NEARCTIS

3rd Workshop

Towards new research area in co-operative traffic management

Nearctis

Excellence in co-operative traffic management

Final Programme

Friday 11 June 2010

Lausanne, Switzerland

Organised by

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

COOPERATION

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Context of the workshop

NEARCTIS is a network of excellence in co-operative traffic management. The 3rd NEARCTIS workshop is an excellent opportunity to meet colleagues working in the traffic management area and to inform and discuss the latest progress of research activities. This workshop should be of interest to the researchers and practitioners working in the transportation field.

The main goal of the NEARCTIS is the development of a joint programme of research activities. The project is about to reach its mid-term and some major deliverables have been published. The fundamental issues, state of knowledge and educational activities of the project are on good way which reflects an increasing activity of the network. The next step will concentrate on the definition of a common research programme and this workshop is the right platform for sharing experiences and for discussing a future vision of the traffic management.

Objective

The main objective of the workshop is the initialisation of a debate on future key research topics related to the deployment of the co-operative systems within the context of scientific challenges and mobility issues. The programme will be composed of 3 main parts:

- targeted presentations linked to NEARCTIS activities
- interactive poster session presented by young researchers
- panel discussion with a participation of well recognised stakeholders in traffic management

Venue

The workshop will take place in Lausanne, Switzerland on 11th June 2010.

http://plan.epfl.ch/epfl/plan_en.html

Ecole Polytechnique Fédérale de Lausanne - EPFL, Room CM1
Location: http://plan.epfl.ch/?room=cm1

Local organisation and contact

EPFL – Transportation Centre (TRACE) – http://transport.epfl.ch

Local organising committee : Prof. André-Gilles Dumont, Ashish Bhaskar, Pierre-Yves Gilliéron, Sonia Lavadinho, Birgitte Seem

Contact: birgitte.seem@epfl.ch , sonia.lavadinho@epfl.ch
tel: +41 21 693 29 21 fax: +41 21 693 63 40

Registration: please refer to the NEARCTIS web pages: http://www.nearctis.org/

3rd workshop NEARCTIS — 11 June 2010

Welcome, coffee — **09:00**

Welcome plenary – Keynote speech — **09:30**

EPFL Transportation Center — Prof. Michel Bierlaire

Keynote speech — Prof. Nikolas Geroliminis, EPFL
"The M^3 of traffic systems: Modeling, Monitoring and Management "

Session 1: Research prospects: vision of research in traffic management — **10:15 - 11:15**

Chair: Jean-Baptiste Lesort, INRETS

- Traffic management: state-of-practice, capabilities and needs — Markos Papageorgiou, TUC
- Some priorities for future co-operative traffic management — Nick Hounsell, USo
- Scenarios for traffic information and management in 2028 — Serge Hoogendoorn, TUD
- Towards a harmonised research agenda — Benjamin Heydecker, UCL

Coffee break — **11:15 - 11:30**

Session 2: Flashlight presentations, overview of research activities — **11:30 - 12:30**

Chair: Prof. André-Gilles Dumont

- Rodrigo Castelan Carlson, Ioannis Papamichail, Markos Papageorgiou, Local feedback-based mainstream traffic flow control on motorways using variable speed limits, Technical University Crete
- Ioannis Kaparias, Konstantinos Zavitsas, Michael Bell, CONDUITS: Benchmarking urban traffic management, Imperial College London
- Sylvain Lassarre, Michel Roussignol, Antoine Tordeux, Macroscopic characteristics in stationary state of a Markovian jump process modelling a traffic flow, INRETS-GRETIA and Paris-Est University
- Yun-Pang Wang, Peter Wagner, Michael Behrisch, Towards a dynamic system optimum based on vehicular data obtained by microscopic simulation, DLR
- Andy H. F. Chow, A macroscopic tool for arterial traffic analysis, University College London

Lunch break — **12:30 - 13:30**

Session 3: Panel discussion – Co-operative systems: today and tomorrow — **13:45 - 15:00**

Chair: Prof. Fritz Busch, TU München, member of the NEARCTIS advisory committee

Panellists: representatives from industry, road operators, research institution

- Frédéric Riva, Siemens Schweiz AG (CH)
- Rana Ilgaz, Transport for London (UK)
- Cornelius Menig, AUDI (D)
- Eugenio Morello, CSST, Centro Studi sui Sistemi di Trasporto (I)
- Siebe Turksma, PEEK Traffic solutions (NL)

Goal of the panel:

- to debate on future research activities in co-operative traffic management
- to share expertise and ideas for future research directions
- to reinforce the role of NEARCTIS within the context of a multidisciplinary research area

Coffee break **15:00 - 15:15**

Session 4: Posters - Research activities of NEARCTIS partners **15:15 - 16:00**

Chair: Dr Ashish Bhaskar

This poster session will be interactive. The authors will be able to present theirs posters to the participants.

List of posters

- Minh Hai Pham, Ashish Bhaskar, André-Gilles Dumont, A Strategy for Developing Risk-Sensitive Active Traffic Management System, EPFL
- Julia Bendul , Wolfgang Stölzle, New Combined Transport Offers dealing with Supply Chain Concepts, University of St.Gallen
- Rodrigo Castelan Carlson, Ioannis Papamichail, Markos Papageorgiou, Local feedback-based mainstream traffic flow control on motorways using variable speed limits, TUC
- N.B. Hounsell , B.P. Shrestha, Differential Priority at Traffic Signals using iBus in London, University of Southampton
- Ben Waterson , Simon Box, Examining the impact of penetration rate on the performance of cooperative traffic management systems, University of Southampton
- Tibye Saumtally, Jean-Patrick Lebacque, Habib Haj-Salem, Side Constrained Traffic Assignment Problem in Dense Urban Area, INRETS
- Thomas Monamy , Jean-Patrick Lebacque, Habib Haj-Salem, Experimental Analysis of Trajectories for the Study of Capacity Drop, INRETS
- Victor Knoop, Christine Buisson, Bart van Arem, Avoiding the under-utilisation of the shoulder lane by ITS measures, TU Delft
- Ioannis Kaparias, Konstantinos Zavitsas, Michael Bell, CONDUITS: Benchmarking urban traffic management, ICL
- Framke van Wageningen-Kessels, Bas van't Hof, Serge Hoogendoorn, Multi-class traffic flow models: do they respect anisotropy?, TU Delft
- Ersan Ozturk, Hasan SEVIM, CIM-Tr: Cooperative Information Management for Traffic Flow, Istanbul Technical University KOSGEB R&D Center
- Gabriel Nowacki , Michał Niezgoda, Thomas Kallweit , National Automatic Toll Collection System Pilot in Poland, Motor Transport Institute; Warsaw
- Boyacı Burak, Geroliminis Nikolas, Exploring the Effect of Variability of Urban Systems Characteristics in the Network Capacity, EPFL
- Ji Yuxuan , Geroliminis Nikolas, Partitioning Urban Traffic Networks based on Spatial and Temporal Features of Congestion, EPFL
- Sylvain Lassarre, Michel Roussignol, Antoine Tordeux, Macroscopic characteristics in stationary state of a Markovian jump process modelling a traffic flow, INRETS-GRETIA and Paris-Est University
- Daniel Krajzewicz, Investigating Ecological Impacts on selected Traffic Management Methods, DLR
- Karsten Kozempel, Ralf Reulke, ARGOS Navigation Filter, DLR
- Wagner Peter, Nippold Ronald, Toledo Tomer, Calibration of microscopic traffic simulation models by acceleration or by trajectory (Run it!), DLR
- Thorsten Neumann, Potentials and Deficits of a recent Approach for urban Traffic Monitoring based on Floating Car Data, DLR
- Yun-Pang Wang, Peter Wagner, Michael Behrisch, Towards a dynamic system optimum based on vehicular data obtained by microscopic simulation, DLR
- Romain Billot, Florian de Vuyst, Nour-Eddin El Faouzi , Integrating the weather effects on traffic : empirical analyses, mathematical modeling and simulation, Ecole Centrale Paris
- Robert Oertel, Adaptive traffic signal control using vehicles' delay times, DLR
- JD (Puff) Addison, Changing variance of journey times with varying arrival and service rates, University College London
- Andy H. F. Chow, A macroscopic tool for arterial traffic analysis, University College London
- Mamy Fetiarison, A simulation framework for the evaluation of pedestrian data collection methods, EPFL

Closure **16:00 - 16:15**

01. Calibration Strategy for Evaluating Traffic Risks Identification Models

Minh-Hai Pham[1], Ashish Bhaskar[1], Edward Chung[2], and André-Gilles Dumont[1]

[1] *Swiss Federal University of Technology, LAVOC, Station 18, Lausanne 1018, Switzerland*
[2] *Queensland University of Technology, School of Urban Development, QUT Gardens Pt, L Block, Level 8, Room 808D, Australia*
minhhai.pham@epfl.ch

Abstract

Our final objective is to develop risk-sensitive active traffic management system whose main parts include traffic risks identification models –RIMs and preventive measures which will be activated once traffic risks are identified. The system will be evaluated and demonstrated by mean of micro simulation. However, one of important issues in simulating traffic safety is that models in simulation have not yet supported traffic events such as crashes. In this paper, we present a strategy to calibrate our simulation models to obtain a set of the best tuned parameters so that the simulation model would represent the best the reality from traffic safety point of view.

