. Synthesizing high-dimensional, agent-based transport demand data from two-dimensional aggregates with iterative multiple histogram matching

Author: Pieter J. Fourie

Abstract

Big data sources such as transit smart card and cellular phone data records are well-suited to agent-based transport planning as they expose the revealed travel demand of a large number of individuals in a city. However, due to privacy concerns, access to these data sources is carefully controlled, and research is difficult to replicate and validate. Authorities are generally more amenable to releasing data summaries in aggregate form, where no single individual's travel pattern can be discerned.

This paper explores iterative histogram matching as a possible way to construct a surrogate data set that displays a similar joint distribution as the original big data source. It takes as its input a set of two-dimensional histograms in principal component and original variable space, recorded at a resolution where no individual is exposed. Initial results show that the method is capable of producing a surrogate data set with a similar speed distribution and fine-grained origin-destination patterns as was contained in the original dataset of transit smart card records recorded for a weekday in 2011 in Singapore.

Speaker: Pieter J. Fourie

Pieter Fourie is a senior researcher at the Future Cities Laboratory, a resource centre of ETH Zurich in Singapore. His research focuses on data-driven, agent-based transport simulation. He has been an active developer of the open-source agent-based transport simulation platform, MATSim, for the past 8 years, and has worked on developing simulations for URA, LTA and South African metropolitan authorities.

8. Towards calibrating congestion games using travel data from wearable sensors

Authors: Erik Wilhelm, Nils Tippenhauer, Melani Jayasuriya, Sandra Siby, Yuren Zhou and Georgios Piliouras

Abstract

An efficient transport system an important benchmark of successful urban development, and therefore minimizing traffic congestion plays a strong role in transport planning and related policy making. Congestion game models are widely used to predict traffic congestion and thereby enable the design of effective improvement measures. To calibrate congestion game models, real world data on traffic patterns in the target system are required to run accurate simulations, but such models are rarely calibrated due to the difficulty in obtaining requisite data. In this work, we present a large-scale traffic data set gathered over the course of the National Science Experiment, and discuss it qualitatively and quantitatively in the context of calibrating game theoretic analysis of congestion games. Based on the data set, we present a novel approach to processing wearable sensor data for developing latency functions for road segments which allows the calibration of congestion game models. Accurate game theoretic models of Singapore's traffic network can help can pave the way for establishing a tighter coupling between theory and practice of efficient routing networks.

Speaker: Erik Wilhelm

Erik Wilhelm is an assistant professor in the Engineering Product Development Pillar at the Singapore University of Technology and Design. He earned his PhD from the ETH-Zurich while studying multi-criteria vehicle design, data analytics, and control optimization. While in Zürich, Dr. Wilhelm co-founded a start-up in the area of vehicle telematics for reducing on-road energy use. His post-doctoral research was performed at the Massachusetts Institute of Technology in the Field Intelligence Lab.

Erik Wilhelm's research goal is the advancement of economically and ecologically sustainable transportation technologies through sensing, inference, and control. His approach to achieving this goal is to work is at various scales from vehicle subsystem design, to powertrain control optimization and automation, to vehicle modelling and technology trade-off analysis, and finally to transportation system analysis and optimization. A major part of Erik's research focuses on researching and developing embedded sensing technologies for sensing, storing, transmitting, and retrieving data to perform vehicle and transportation system design. Additional research activities include developing miniature smart-grid sensors for non-invasive current sensing, wireless sensors for student experimentation, and distributed robotic swarming systems. The common research theme pervading all of Dr. Wilhelm's activities is the secure and flexible distribution of intelligence from centralized servers to distributed embedded systems.