European Research Council
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MAGnUM
Multiscale and Multimodal Traffic Modelling Approach for Sustainable Management of Urban Mobility

European Commission

ERC MAGnUM Workshop

November 2018, 13th - 15th
ENTPE, Lyon, France

Program

LICIT

IFSTTAR

UNIVERSITÉ DE LYON

ENTPE
L'école de l'aménagement durable des territoires

Workshop Program

ERC in transportation

Tuesday, 13th **Three ERC grants in transportation**

Grand Amphithéatre de l'Université de Lyon, 90 rue Pasteur, Lyon

13:00-13:50 Prof. Serge Hoogendoorn, TU Delft, The Netherlands, ERC advanced

Allegro : Unravelling slow mode traveling and traffic: with innovative data to a new transportation and traffic theory for pedestrians and bicycles

13:50-14:40 Prof. Nikolas Geroliminis, EPFL, Switzerland, ERC Starting

METAFERW: Modeling and controlling traffic congestion and propagation in large-scale urban multimodal networks

14h40-15:30 Prof. Ludovic Leclercq, IFSTTAR, France, ERC consolidator

MAGnUM: Multiscale and Multimodal Traffic Modelling Approach for Sustainable Management of Urban Mobility

Masterclass day 1

Wednesday, **Masterclass in Transportation, traffic engineering and ITS**

Amphithéâtre Prunier, ENTPE, 3 Rue Maurice Audin, Vaulx-en-Velin

10:00-10:40 Prof. Monica Menendez, NY-AD, Abu Dhabi, Emirates

Multimodal operations: from local analysis to network modeling

10:40-11:20 Prof. Arnaud de la Fortelle, Mines-ParisTech, Paris, France

coming soon…

11:20-12:00 Prof. Jorge Laval, GeorgiaTech university, Atlanta, USA

coming soon…

14:00-18:00 PhD Defense : Guilhem Mariotte, ERC MAGnUM PhD student

Dynamic Modeling of Large-Scale Urban Transportation Systems

Masterclass day 2

Thursday, 15th **Masterclass in Transportation, traffic engineering and ITS**

Amphithéâtre Prunier, ENTPE, 3 Rue Maurice Audin, Vaulx-en-Velin

10:00 Prof. Kay Axhausen ETHZ, Zuric, Switzerland

Which autonomous vehicle revolution?

10:40 Prof. Margarida Coelho, University of Aveiro, Portugal

Assessment of road transportation impacts: the role of Intelligent Transportation Systems in sustainable mobility

11:20 Prof. Francesco Viti, University of Luxembourg, Luxembourg, Luxembourg

Mobile Phone Data Analytics for Network State Estimation

14:00-18:00 PhD Defense : Sergio Batista, ERC MAGnUM PhD student

Dynamic traffic assignment for multi-regional transportation systems considering different kinds of users' behavior

Serge Hoogendoorn

Professor
TU Delft
Delft, The Netherlands
Website: http://www.allegro-erc.nl/

Title Allegro: Unravelling slow mode traveling and traffic: with innovative data to a new transportation and traffic theory for pedestrians and bicycles

Abstract The researchers of Allegro are trying to develop and empirically underpin comprehensive behavioural theories, conceptual models and mathematical models to explain and predict the dynamics of pedestrians, cyclists and mixed flows within an urban context. All relevant behavioural levels will be investigated, including acquiring spatial knowledge, activity scheduling, route choice and operations. Special attention will be given to the role of ICT on learning, and choice behaviour.

Bio Serge Hoogendoorn holds the chair in Traffic Operations and Management at the Transport and Planning department (CEG), and he leads the coordinated and cooperative traffic management cluster at the TU Delft Transport Institute. He is also Principal Investigator Mobility with the Amsterdam Institute for Advanced Metropolitan Solutions AMS. He holds honorary professorship positons at the South-East University (Nanjing) and at Swinburne University of Technology (Melbourne).

Hoogendoorn has received a number of personal research grants: a Veni, Vidi and Vici, and most recently an ERC Advanced Grant. He was awarded the latter for five-year research into traffic theory for pedestrians and cyclists, a subject in urgent need of scientific knowledge. Together with partners like Rijkswaterstaat he has developed and applied innovative traffic concepts, such as decreasing so-called phantom queues with the help of dynamic speed limits.