Keywords: *risk identification models, risk-sensitive active traffic management system, traffic safety, simulation, calibration*

02. New Combined Transport Offers dealing with Supply Chain Concepts

Julia Bendul[1], Wolfgang Stölzle[2]

[1]*Research Associate, University of St.Gallen; Ph: +41-71-224 72 86;* Julia.bendul@unisg.ch
[2]*Full Professor, University of St.Gallen; Ph: +41-71-224 72 81;* wolfgang.stoelzle@unisg.ch

Abstract

During the last 20 years, supply chain performance requirements have changed influenced by global trends. For instance the sustainability discussion, new information and communication technologies as well as increasing energy prices have altered customers' demands for products and services in terms of quality and cost. Shippers react by introducing logistics and supply chain concepts, such as Just-in-Time (JIT) and Vendor Managed Inventory (VMI) to meet velocity, delivery reliability and quality requirements as the basis for their corporate success. As a result, the expectations on transport efficiency and logistics service quality do continuously change, too.

In mid-term, shifting carriage from the stressed road network to alternate traffic carriers will become crucial to keep the high level of reliability in terms of quality, flexibility and velocity. Combined transport are supposed to be one opportunity to solve the conflict between the rising supply chain performance requirements, the problems with road transports as well as the ongoing sustainabilty discussion. However, innovative combined transport concepts are needed to sucessfully integrate rail and inland vessel into the high performance supply chains. At the same time especially rail and combined transports are critisized for their pretended lacking innovativeness.

By means of a literature research we identify the most important global trends influencing shippers' supply chain performance requirements and the effect on the integrated logistics and supply chain concepts. We specify these results by means of 35 expert interviews and identify industry and company specific developments and concepts.

Second, we refer to the Swiss Post as an indicative example for an innovative combined transport concept meeting the demanding performance requirements in a retail supply chain. Still recent research and practice are dominated by the paradigm that an integration of rail transports into short distance transport chains, i.e. distances below 300 km, is economically not possible. The introduced combined transport concept excesses notional boundaries and successfully deals with time and quality requirements on distances even below 100 km. We use this example to point the importance of cross-company innovativeness in the field of combined transports and identify promising innovation fields.

Third, we analyze the case study to elucidate the idea of an integrated combined transport innovation management for all combined transport actors dealing with changing supply chain performance requirements in general and the logistics and supply chain concepts in particular. Following the proposed frameworks suggested by Wagner (2008), Flint et al. (2005) and Pfohl (2007) we show how innovation management can serve as an instrument to develop innovative and integrated combined transport concepts and corresponding business models.

Selected References

Flint, D. J. / Larsson, E. / Gammelgaard, B. / Mentzer, J. T. (2005). Logistics Innovation: ACustomer Value-Oriented Social Process. Journal of Business Logistics, 26(1), pp. 113-147.

Pfohl, H.-C. & Bundesvereinigung Logistik (Deutschland) (2007): Innovationsmanagement inder Logistik - Gestaltungsansätze und praktische Umsetzung. Hamburg 2007.

Wagner, S. (2008): Innovation Management in the German Transport Industry. In: Journal ofBusiness Logistics, 29(2), pp. 215-231.

Keywords: *intermodal transport, combined transport, logistics concept, supply chain concept, innovation management.*

03. Local feedback-based mainstream traffic flow control on motorways using variable speed limits

Rodrigo Castelan Carlson[1], Ioannis Papamichail[2], Markos Papageorgiou[3]

[1] *Technical University of Crete; Ph: +30 2821037383;* rcarlson@dssl.tuc.gr
[2] *Technical University of Crete; Ph: +30 2821037422;* ipapa@dssl.tuc.gr
[2] *Technical University of Crete; Ph: +30 2821037289;* markos@dssl.tuc.br

Abstract

Motorway traffic flow congestion is a serious problem of all modern societies. The ever increasing traffic demand leads to increasing daily traffic congestion and its undesirable consequences, while several employed control measures to tackle congestion may face limitations. Thus, the efficient, safe, and less polluting transportation of persons and goods on motorways calls for new and innovative control measures that would drastically improve the current traffic conditions.

Mainstream traffic flow control (MTFC) is a recently proposed approach that aims at directly influencing the motorway mainstream traffic flow via an appropriate actuator, such as variable speed limits (VSL), specially operated traffic lights or emerging vehicle-infrastructure integration systems. MTFC may be used for throughput maximization at active motorway bottlenecks with reduced daily capacity due to capacity drop. This was demonstrated to lead to substantial savings (50% reduction of the average journey times) when applied to a strategic ring-road motorway, using an optimal control approach and VSL as a MTFC actuator. MTFC by use of VSL has been considered to some extent in some recent works under different approaches and traffic application settings. Most of these works, however, are not deemed sufficiently practicable for ready field implementation, because they use sophisticated methods or require a number of parameters difficult to obtain.

A simple yet efficient local cascade feedback MTFC strategy using VSL as an actuator has been developed. A macroscopic second-order traffic flow simulator (METANET) was used to evaluate the feedback controller on a hypothetical motorway stretch. The performance of the feedback controller was evaluated under different configurations, taking into account several practical restrictions that must be considered for a safe implementation, such as discrete speed limit values and limited difference between two subsequently posted speed limits. The feedback controller performance was then compared to the optimal control approach and no-control scenarios. The feedback control law approximates the efficiency of the optimal control approach, while being more suitable for field implementation, as it requires only four easy to design parameters and two real-time measurements.

Along with a real test in the field, future work includes coordination of feedback MTFC controllers and the integration of feedback MTFC with other control measures such as ramp metering. The use of alternative actuators, other than VSL, will also be tested.

Keywords: *Mainstream traffic flow control, variable speed limits, motorway traffic flow control, feedback control*

04. Differential Priority at Traffic Signals using iBus in London

N.B. Hounsell[1] and B.P. Shrestha[2]

Transportation Research Group; University of Southampton; UK
[1]N.B.Hounsell@soton.ac.uk ; [2]B.P.shrestha@soton.ac.uk

Abstract

Buses in London play a vital role in the movement of the people in the capital. With more than 8000 buses serving more than 700 routes and carrying 6 million people a day, the bus network is one of the largest in the world. Operating efficiency is a key aspect of the service, so Transport for London (TfL) is continuing to implement a variety of measures to help buses. These include the introduction new bus fleets, flat fare and automatic ticketing, bus lanes, red route designation, bus priority at traffic signals and a new automatic vehicle location (AVL) system for the bus fleet – iBus.

iBus is a GPS-based AVL system which supports real time passenger information, bus fleet management and bus priority at traffic signals amongst its applications. In this iBus based bus priority system, buses are detected at the bus detector locations configured in the on-bus computer (also known as "virtual detectors") to trigger priority. Depending on the situation at the junction, priority is then given to the detected bus by altering signal timings in its favour. In addition to flexible bus detection facility, iBus based bus priority also has a provision of real time bus location information of the buses at the centre. The flexibility of such virtual detectors and the availability of real time bus location information have now provided opportunity to enhance current priority facility with the provision of: (i) detection further upstream; (ii) 'cancel detection' near the stop-line to cancel priority once the bus has exited the junction; (iii) multiple detector combinations; and (iv) differential priority to give priority to the buses depending on their requirements

Among these opportunities, the focus of recent R&D has been in the area of 'Differential Priority' strategies, in terms of implementation methods and potential benefits. 'Differential Priority' is the strategy where buses are given different levels of priority according to their punctuality/regularity performance. These strategies seeking to improve punctuality/regularity of the buses enhance the current facility where priority is given to all detected buses without assessing their needs. The paper will describe the capability of iBus based bus priority for giving such priority and discuss the design considerations for different levels priority to be implemented. This will include the analysis of current lateness profiles of the buses based on field results collected automatically on a London bus route using iBus data. These profiles are very useful in deciding the lateness threshold to assign different priority levels to the buses. Finally, the paper will conclude with a discussion of other opportunities presented by the detailed second-by-second bus performance data recorded by iBus. Such detailed data has the potential for many further applications such as: performance monitoring, dwell time calculations and network state estimation, which could be valuable data for more general traffic management and control in London.

Keywords: *Differential priority, iBus, Bus priority*

05. Examining the impact of penetration rate on the performance of cooperative traffic management systems

Ben Waterson[1] and Simon Box

Transportation Research Group; University of Southampton; UK
[1]B.J.Waterson@soton.ac.uk

Abstract

While developments in in-vehicle technologies for cooperative traffic management have made it possible to receive detailed information from and pass information to individual vehicles, the uptake of such in-vehicle systems is typically slow (after a small 'new gadget' boost when they are first released). One consequence of this low initial 'penetration rate' is that there often fails to be the critical level necessary to achieve the full benefit from the cooperative systems. Individual travellers (on who the cost of implementation often falls) are then reluctant to adopt the new technology as the perceived benefits do not yet outweigh the costs and hence high penetration rates remain elusive. This presentation will therefore consider an example of a traffic signal control algorithm based on data from individual vehicles to illustrate the relationship between the penetration rate of equipped vehicles and the overall benefit of the system, and suggest that at low penetration rates additional benefit can be achieved by combining the cooperative systems with more traditional data sources rather than operating them in isolation.

06. Side Constrained Traffic Assignment Problem in Dense Urban Area

Tibye SAUMTALLY[1], Jean-Patrick LEBACQUE[2], Habib HAJ-SALEM[2]

[1] *Université Paris-Est, GRETIA, INRETS, 93166 Noisy le Grand, France Ph: +33 1 45 92 56 14*
[2]*INRETS, GRETIA, Le Descartes 2, 2 rue de la Butte Verte, 93166 Noisy le Grand, France*
tibye.saumtally@inrets.fr

Abstract

This paper proposes a survey of bidimensional modelling for traffic flows in a large and dense network of an urban area. This network is viewed as a continuum where each point is characterized with a cost of travel dependent on the local direction and a side constraint in privileged directions. A side constraint is a means to obtain a more precise description of traffic flow as far as it does not allow traffic flow to exceed the capacity of the roads.

The survey deals with a *multi-commodity* traffic assignment. We suppose that there are a few destinations for the customers in the area. All the customers are uniformly distributed in the area and try to get to their destination. The traffic flows from the area to the destinations are one *commodity*.

The equilibrium of traffic flows is given by the principles of Wardrop. We use a Lagrangian method to solve the problem.

Keywords: *Network flow, Continuum modelling, Side constraints, Traffic assignment, Lagrangian method*

07. Network flow, Continuum modelling, Side constraints, Traffic assignment, Lagrangian method

Thomas MONAMY[1], Jean-Patrick LEBACQUE, Habib HAJ-SALEM

[1]. Université Paris-Est, GRETIA, INRETS, 93166 Noisy Le Grand, France, Ph: +33145925613
[2]INRETS, GRETIA, Le Descartes2, 2 rue de la butte verte, 93166 Noisy Le Grand, France
monamy@inrets.fr

Abstract

The automobile traffic congestion annually generates an estimated cost of several million euros for such a urban area as a European capital. At the origin of this congestion, the capacity drop is a well-known phenomenon, but which has only been studied a few times various existing models of traffic because of its complexity. The capacity drop is related to the hysteresis of traffic: for a state of disturbed traffic, the return to the normal of the traffic is delayed when demand decreased.

This paper intends to present a few investigations on NGSIM database. The NGSIM database is constituted of several series of videos which are 10 frames per second recorded, provided with a record of the vehicle trajectories appearing on the videos. The datasets are recorded on 6 lane roads, the considered road sections all contain on and off ramps.

The main point of these investigations is to find clues or patterns of hysteresis phenomena on the records, and to compare them with the video observed phenomena to get closer to the capacity drop phenomena. Some observations about the data aggregation in space and time and the observed phenomena will be stated.

The target of this work is to understand better what happens when capacity drop occurs, in order to provide a good start for an accurate modelling of this phenomenon.

Keywords: *Congestion, Capacity drop, Trajectories, Aggregation, Videos*

08. Avoiding the under-utilisation of the shoulder lane using ITS measures

Victor L. Knoop[1], Christine Buisson[2], Bart van Arem[3]

[1]*Delft University of Technology & Laboratoire d'Ingénierie Circulation Transports (INRETS/ENTPE); Ph: +31 15 278 8413;* **v.l.knoop@tudelft.nl**

[2] *Laboratoire d'Ingénierie Circulation Transports (INRETS/ENTPE); Ph: +33 4 72047713;* **christine.buisson@entpe.fr**

[3]*Delft University of Technology; Ph: +31 15 278 86342;* **b.vanarem@tudelft.nl**

Abstract

The distribution of traffic over different lanes is an important factor in the traffic operations. Daganzo (2002) states that all drivers who want to go faster ("rabbits") use the median lane in case the speed there is higher than on the shoulder lane. Therefore, it is expected that up to the moment congestion sets in, the flow on the passing lanes is higher than on the shoulder lane. This study presents empirical evidence of this under-utilisation. Even if the traffic on shoulder lane is supposed to consist of trucks only, and taking a high passenger car equivalent for trucks of 2 (Highway Capacity Manual, 2000), at capacity the flow on the shoulder lane is still lower.

Apart from the behavioural theory of Daganzo, there are more reasons why the shoulder lane is under-utilised. Our study shows that drivers on the motorway will move out of the shoulder lane to enable the drivers on the slip lane to merge into the traffic stream. This is even a further under utilisation of the right lane, which might cause congestion on the main motorway.

There are possibilities to avoid the under-utilisation. One of them could be a dynamic speed limit. In fact, this speed limit causes the rabbits to "sluggishly" find themselves comfortable at driving at lower speeds, thereby moving into the under-utilised shoulder lane. This is one way in which under-utilisation of the right lane can be partially avoided. There are other ways as well, for instance using "traditional" ITS measures like a dynamic speed limits or overtaking prohibition, advising drivers to occupy all lanes equally. These can potentially completely avoid the under-utilisation there can be.

However, the full occupancy of the lanes, including the shoulder lane, could cause problems at merges and on-ramps. The same problem, a shoulder lane that is too occupied to have a smooth merging process, also arises in case of a truck overtaking prohibition and one slow vehicle. The trucks will than form one large platoon following this leader, hardly leaving any space for merging vehicles.

Cooperative ITS measures, contrary to the "traditional" ITS measures using communications with the vehicle to give in-vehicle advice, can provide the solution for smooth traffic operations even in case all lanes are used near capacity and provide solutions for merging situations. When vehicles are equipped with boxes that could give individual advice to drivers, it would be possible to advise individual drivers on the motorway to move out of the shoulder lane if needed for an individual merge. These advices can assist during lane changing manoeuvres, which are the main cause of stop-and-go waves [Ahn & Cassidy 2007]. An individual lane change advice can smooth the traffic flow. For instance, a merging driver can be advised on a particular gap that is best to merge into. With communicating vehicles, a driver can even be guided towards a gap that still has to be created. In case no appropriate gap is found, the driver of the merging vehicle can be advised to wait on the merging lane until a gap large enough appears. This way,

the individual advice takes over the role of ramp metering.

Summarising, this paper quantifies the lane usage and explores, qualitatively, the intervention possibilities of “traditional” and “co-operative” ITS measures in the lane choice process.

References

Daganzo, C. F. (2002). A behavioral theory of multi-lane traffic flow. Part I: Long homogeneous freeway sections, Transportation Research Part B: Methodological 36: 131 - 158.