Ludovic Leclercq

Professor
LICIT, ENTPE/IFSTTAR
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Website: https://magnum-erc.weebly.com/

Title Multiscale and Multimodal Traffic Modelling Approach for Sustainable Management of Urban Mobility

Abstract Very recently, a new modelling approach has been proposed to represent congestion dynamics at large scales. It relates the total travel production to the vehicle accumulation in a traffic network with for now a restrictive condition about network homogeneity. This approach is very promising for designing new traffic management systems but heterogeneous situations should be handled by properly connecting with the local scale to account for the effects of the local distributions and variations of the driver behaviour (demand) and the network structure (supply). Investigating these relationships and proposing a full set of consistent models representing traffic dynamics at several relevant scales (successive spatial and temporal integration) is very challenging with high potential gains for traffic control applications. This is the primary goal of MAGnUM and will be achieved by mixing analytical investigations on idealized but insightful test cases with explanatory approaches based on data gained from dynamic simulations or serious game sessions on more realistic and complex cases.

The second goal of the project concerns the design of innovative traffic management strategies at multiple urban scales. Breakthroughs will be achieved by considering multiple and competitive objectives when optimizing with a tight focus on environment issues and multi-modality.

Bio Ludovic Leclercq is a Professor at IFSTTAR (The French Institute of Science and Technology devoted to Transport, Planning and Networks) and is affiliated to the University of Lyon. He received his engineering and master degrees in Civil Engineering in 1998, his PhD in 2002 and his habilitation thesis (HDR) in 2009. He is currently deputy director of the LICIT laboratory and head of a research group about traffic modeling and analysis. His research interests correspond to multiscale and multimodal dynamic traffic modeling and the related environmental externalities. Smart cities, mobility as a service, sustainable and reliable transportation systems are some of the applications his researches are targeting. He is a member of the editorial board of Transportation Research part B, CACAIE, and the Journal of Intelligent and Connected Vehicles, the committee "Traffic Flow Theory and Characteristics" of the TRB, the international advisory committee of ISTTT and is associate editor of Transportmetrica B and the Journal of Advanced Transportation. He has co-authored 56 publications in top peer-reviewed journals, has supervised 7 PhD and is currently supervising 6 PhD students. In 2015, he was awarded the most prestigious research grant in Europe, i.e. an ERC consolidator grant in Social Science and Humanities.

Nikolas Geroliminis

Professor
Urban Transport Systems Laboratory, EPFL
Lausanne, Switzerland
Website: https://actu.epfl.ch/news/nikolaos-geroliminis-modeling-controlling-traffic-/

Title Modeling and controlling traffic congestion and propagation in large-scale urban multimodal networks

Abstract This ERC project targets to operate traffic in future cities in a holistic way that was not possible until now. It tackles the problem of modeling and optimization in large-scale congested traffic networks with an aggregated realistic representation of traffic dynamics and route choice and multiple modes of transport. Mobility will advance through the integration of big data, the understanding of multimodal patterns, the coordination and optimization of urban efficiency and sustainability for the travel of people and goods. This is challenging because cities are highly complex systems. Nevertheless, cities are becoming smarter in ways that enable us to monitor, analyze and improve the quality of life in real time. 'Big mobility data' provides a unique social observatory that can help us understand how congestion develops and evolves, and discover hidden patterns and identify models that can contribute in efficient traffic management techniques to improve cities' mobility and accessibility. Congestion governance in urban systems is currently fragmented and uncoordinated and traditional approaches use more detailed models with a higher degree of unpredictability and complexity that cannot be solved in real time. This is a highly motivated problem both because of the socio-economic influence of congestion and the challenges embedded in the optimization framework and the modeling aspects. Our recent research shows that by developing realistic network based aggregated models of congestion we don't need to know the exact position of every particle in a city and all parameters of our models are observable quantities, like in the law of ideal gas in chemistry. Thus, real-time coordinated strategies can be enhanced. To integrate all the aforementioned challenging questions, a fundamental change in the scientific approach is required through a multidisciplinary combination of physics, engineering and social sciences.

Bio Prof. Nikolas Geroliminis is an Associate Professor at EPFL and the head of the Urban Transport Systems Laboratory (LUTS). Before joining EPFL he was an Assistant Professor on the faculty of the Department of Civil Engineering at the University of Minnesota. He has a diploma in Civil Engineering from the National Technical University of Athens (NTUA) and an MSc and Ph.D. in civil engineering from University of California, Berkeley. He also serves as an Associate Editor in Transportation Research part C, Transportation Science and IEEE Transactions on ITS and in the editorial board of Transportation Research, part B, and of many international conferences. His research interests focus primarily on urban transportation systems, traffic flow theory and control, on-demand transport and shared mobility, Optimization and Large Scale Networks. He is a recipient of the ERC Starting Grant "METAFERW: Modeling and controlling traffic congestion and propagation in large-scale urban multimodal networks"