Ahn, S. & Cassidy, M. (2007). Freeway Traffic Oscillations and Vehicle Lane-Change Maneuvers, Proceedings of the 17th International Symposium of Transportation and Traffic Theory, Elsevier, Amsterdam: 691-710.

Transportation Research Board, (2000). Highway Capacity Manual.

Acknowledgement

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Keywords: *Lane distribution, lane-changing, co-operative*

09. CONDUITS: Benchmarking urban traffic management

Ioannis Kaparias[1], Konstantinos Zavitsas[2], Michael Bell[3]

[1]*Imperial College London; Ph: +44 20 7594 5952;* ik00@imperial.ac.uk
[2]*Imperial College London; Ph: +44 20 7594 5952;* kz01@imperial.ac.uk
[3]*Imperial College London; Ph: +44 20 7594 6091;* mghbell@imperial.ac.uk

Abstract

Following on from a previous city comparison study in terms of traffic management technologies and policies, which formed the first step of an urban traffic management benchmarking exercise, the present study is concerned with collecting and analyzing detailed data and feedback from a number of European cities on a series of best practices in order to create an extended database on the traffic management policies and technologies implemented in Europe. Within the framework of the CONDUITS (Coordination of Network Descriptors in Urban Intelligent Transport Systems) project, a questionnaire was developed and distributed to the local authority organizations in traffic management systems and services of a number of European cities, so as to collect the data required. A few further cities outside Europe were also approached, so as to form the basis of a meaningful comparison between European and non-European cities. The questionnaire covered traffic-management-related topics, such as general statistics of the transport systems, organizational structures, monitoring and forecasting, provision of traffic information and urban traffic control. Special focus was given to demand management, traffic control centers, public transport and parking. Cities were also given the opportunity to describe in more detail a specific policy or technology that they wished to demonstrate, as well as to state any other aspect of their traffic management strategy not covered by the questionnaire. The questionnaire was eventually completed by 35 European cities in 16 countries, in addition to five further cities in Asia and South America. The results of the study are summarized and presented here, along with the next steps of the project, involving the definition and application of Key Performance Indicators for urban traffic management, as a framework for a robust benchmarking process.

Keywords: *Traffic management, Intelligent Transport Systems, benchmarking*

10.Multi-class traffic flow models: do they respect anisotropy?

Femke van Wageningen-Kessels[1], Bas van't Hof[2], Serge Hoogendoorn[3], Hans van Lint[4], Kees Vuik[5]

[1]*TUDelft, Faculty of Civil Engineering and Geo Science, The Netherlands; Ph: +31 15 27 84406;* f.l.m.vanwageningen-kessels@tudelft.nl

[2]*VORtech Computing, Delft, The Netherlands; Ph: +31 15 2511943;* bas@vortech.nl

[3]*TUDelft, Faculty of Civil Engineering and Geo Science, The Netherlands; Ph: +31 15 27 85475;* s.p.hoogendoorn@tudelft.nl

[4]*TUDelft, Faculty of Civil Engineering and Geo Science, The Netherlands; Ph: +31 15 27 85061;* j.w.c.vanlint@tudelft.nl

[5]*TUDelft, Faculty of Electrical Engineering, Computer Science and Mathematics, The Netherlands; Ph: +31 15 27 85530;* c.vuik@tudelft.nl

Abstract

Traffic flow models are used for many applications such as traffic state estimation and prediction. Recently, several multi-class extensions of these models have been introduced. Multi-class models take into account heterogeneity of both vehicles and drivers in many aspects such as vehicle length, (desired) vehicle speed, time headway, etc.

Traffic flow models are supposed to be hyperbolic and anisotropic. If the model is hyperbolic this means that disturbances travel at finite velocity. For example, if one vehicle suddenly brakes, this should only have an immediate influence on vehicles close to this vehicle; other vehicles might be influenced by it, but only after some time. If the model is anisotropic this furthermore means that disturbances do not travel faster than the vehicles themselves. That is: the model should reflect that drivers only react on vehicles in front of them, not on vehicles behind them. Clearly, both hyperbolicity and anisotropy are important properties of any realistic traffic flow model. Furthermore, a model can only be anisotropic if it is hyperbolic. However, only the most simple models have been analyzed on these properties and little or nothing is known about the properties of more advanced models such as the ones introduced by Ngoduy and Liu (Physica A, 385 (2) (2007): 667-682), Logghe and Immers (Transportation Research Part B, 42 (6) (2008) 523-541) and Van Lint et al. (Transportation Research Record (2008)).

We introduce a framework to analyze whether multi-class traffic flow models are hyperbolic and anisotropic. The framework is based on the Lagrangian formulation of a generic multi-class kinematic wave traffic flow model. The framework is applied to all such models known to the authors. It is concluded that most of them (but not all!) are hyperbolic and anisotropic under certain modeling conditions. The modeling conditions are related to the fundamental diagram (the speed should be a non-increasing function of the density) and to the passenger car equivalent (pce)-value. The pce-value reflects that long and/or slow vehicles, such as trucks, take more space than passenger cars. If these pce-values depend on the current traffic state (they are 'dynamic'), they should not increase 'too much' if the traffic density increases. We conclude that only models satisfying the conditions for hyperbolicity and anisotropy can represent real traffic and could be used for traffic state estimation and prediction.

Keywords: *Traffic flow models, multi-class, anisotropy*

11. CIM-Tr: Cooperative Information Management for Traffic Flow

Ersan OZTURK, Hasan SEVIM

Mobitech
İstanbul Technical University KOSGEB R&D Center
A blok No:26 Maslak Istanbul Turkey
ersan.ozturk@mobitech.com.tr , hasan.sevim@mobitech.com.tr

Abstract

CIM-Tr is the first application that is based on the project IMOGA1 [1] which suggested a novel architecture to address the issues of integrating mobile devices into a Grid applications and sharing and producing information in a cooperative manner. The developed client application running on mobile devices located in vehicles, such as the mobile phone of the driver, sends location and speed information to the server application in short time intervals via GPRS. The developed server application, which is preloaded with the road coordinates in Geographic Data Files (GDF) format, locates the street that the vehicle is moving along and the received speed information is recorded along with a timestamp. Display applications have also been implemented to calculate average of speeds at that very moment and post it on the Internet and WAP. When there is no actual data, i.e. there is no vehicle moving on a specific street, statistical data is utilised to produce such information. Thus foreseeing the traffic not only spatially but also in time is made possible. The client application running on the mobile device can exploit the information produced by the integrated system. It is planned to offer traffic information to navigation devices also via TMC interface assuming that they will gain GPRS communication ability soon. Although producing and sharing traffic information is the essential aim of the project it is also shown that additional features such as vehicle tracking, location based mobile marketing or even a systematic approach for traffic management can be done with CIM-Tr. These features will enable us to produce a triangular benefit system between contributors, GSM operators, application owners.

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12.National Automatic Toll Collection System Pilot in Poland

Gabriel Nowacki[1], Michał Niezgoda[2], Thomas Kallweit[3]

[1]*Motor Transport Institute; Warsaw, PL; Ph: +48228113231;* gabriel.nowacki@its.waw.pl
[2]*Motor Transport Institute; Warsaw; PL; Ph: +48228113231;* michal.niezgoda@its.waw.pl
[3]*FELA Management AG; Diessenhofen; CH; Ph: +41629618100;* thomas.kallweit@fela.ch

Abstract

The paper refers to some problems of European Electronic Tolling Service (EETS) implementation in Poland. The existing EETS systems in the European Union member states are not interoperable due to many differences. European Commission has taken bold steps to address that issue. The first one was Directive 2004/52/EC on the interoperability in the Community. The second was decision to launch Europe's own Galileo system. The third was EC decision from 6 October 2009 based on CESARE and RCI projects.

Motor Transport Institute has developed in the structure of the National Automatic Toll Collection System (NATCS) to cooperate with FELA Management AG and AutoGuard SA. NATCS consists of National Automatic Toll Collection Centre (NATCC), OBU and control subsystem. The control subsystem distinguishes between automatic enforcement through control gates, enforcement by mobile teams, and patrol teams.

NATCS system is based on a combination of mobile communications using the GSM-GPRS standard technology, the satellite-based global positioning system GPS and 5, 8 GHz microwave technology. An innovative element of NATCS is the On-Board Unit (OBU), which automatically calculates the amount of charge. OBU will be installed in vehicles windscreen and realized the following functions:

– Vehicles data storage.

– Digital map nodes and points storage.

– Toll charges calculation based on introduced data (admissible mass, No of axles, emission class, distance, tariff model).

– Analyze data coming from module and sensors (GPS, GSM, DSRC).

– Optical and sound signalization of working parameters on OBU display (for instance distance, fees, proper working).

– Safety data transmission to system and communication with control gates (stationary and mobile).

– Remote data actualization and parameters exchange.

– Data security based on cryptographic module.

– Additional DSRC module (5,8 GHz) to spread services and interoperability.

Keywords: *European Electronic Tolling Service (EETS) National Automatic Toll Collection System (NATCS), Dedicated Short Range Communication (DSRC), GPS/GSM based systems, microwave technology.*

13. Exploring the Effect of Variability of Urban Systems Characteristics in the Network Capacity

Boyacı Burak and Geroliminis Nikolas

Urban Transport Systems Laboratory, Ecole Polytechnique Fédérale de Lausanne
Nikolas.Geroliminis@epfl.ch

Abstract

Mobility and transportation are two of the leading indicators of economic growth of a society. As cities around the world grow rapidly and more people and modes compete for limited urban space to travel, there is an increasing need to understand how this space is used for transportation and how it can be managed to improve accessibility for everyone. Various theories have been proposed for the past 40 years to describe vehicular traffic movement in cities on an aggregate level. The first instance of a macroscopic fundamental diagram (MFD) showing an optimum car density was presented by Godfrey (1969). Earlier studies looked for macro-scale traffic patterns in data of lightly congested real-world networks (Godfrey 1969; Ardekani & Herman 1987; Olszewski et al. 1991) or in data from simulations with artificial routing rules and static demand (Mahmassani et al. 1987; William et al. 1987; Mahmassani & Peeta 1993). However, the data from all these studies were too sparse or not investigated deeply enough to demonstrate the existence of an invariant MFD for real urban networks.

Support for its existence has been given only very recently (Geroliminis & Daganzo 2007, 2008). These references showed that (1) the MFD is a property of the network itself (infrastructure and control) and not of the demand, i.e. the MFD should have a well-defined maximum and remain invariant when the demand changes both with the time-of-day and across days and (2) the space-mean flow is maximum for the same value of critical density of vehicles, independently of the origin-destination tables and (3) there is a robust linear relation between the neighborhood's average flow and its total outflow (rate vehicles reach their destinations).

However, to evaluate topological or control-related changes to the network (e.g., re-timing the traffic signals or allocating the percentage of streets devoted to public transit) one needs to know how the MFD is affected by these changes. To this end, Daganzo and Geroliminis (2008) explored the connection between network structure and a network's MFD for urban neighborhoods with cars controlled by traffic signals and derived an analytical theory for the MFD. This paper shows that a macroscopic fundamental diagram (MFD) relating average flow and average density must exist on any street with blocks of diverse widths and lengths, but no turns, even if all or some of the intersections are controlled by arbitrarily timed traffic signals. Exact analytical expressions in terms of a shortest path recipe are given, both, for the street's capacity and its MFD. Approximate formulas that require little data are also given. The MFD's produced with this method for the central business districts of San Francisco (California) and Yokohama (Japan) are very close with those obtained experimentally in Geroliminis and Daganzo (2007, 2008) . Information needed to estimate this network MFD's are average network (total length of roads in lane-km, number of lanes, length of links), control (signal offsets, green phase and cycle time) and traffic (free flow speed, congested wave speed, jam density, capacity) characteristics.

However in previous studies, Variational Theory has been applied only in cities with deterministic network, control and traffic characteristics. In our study we are aiming to generate an MFD for streets with variable link and green signal interval lengths and understand the effect of variability for different

cities and signal structures. Furthermore, this variability gives the opportunity to mimic the effect of turning movements and heterogeneity in driver's behavior. This will be a key issue in planning the signal regimes such a way that maximizes the network capacity and the range of this capacity at the same time.

14. Partitioning Urban Traffic Networks based on Spatial and Temporal Features of Congestion

Ji Yuxuan and Geroliminis Nikolas

Urban Transport Systems Laboratory, Ecole Polytechnique Fédérale de Lausanne
Nikolas.Geroliminis@epfl.ch

Abstract

In transportation, it is shown that a macroscopic fundamental diagram (MFD) linking space-mean flow, density and speed exists in some kinds of urban transportation networks under regularity conditions. An MFD is further well defined if the network is homogenous with similar links. However in reality, many urban transportation networks are heterogeneous with different levels of congested conditions. Therefore we are interested in studying whether MFD also exists in heterogeneous networks that can be partitioned into homogeneous components. In addition, based on the partitioning results with regions of different congestion levels, effective measures can be made to alleviate the conditions in highly congested areas, such as setting up new infrastructures or controlling signals. Thus, resources can be deployed more economically and effectively. The important thing we have been considering until now is the partitioning of the transportation networks based on its spatial and temporal congestion conditions. There is a vast literature studying clustering algorithms such as k-means, hierarchical clustering and graph-based approach. Clustering algorithms are being broadly used in diverse fields such as in data mining, image segmentation and information retrieval fields. However the transportation network has some unique features and partitioning criteria. For example, we are aiming to partition the network based on both spatial and vehicle density information of links and it makes more sense to denote the spatial distance by the shortest routing length between two links, instead of their Euclidean distance. Based on field knowledge, we do not prefer very small regions that contain only few links but clusters to be near compact and not have weird shapes. These criteria imply that we hope to capture the main traffic components, ignoring the small regions of the networks. In our current work, we apply an instance of the Normalized Cut algorithm in graph partitioning as an initial clustering and make further refinement of the clustering result based on our criteria for a well-defined MFD.

15. Macroscopic characteristics in stationary state of a Markovian jump process modelling a traffic flow

Sylvain Lassarre[1], Michel Roussignol[2], Antoine Tordeux[1,2,*]

[1]*INRETS-GRETIA, Le Descartes II, 2 rue de la Butte Verte, 93166 Noisy le Grand, France*
[2]*Univ. Paris-Est, LAMA, UMR-CNRS 8050, 5 bd Descartes, 77454 Marne-la-Vallée, France*
[*]*Ph: +33 145 925 500;* **antoine.tordeux@gmail.com**

Abstract

Markovian jump processes represent an alternative to the modeling of traffic flow by differential equations systems. For instance, the zero-range process can be used to produce a microscopic traffic flow model, for which the speed of each vehicle is a function of the distance gap ([1]). The invariant asymptotic distributions of the process are known both on a finite ([2]) and infinite ([3]) space. We present an analytical exploration of the properties of this model in a stationary state. The aim is to highlight the links between the microscopic parameter form and the macroscopic performances of the flow. Two approaches are compared: an approach in finite space and an approach in infinite space. The formulas defining the macroscopic performance indicators, like the flow-density diagram, are exactly calculated but are hard to interpret. We show that, in the limit case where the spatial step tends towards zero, explicit formulas exist, of which an interpretation is advanced. The distributions of vehicles speed and gap are unimodal. The model does not produce some kinematic wave in a stationary state. A parameter of reaction time is introduced by delaying the distance gap variable. When the reaction time is strictly positive, the stochastic process defining the model is not a zero-range process. The invariant state of the system is unknown. We observe by simulation (see a figure below) that the reaction time can engender waves and a bimodal distribution of vehicles speed and gap in stationary state like in microscopic car-following models by delay-differential equations systems.