Monica Menendez

Associate Professor of Civil Engineering
New York University Abu Dhabi (NYUAD)
Abu Dhabi, UAE
Website: https://nyuad.nyu.edu/en/academics/divisions/engineering/faculty/monica-menendez.html

Title Multimodal operations: from local analysis to network modeling

Abstract Multimodal operations are an intrinsic part of most cities worldwide. Their analysis, however, is still often carried out in an independent manner for each mode (i.e. each mode is modeled and optimized individually). This, evidently, limits both the accuracy of the models, and the effectiveness of the optimized solutions; as improvements to one mode often come at the expense of the other modes.
In this talk we will review multiple modeling tools that allow us to look at the system holistically, and evaluate buses and cars simultaneously. This way we can take into account their interactions, and evaluate the trade-offs between them. We will start the discussion with a description of some analytical tools at the local level, and finish with some empirical tools at the network level.

Bio Monica Menendez is, since January 2018, an Associate Professor at New York University in Abu Dhabi; and a Global Network Associate Professor at the Tandon School of Engineering in New York University. Between 2010 and 2017, Dr. Menendez was the Director of the research group Traffic Engineering at ETH Zurich. Prior to that, she was a Management Consultant at Bain & Company. She joined Bain after receiving a Ph.D. in Civil and Environmental Engineering from UC Berkeley. Her research interests include monitoring, modeling, and control of multimodal transportation systems, paying special attention to new technologies and data sources. She is the author of around 50 peer reviewed journal publications and over 130 conference proceedings and reports; and a member of multiple editorial boards for top journals in Transportation.

Arnaud de la Fortelle

Professor
Mines-ParisTech
Paris, France

Coming soon

Jorge Laval

Professor
GeorgiaTech university
Atlanta, USA

Title Stochastic Approximations for the Macroscopic Fundamental Diagram of Urban Networks

Abstract This presentation focuses on a formulation of the reactive dynamic user equilibrium problem in continuum form using a network-level Macroscopic Fundamental Diagram (MFD). Compared to existing continuum models for cities -- all based in Hughes' pedestrian model in 2002 -- the proposed formulation (i) is consistent with reservoir-type models of the MFD literature, shedding some light into the connection between these two modeling approaches,(ii) can have origins and destinations continuously distributed on the region, and (iii) can incorporate multi-commodity flows without additional numerical error. The proposed multi-reservoir numerical solution method treats the multi-commodity component of the model in Lagrangian coordinates, which is the natural representation to propagate origin-destination information (and any vehicle-specific characteristic) through the traffic stream. Fluxes between reservoir boundaries are computed in the Eulerian representation, and are used to calculate the speed of vehicles crossing the boundary. Simple examples are included that show the convergence of the model and its agreements with the available analytical solutions. We find that (i) when origins and destinations are uniformly distributed in a region, the distribution of the travel times is given by a one parameter scaling of the free-flow travel time distribution, (ii) the magnitude of the detours from the optimal free-flow route due to congestion increase linearly with the inflow and decreases with the square of the speed, and (iii) the total delay of vehicles in the network converges to the analytical approximation when the size of reservoirs tends to zero.

Bio Jorge Laval is an Associate Professor at the School of Civil and Environmental Engineering, which he joined in 2006. After obtaining his B.S. in Civil and Industrial Engineering from Universidad Catolica de Chile in 1995, Dr. Laval worked as a transportation engineer for 5 years at the Chilean Ministry of Public Works in Santiago, Chile. He received his Ph.D. in Civil Engineering from the University of California, Berkeley in 2004. Prior to joining Georgia Tech, Dr. Laval held two consecutive one-year postdoctoral positions at the Institute of Transportation Studies at UC Berkeley, and at the French National Institute for Safety and Transportation Research (INRETS/ENTPE). Professor Laval's main research thrust is in the area of traffic flow theory, modeling and simulation, focusing in understanding congestion in urban networks and how to manage it. He has made important contributions towards understanding the capacity of freeways, the connection between driver behavior and stop-and-go waves, freeway ramp-metering strategies, dynamic traffic assignment and congestion pricing.