Keywords: *traffic flow – Markovian jump process – zero-range model – stationary state – reaction time – kinematic wave*

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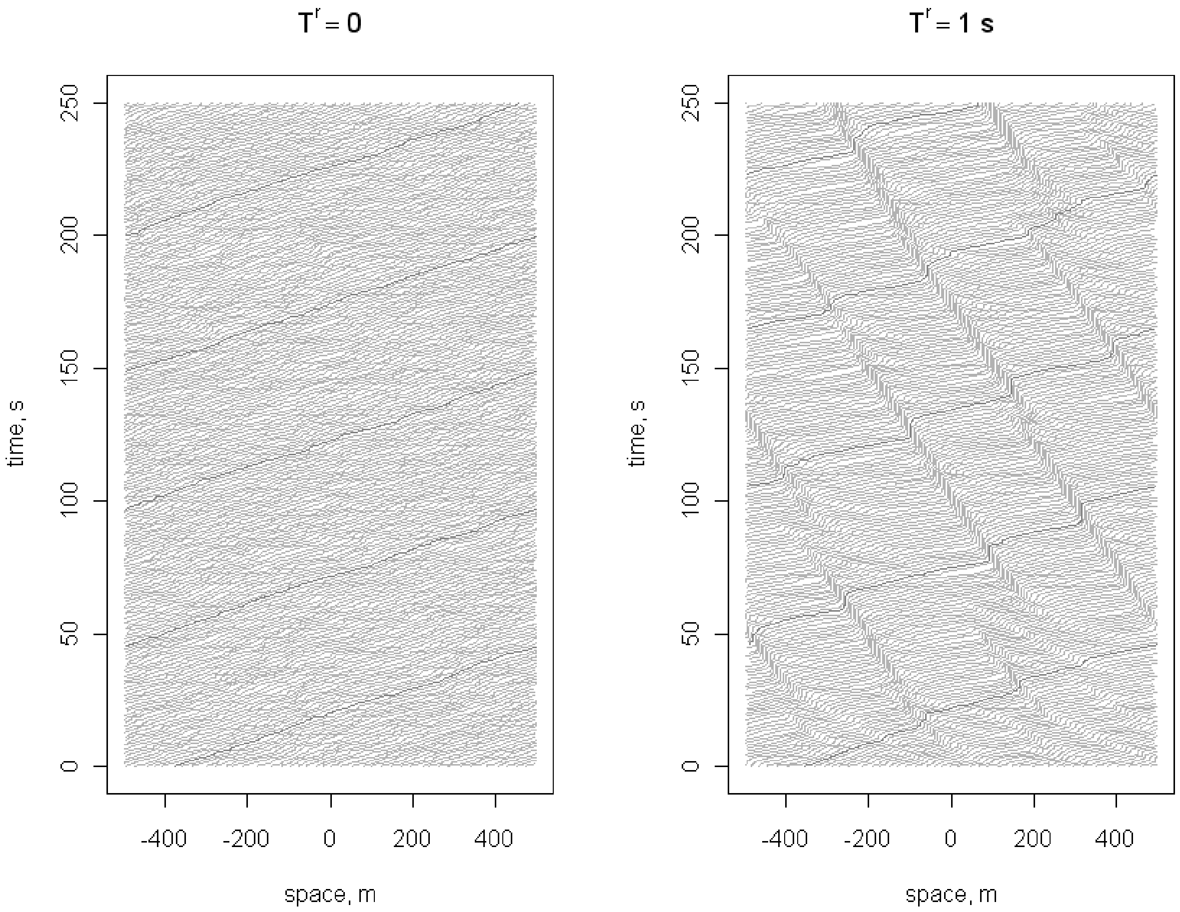

Figure: Illustrative examples of 41 vehicles trajectories on a ring produced by the microscopic stochastic Markovian jump process with, at left, a reaction time nil and, at right, a reaction time equal to 1 second. Random initial conditions.

16. Investigating Ecological Impacts on selected Traffic Management Methods

Daniel Krajzewicz

[1] *Institute of Transportation System, German Aerospace Center; Ph: +49 30 67055 273*
Daniel.Krajzewicz@dlr.de

Abstract

Within the iTETRIS project [1, 2], the used SUMO traffic simulation [3, 4] was extended by models for computing the emissions of pollutants CO, CO2, HC, PM_x, and NO_x, as well as for computing the fuel consumption on a microscopic, per-vehicle, base. The emission model was based on the HBEFA ("Handbuch der Emissionsfaktoren") [5] database which covers a large variety of vehicle types, considering differences between passenger and heavy duty vehicles, the engine displacement, the fuel type, and the EURO emission norm of the vehicles. This database was reformulated into a microscopic model which uses the vehicle class, the vehicle's speed and the vehicle's acceleration for computing the amount of a certain pollutant's emission within one discrete time step [6]. The kind of this model's embedding within SUMO allows to collect and to evaluate the ecological impacts of traffic management strategies on per-vehicle, per-lane, and per-road base. Using this information, two sub-topics of traffic management were addressed: ecological routing and the ecological impacts of traffic lights. In the following, the results of these investigations will be presented.

Ecological routing, trying to find routes through a network which reduce the emission of a certain pollutant, is raising in interest in the recent time. The investigations described herein are trying to answer the questions whether ecological routing is possible at all, how the differences to conventional, travel-time based, routing are shaped and which benefits one could expect when trying to minimize a certain pollutant's emission. To evaluate these questions, a microscopic traffic assignment using the Gawron approach [7] was performed for a scenario which covers the traffic within the inner city ring of the city of Bologna. Besides travel times, further assignment runs were done where the available pollutants (see above) were used as weights for the road network's edges. The preliminary results show that a) an assignment against other measures than travel time is possible – vehicles are spread over the complete network and the resulting route sets yield in reasonable traffic, avoiding jams; b) during the assignment, the route set is optimized against the respective measure in most cases, yielding in a route set with the lowest emission of PM_x if PM_x is used as measure, for example; c) the optimization against a measure reduces the amount of a certain pollutant by up to 10%. It should be stated, that at the current state of the investigations, the last statement (c) is relatively vague. Further runs using different scenarios, and probably differing between different network densities should be done for verifying it.

The second set of investigations dealt with measuring the ecological impacts of traffic lights. For investigating the relationships between the vehicular pollutant emissions and conventional measures, an abstract scenario was used made of a single intersection and only one flow. The intersection was set to be controlled by a traffic light with an overall duration of 180s. The amount of green time for the modeled flow was varied between 170s and 10s within subsequent simulation runs and both conventional – delay time, waiting time, queue length – and pollutant emission measures were collected. By putting the obtained results against each other, an almost linear relationship between the "delay time" and the amount of emitted pollutants was observed. This observation is assumed to be relevant, because such a relationship allows the optimization of traffic lights against a single measure – the delay time – instead of the need to incorporate a set of measure to optimize against.

Keywords: *traffic management, ecological issues, navigation, traffic lights*

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17.ARGOS Navigation Filter

Karsten Kozempel[1], Ralf Reulke[2]

[1]*German Aerospace Center; Ph: +493067055466;* karsten.kozempel@dlr.de
[2]*German Aerospace Center; Ph: +493067055518;* ralf.reulke@dlr.de

Abstract

The following paper shows an approach to measure orientation data of sensors during an airplane flight for traffic data acquisition. This orientation data is necessary for georegistration of any taken aerial images and extracted features. Since an inertial measurement unit is a very costly component, alternative methods for orientation determination should be considered. In this paper we present an approach achieving this only by using a GPS position and a database of the road network around. To adjust the rotation angles a simplex optimization algorithm is used and the measurement will be supported by additionally achieving relative orientation information between adjacent images. A Kalman filter is used to estimate the optimal result from the two complementing values.

The absolute orientation approach yields convergence rates of more than 96 percent while the relative orientation discards outliers. The whole process yields a rotation error of around 0.14 degrees, which is sufficient for traffic surveillance purpose.

Keywords: *Optical navigation, kalman filtering, inertial measurement, road extraction*

18.Calibration of microscopic traffic simulation models by acceleration or by trajectory (Run it!)

Wagner, Peter[1]; Nippold, Ronald[2]; Toledo, Tomer[3]

[1]*Institute of Transportation Systems, German Aerospace Centre, Berlin, Germany; Ph: +49 30 67055-237;* Peter.Wagner@dlr.de
2*Institute of Transportation Systems, German Aerospace Centre, Berlin, Germany; Ph: +49 30 67055-263;*
Ronald.Nippold@dlr.de
3*Faculty of Civil and Environmental Engineering, Technion - Israel Institute of Technology, Haifa, Israel; Ph: +972 4 829-3080;*
toledo@technion.ac.il

Abstract

Microscopic car-following models for traffic simulations are believed to model an underlying reality. Reality unveils itself e.g. by measurements of a vehicle's speed $v(t)$, the net distance to the leading vehicle $g(t)$ and its acceleration a(t) in reaction to the behaviour of the vehicle in front. This leading vehicle is commonly described by its position $X(t)$ and speed $V(t)$. Additionally to these dynamics a given model depends on a set of time-independent model parameters p_i and a yet to be described stochastic process ξ producing acceleration noise with an amplitude of D. Hence, a car-following model can be described with the following equation: $a = F(g, v, V, p_i) + D\xi$.

The art of calibration consists in a suitable method for computing the set of the parameters p_i, that describe best a certain realization (measurement) defined by an empirical time-series $\{g'(t), v'(t), a'(t)\}$ under the boundary condition of the lead vehicle's speed time-series $V'(t)$ and given initial conditions $\{g(0)=g'(0), v(0)=v'(0), a(0)=a'(0)\}$.

In calibrating microscopic traffic flow models two different strategies have been followed so far. In the first approach, the data are used to fit the model function $F()$ directly. Therefore, this approach is called “direct” or “local” fit in the following. In detail, this means e.g. to maximize a following likelihood function: $E(\text{lf}) = \Sigma \log L(a(\text{lf})\ (g', v', V') - a_i')$. The likelihood function chosen here is the Laplace distribution, the difference $\Delta a = a_i(\text{lf}) - a_i'$ seems to be distributed according to $L \propto \exp(-|\Delta a|/\sigma)$, where σ is the shape parameter of the Laplace distribution. This approach is used in a width range of literature.
In the second approach, first a simulation is run which solves the differential equation of the car-following model under the initial boundary condition state above, and with the boundary condition in time set by the lead vehicle, and according to a given set of parameters p_i.

If this is done with a simple Euler forward scheme, the following equations have to be solved first (with Δt the time-step size of the Euler scheme): $v(t+\Delta t) = v(t) + \Delta t\ F(g, v, V, p_i) + \text{sqrt}(\Delta t\ D\xi)$ and $g(t+\Delta t) = \Delta t/2\ (V(t) + V(t+\Delta t) - v(t) - v(t+\Delta t)$

Here, the last equation is needed, because the dynamical variable $g(t)$ has to be computed from the change of the coordinates of the lead and following vehicle. Then, the trajectory created in this way is compared to the empirical data (therefore the name trajectory fit): $E(\text{tf}) = \Sigma \log L(a(\text{tf})\ (g(\text{tf})(t), v(\text{tf})(t), V') - a_i')$. Note, that in the case of a trajectory, the error function could also contain the speeds v or the headways g which are usually more sensitive to errors in the models. To ensure the comparison between the two approaches, only the accelerations a have been used here.

In theory, these two approaches should be equivalent. However, in the examples tested for this paper this is not necessarily the case. The final results are not so easy to explain. It seems that the determination of the trajectory contains more information than what is contained in the acceleration function alone. However, this has definitely to be explored into more detail.

Keywords: *microscopic traffic simulation, car-following behaviour, model calibration*

19. Potentials and Deficits of a recent Approach for urban Traffic Monitoring based on Floating Car Data

Thorsten Neumann

Institute of Transportation System,; German Aerospace Center (DLR); Ph: +49 (0)30 67055-208
thorsten.neumann@dlr.de

Abstract

Recently, the author proposed a new approach how to take advantage of common floating car data in context of urban traffic monitoring (cf. Neumann, 2009: Efficient queue length detection at traffic signals using probe vehicle data and data fusion, 16th ITS World Congress, Stockholm). Treading an innovative path concerning the processing of observed vehicle positions, it provides a promising method for estimating queue lengths at signalized intersections.

Moreover, the conceptual ideas of the approach are not even limited to this very special case as has been discussed shortly in former publications. In principle, unsignalized intersections and/or other traffic state variables can be considered as well. Previous presentations and articles, however, always focused on the algorithmic aspects of the new technique and on the quality of results. In contrast to that, this contribution takes up the practitioner's perspective and examines the wide range of possible applications of current and future versions of the proposed ideas.

After a short review about the basic concepts and after summarizing the corresponding main results from former studies, the paper discusses capabilities and limitations of the new approach and shows how these are influenced by several constraints such as the available number of floating cars and/or suboptimal model parameters.

Based on that, typical applications in traffic planning and control are identified which might benefit from enhanced versions of the described method. Conceivable fields are traffic signal control, traffic assignment and simulation, quality management or dynamic routing, for instance.

Moreover, the new approach theoretically allows for the incorporation of arbitrary supporting traffic information. That is, additional detector data as well as the results of other complex traffic monitoring systems can be integrated efficiently into the framework of the proposed method to improve the overall quality of urban traffic state estimation. Particularly, existing systems have not necessarily to be replaced but can be used further on in a bigger context.

Finally, future cooperative systems (C2X) will probably provide the facility of enabling also private cars for traffic monitoring to a large extent in sense of continuously sampling their positions in the road network, for instance. Hence, if implemented in a suitable way, such data were not only capable of being integrated into the described algorithms as supporting information (using a standardized data fusion interface) but would comprehensively complement the new method's basic data source itself. In doing so, the most crucial drawback of common floating car systems, i.e. low penetration rates, were simply overcome. Notably, possibly uprising privacy concerns in politics and society are easily rejected at the same time as the proposed method gets along completely without any kind of vehicle identification or vehicle tracking. That is, a major hurdle when talking about observing individual cars in traffic does not apply in this case.

Keywords: *Floating Car Data; Urban Traffic Monitoring; Traffic Planning & Control; Cooperative Systems*

20. Towards a dynamic system optimum based on vehicular data obtained by microscopic simulation

Yun-Pang Wang[1], Peter Wagner[2], Michael Behrisch[3]

[1]*Institute of Transportation Systems, German Aerospace Center (DLR); Ph: +49 3067055213;* yun-pang.wang@dlr.de
[2]*Institute of Transportation Systems, German Aerospace Center (DLR); Ph: +49 3067055237;* peter.wagner@dlr.de
[3]*Institute of Transportation Systems, German Aerospace Center (DLR); Ph: +49 3067055210;* michael.behrisch@dlr.de

Abstract

Microscopic traffic simulation has been applied since decades. It is a widely accepted fact that it can be necessary to consider individual travelers to better describe both drivers' behaviors and interactive effects among network infrastructure, drivers and traffic control applications. Furthermore, it is also used as an evaluation tool for analyzing influences of proposed management strategies and traffic-related telematics technologies on network performances, such as efficiency and safety. Achieving a system optimum in a road network is the main concern of traffic managers at all times, although most road users tend to choose a route which is best suitable for their journeys in practice. The main difference between system optimum and user equilibrium is the marginal total travel costs, which are the costs that an additional road user causes to the other road users already travelling in the network during the analysis period (usually expressed as an extra travel time cost).

Generally, travel times can be determined, i.e. approximated, by given link travel time functions, which are functions of link flows. The functional forms and respective parameters of the most travel time functions are derived from empirical data. This approach has been extensively applied in the macroscopic traffic modeling and the dynamic traffic assignment modeling. Therefore, respective marginal costs can be obtained by calculating the corresponding derivatives. However, such travel time functions and their derivates are not required and also not applied in a microscopic simulation, since travel times, travel flows and other parameters can be directly measured in a simulation. In this study we investigated how to define and calculate marginal costs towards a system optimum as well as how to compute link travel times during different flow rates. This is achieved with use of simulated vehicular data, in which travel time information is aggregated at link level. For this purpose, the open source simulation package SUMO, Simulation of Urban MObility, is applied in this study.

Keywords: *system optimum, microscopic simulation, SUMO*

21.Integrating the weather effects on traffic : empirical analyses, mathematical modeling and simulation

Romain Billot ([1, 2]) Florian de Vuyst [2], Nour-Eddin El Faouzi [1]

[1] *Transport and Traffic Engineering Laboratory (LICIT), INRETS-ENTPE 69675 Bron Cedex, France;*
[2] *Applied Mathematics Laboratory (MAS), Ecole Centrale Paris,92295 Châtenay-Malabry – France*
romain.billot@inrets.fr , elfaouzi@inrets.fr

Abstract

In this work, a traffic modeling approach is introduced in order to integrate the weather impact into a mesoscopic kinetic model. From empirical investigations, the weather impact on traffic at several levels is assessed, enabling different kinds of distribution modeling (parameterization of the fundamental diagram, weather-dependent time headway distribution). Then, these equilibrium distributions act as source terms into multiple-equation models. The global framework is a Vlasov-Fokker-Planck kinetic equation from which macroscopic equations can be derived. The numerical discretization in both Lagrangian and Eulerian approaches as well as the properties of the model enable a satisfactory representation of the traffic dynamics, highlighting the significant changes in the model behavior faced with various weather conditions. The results pave the way for developing a weather-responsive traffic management.