Guilhem Mariotte

PhD Student
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Title Dynamic Modeling of Large-Scale Urban Transportation Systems

Abstract Congestion in urban areas has become a major issue in terms of economic, social or environmental impact. For short or mid term, using dynamic road traffic simulation can help analyzing and providing guidelines to optimization policies of existing infrastructures. Today, because of the complexity of transport systems, classical modeling tools are limited to small geographical areas (of a district size). Computational time, together with simulation calibration, are notably very constraining at large scales. However, a new generation of models designed for metropolitan areas has arisen over the past decades. These models are based on a phenomenological relationship between travel production and the number of vehicles in a given spatial area of a road network, known as the Macroscopic Fundamental Diagram (MFD). This relationship, supported by empirical evidences from several cities around the world, has allowed the study of different traffic control schemes at a whole city scale, but was rarely used for traffic state forecasting.

The aim of this PhD is to propose an efficient modeling tool, based upon the concept of MFD, to simulate and analyze traffic states in large metropolitan areas. The theoretical framework of this tool must be consistent and applicable for traffic state forecasting, development of new control policies, traffic emission estimation, etc. There are two major contributions in this PhD. The first one is analyzing the mathematical and physical properties of existing models, and formalizing the dynamics of several trip lengths inside the same urban zone. In particular, this formalization distinguishes between internal trips and trips crossing the zone. Flow merging and diverging issues are also addressed when congestion propagates from one zone to another. The second contribution is proposing a new trip-based model based on individual traveled distance. This approach allows to treat users independently (previously represented with continuous flows), and thus to define their characteristics more precisely to couple their trips with assignment models on different paths. Finally, examples of application from various collaborations are given in the last part of this thesis. It includes a simulation study of the Grand Lyon urban area (France), as well as new modules to simulate search-for-parking or perimeter control. This PhD is part of a European ERC project entitled MAGnUM: Multiscale and Multimodal Traffic Modeling Approach for Sustainable Management of Urban Mobility.

Kay Axhausen

Professor
ETHZ
Zürich, Switzerland
Website: http://archiv.ivt.ethz.ch/people/axhausen.html

Title Which AV revolution?

Abstract The current discussion about AV is dominated by the discussion of the technology and its challenges. This presentation will highlight the other issues, which need or should be discussed: the likely costs of AV service and the various policy questions around AVs: What market structure do we want? What is the target of AV dominated traffic? How do we provide services for the disadvantaged? It will be based on recent work at ETH and elsewhere.

Bio Dr. K.W. Axhausen is Professor of Transport Planning at the Eidgenössische Technische Hochschule (ETH) Zürich. Before he worked at the Leopold-Franzens Universität, Innsbruck, Imperial College London and the University of Oxford. He has been involved in the measurement and modelling of travel behaviour for the past 35 years contributing especially to the literature on stated preferences, micro-simulation of travel behaviour, accessibility, valuation of travel time and its components, parking behaviour, activity scheduling and travel diary data collection. Current work focuses on the agent-based micro-simulation toolkit MATSim (see www.matsim.org).

Margarida Coelho

Professor
University of Aveiro
Aveiro, Portugal

Title Assessment of road transportation impacts: the role of Intelligent Transportation Systems in sustainable mobility

Abstract The most direct impacts of road transportation relate to traffic congestion, road safety, fuel consumption, emissions (with implications on air quality) and noise levels. The implementation of policies in the transportation sector should consider the level of contribution of each externality and its geographical scale. Thus, in a context of big data availability and digitalization of the transportation sector, a relevant research topic is to explore the nature of these dynamic externalities, in order to efficiently manage current road networks. On another hand, it is indisputable that recent advances in technologies can affect road user's travel behavior. The use of Intelligent Transportation Systems (ITS) can be an opportunity to reduce significantly transport externalities and costs by improving safety, reducing fuel consumption, traffic congestion and emissions. In this communication the on-going projects coordinated by the Centre for Mechanical Technology and Automation (TEMA) of the University of Aveiro (UA) on the ITS field will be presented. The focus will be on the importance of the integrated assessment of different impacts (traffic congestion, emissions, safety and noise). A particular attention will be given to the interaction of motor vehicles with vulnerable road users (pedestrians and cyclists). This Communication fits within Objective 11 "Sustainable Cities and Communities" of Sustainable Development Agenda, which aims that, by 2030, access to affordable, secure, sustainable and affordable transportation systems for all will be provided, with special attention to the needs of people in vulnerable situations.

Bio Margarida Coelho finished her PhD at Instituto Superior Técnico (IST) at Lisbon in 2005, within a partnership between IST and the Institute for Transportation Research and Education, of North Carolina State University, USA. She is an Assistant Professor at the Department of Mechanical Engineering of the University of Aveiro, the Vice-Director of the Research Centre for Mechanical Technology and Automation, and the Scientific Coordinator of the R&D Group on Transportation Technology of that Centre.