Keywords: *traffic modeling, weather, vlasov, time headways.*

22. Adaptive traffic signal control using vehicles' delay times

Robert Oertel[1]

[1]*Institute of Transportation Systems, German Aerospace Center (DLR) Berlin, Germany*
robert.oertel@dlr.de

Abstract

The quality of traffic within a signalized road network is mainly based on an efficient allocation of available green times. At an isolated intersection this task can usually be realized with two different controlling schemes: Either with a fixed time or with a conventional vehicle actuated control. The fixed time control has no information about the current traffic conditions and uses predefined green times, which are adapted towards an average number of arriving vehicles within a cycle. If there is any stochastic variation of this mean value, the fixed time control has no possibility to react. In this case of changing demand patterns a vehicle actuated control performs better. It uses inductive loops to gather the time gaps between arriving vehicles and does not terminate the green phase until a queue on an approach is completely dissolved. This moment of the phase switch is characterized by the shift from constantly small to randomly distributed time gaps and corresponds with the reduction of delay times, accumulated during a previous red phase, to zero. Due to this device the average travel time per vehicle can be decreased in comparison to the fixed time control.

This effective adaptive approach can also be applied to the state-of-the-art detection equipment like FCD, C2I and traffic cameras. The idea is to collect and process vehicles' delay times directly instead of measuring time gaps. That new delay based control acts as already described: As soon as the accumulated delay on an approach is minimized to zero, the running green phase is terminated. With this new approach high priced inductive loops are becoming needless, while at the same time the reliability of the traffic signal increases.

To evaluate which basic conditions are necessary to make this new device successfully work, a simulation study was done. A simple intersection, consisting of two crossing one-way roads, was modeled and various scenarios with flexible demand patterns and variable degrees of equipped and ascertainable vehicles were tested. The performance indicator was the average delay time per vehicle, the reference control schemes were an optimized fixed time control, based on the Webster equation, and an adaptive control, actuated by time gaps. To handle the special case of FCD and C2I penetration rates close to zero in an appropriate manner, the described approach had been enhanced. As a result, the delay time from one out of ten vehicles needs to be known to the traffic signal controller to achieve the same performance like the optimized fixed time control. Only one out of three vehicles' delay times needs to be detected to outperform the time gap actuated control.

After these promising but simulation-based results, the next step will be the further characterization of the aforementioned results in a more complex simulation study and finally in a real-life application, where the theoretical results can be consolidated. If this next step turns out to be successful, another vehicle actuated control scheme gets available, which has the promise to work with a low degree of infrastructure investment and provides congestion relief.

Keywords: *signal control, delay times, FCD, C2I*

23. Changing variance of journey times with varying arrival and service rates

JD (Puff) Addison

Centre for Transport Studies, University College London,
puff@transport.ucl.ac.uk

Abstract

With the increased interest in supplying traveller information has come increase interest in accurate journey time estimation. This is in turn has lead to an interest in journey time variability. One of the observed phenomena is that after an incident or other source of delay is that the variance of journey times continues to increase for a time after the mean journey time starts to return to its long term value. This can be understood in terms of non equilibrium queueing theory.

The solution for the non-equilibrium M/M/1 queue with constant mean arrival and service rates is well known. Less well known is the (partial) solution for time varying arrival and service rates. This presentation will outline this solution. In addition we will present some results of analysis and simulations using M/M/1 and other queues such as M/D/1 and chains of queues.

24. A Macroscopic Tool for Arterial Traffic Analysis[2]

Andy H. F. Chow

Centre for Transport Studies, University College London, UK
andy@transport.ucl.ac.uk

Abstract

There are various ways to analyze urban arterial traffic, with widely varying levels of detail. On the coarser end of the spectrum are the steady-state formulas (e.g. Highway Capacity Manual, 2000). These formulas estimate the average system performance based on mean traffic conditions. The major disadvantage of such approach is the inability to capture traffic dynamics and other temporal effects such as coordination. On the other side of the granularity spectrum are the micro-simulation models. These models apply certain predefined rules to reproduce the trajectories of individual vehicles in the traffic environment. In principle, micro-simulation can capture fine detail of a real world system. However, calibrating and running such model can be expensive in terms of computational and human resources. Considering the drawbacks of steady-state formulas and micro-simulation, macroscopic approaches have been proposed in the literature for analyzing arterial traffic. Nevertheless, most of these studies were only limited to small networks with few admissible traffic movements, and hence there is a lack of implication on practical applications.

This presentation introduces a practical macroscopic tool to analyse urban arterial traffic. The tool is called Aurora Road Network Model (Aurora RNM), which is developed under the TOPL (Tools for Operational Planning) project at University of California – Berkeley. TOPL is proposed as a set of software programs to facilitate the construction, calibration, maintenance, with the use of macroscopic models of vehicular traffic systems (see Kurzhanskiy, 2007). Aurora-RNM is a graphical traffic simulation environment which implements a modified version of Daganzo's cell transmission model (CTM) (Daganzo, 1994). Aurora-RNM is designed as a link-node based adaptation of the cell-transmission model. In addition to links and nodes, each designated intersection can also contain a signal controller, which regulates the flow of traffic through the intersection. Following the NEMA standard in the United States, each controller can coordinate up to 8 signal phases, that is, 8 independent stream of traffic that traverse the node.

A 0.9 mile long road section in the city of Albany, CA, is first used to test the performance of the Aurora arterial model. Given the pre-timed signal timing plan, wireless sensors were installed at several intersections along the road. Information including demand profile, free flow speeds, intersection discharge rates, and travel time profiles were derived. Results showed that the difference between the travel time estimates by the sensor measurements and Aurora RNM simulation was less than 3%. This suggests that Aurora RNM could represent the actual traffic reasonably well. To further demonstrate the applicability of Aurora RNM for large scale applications, another 17-mile long arterial in San Francisco Bay Area is selected to test its performance. Results show that Aurora RNM can represent the actual traffic phenomena including cycle failure and spill-over of queues. Following the traffic simulation result, various measures of effectiveness are calculated which include delays, green utilizations (under

[2] It is a joint work with Gabriel Gomes, Alex Kurzhanskiy, Dongyan Su, and Pravin Varaiya while the author was a postdoctoral researcher at Institute of Transportation Studies, University of California – Berkeley through the California PATH program.

oversaturation), queue lengths, vehicle trajectories, travel time distributions, and band-widths of progression. This research contributes to the area of arterial traffic management as our proposed macroscopic model will have several advantages – increases simulation speeds, automates calibration, etc. – over the widely used microscopic models in practice.

References

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25. A simulation framework for the evaluation of pedestrian data collection methods

Mamy Fetiarison

Swiss Federal University of Technology, TRANSP-OR, Lausanne 1018, Switzerland
mamynirina.fetiarison@epfl.ch

Abstract

The design and development of pedestrian walking models is an arduous task that requires detailed and appropriate data for model estimation and validation. A new methodology is proposed to analyze the walking behavior of pedestrians with substantially lower data requirements. To that aim, a simulator serves as pedestrian data generator. This has two advantages. First, established models of walking behavior can be used as a "synthetic reality" from which new experimental models can be estimated prior to a real-world data collection campaign. Second, the design of pedestrian experiments can be evaluated by experimentation.

The laboratory is built around the generic pedestrian simulator, which provides two major interfaces: The first interface links a pedestrian simulation model to the simulator that is used to generate synthetic reality. The second interface extracts data from the synthetic reality that is gathered by (equally simulated) sensors. This data is what would be costly to collect in a real experiment, but in a synthetic environment it is available in abundant amounts and at arbitrary quality. Beyond these two major interfaces, the simulation system provides facilities for the specification of different scenarios. This includes the description of the physical environment, pedestrian characteristics, and the pedestrians plans (intentions).

The capabilities of a first prototype of the simulation framework are demonstrated for the following application: The positions and velocities of a proportion of pedestrians population entering into a bottleneck are collected at predetermined intervals, thus simulating the acquisition of GPS data (eg from smartphones) or cameras following some pedestrians. Analyses are primarily designed to determine the proportion of individuals to track to meet various criteria in order to obtain satisfactory density measurements. These criteria are framed in terms of cost minimization such as the GPS tracking equipment cost or the number of pedestrians involved in the experiment.