Her research interests are: impacts of transportation systems (namely, traffic congestion, energy consumption, pollutant emissions and road safety), intelligent transportation systems, and life cycle assessment. Margarida Coelho has more than 40 scientific papers published (or in press) in international journals (such as the Transportation Research Part D: Transport and Environment, International Journal on Sustainable Transportation, Atmospheric Environment, Transportation Research Record, International Journal of Hydrogen Energy, Science for Total Environment, and Journal of Nanoscience and Nanotechnology), besides other publications in book chapters and proceedings of scientific conferences.

Francesco Viti

Professor
University of Luxembourg
Luxembourg, Luxembourg
Website: TO FILL

Title Mobile Phone Data Analytics for Network State Estimation

Abstract In this talk we explore how the interplay between transportation and mobile networks manifests itself in mobile network billing and signalling data, and we show how to use this data to estimate different transportation supply and demand models. We first focus on modelling travel time distributions from Cell Dwell Times (CDT). We also encounter proportionality between the square of the mean CDT and the number of handovers in the system. This motivated our later studies of traffic state models generated from mobile network data. We show how handovers can be used as a proxy metric for flows in the underlying urban road network. Using a traffic flow theory model inspired by the well-known concept of Macroscopic Fundamental Diagrams, we show that clusters of mobile network cells behave characteristically, and with this model we reach a MAPE of 11.1% with respect to floating-car data as ground truth. The presented model can be used in regions without traffic counting infrastructure, or complement existing traffic state estimation systems.

Bio Francesco Viti is Associate Professor at the University of Luxembourg within the Department of Computational Engineering and Science, and is the head of the MobiLab Transport Research Group. He is also affiliated member of the Civil Engineering Institute and the Luxembourg Center for Logistics within the University of Luxembourg. His research activities range from mobility analysis, development of decision support systems for travellers and for transport operators, Intelligent Transport Systems and complex network modelling and control. He is author of over 80 papers indexed in Scopus. He is Associate Editor for Transportation Research Part B, Part C, Journal of ITS and Journal of Advanced Transportation.

Sergio Batista

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Title Dynamic traffic assignment for multi-regional transportation systems considering different kinds of users' behavior

Abstract The population growth in urban areas represents an issue for transportation planning. This is because transportation systems and infrastructures are not adapted to quickly respond to sudden increases of the demand. The latter increases the level of congestion, leading to large monetary costs and environmental issues. Policy measures are then needed to decrease the level of congestion and increase the efficiency of transportation systems. In a short term, traffic simulation is a powerful tool that can be used to design solutions to decrease congestion. However, traffic simulators are computationally demanding and difficult to calibrate for large scale applications.

After the seminal works of Daganzo (2007) and Geroliminis & Daganzo (2008), an aggregated traffic modeling is becoming more popular among the traffic flow community. The city network is divided into regions where a well-defined Macroscopic Fundamental Diagram (MFD) regulates the traffic conditions inside each one. The MFD relates the average trafic flow and density inside a region. In the literature, one can distinguish two MFD-based models: the accumulation-based (Daganzo 2007; Geroliminis & Daganzo 2008); and the trip-based (Arnott 2013; Lamotte & Geroliminis 2016; Mariotte et al. 2017). The MFDbased models simulate traffic as exchange flows between regions instead of the traditional traffic simulators, where one tracks the users' trajectories in the city network. The scaling of a city into a regional network yields new challenges that have not yet been addressed in detail in the literature. Up to today, only Yildirimoglu & Geroliminis (2014) proposes a dynamic traffic assignment framework to solve for the Stochastic User Equilibrium, considering the accumulation-based model. Their framework is based on the simple Multinomial Logit model and does not explicitly deal with trip length distributions. Moreover, their framework does not consider that users are different from each other and have different purposes and preferences for their travels. In the literature there are discussed several assignment models that account for different kinds of users behavior as well as users heterogeneity. This leads to different network equilibrium. The Deterministic User Equilibrium is based on the 1st Wardrop principle and assumes that users are perfectly rational and aim to minimize their own travel times. The Stochastic User Equilibrium assumes that users perceive route travel times with uncertainty due to the variable traffic conditions. Users also aim to minimize their own travel times. As shown by survey data (e.g. Zhu 2011), users do not always choose routes with the minimal travel times. There are alternative models that account for different kinds of users behavior. Prospect Theory considers that users evaluate their route choices as time prospects that are

Thank you
for attending this workshop !