10121 Abstracts Collection
Computational Transportation Science
— Dagstuhl Seminar —

Glenn Geers[1], Monika Sester[2], Stephan Winter[3] and Ouri E. Wolfson[4]

[1] National ICT Australia - Kensington, AU
Glenn.Geers@nicta.com.au
[2] Leibniz Universität Hannover, DE
monika.sester@ikg.uni-hannover.de
[3] The University of Melbourne, AU
winter@unimelb.edu.au
[4] Univ. of Illinois - Chicago, US
wolfson@cs.uic.edu

Abstract. From 21.03. to 26.03.2010, the Dagstuhl Seminar 10121 "Computational Transportation Science " was held in Schloss Dagstuhl – Leibniz Center for Informatics. During the seminar, several participants presented their current research, and ongoing work and open problems were discussed. Abstracts of the presentations given during the seminar as well as abstracts of seminar results and ideas are put together in this paper. The first section describes the seminar topics and goals in general. Links to extended abstracts or full papers are provided, if available.

Keywords. Computational Transportation Science

10121 Report – Towards a Computational Transportation Science

In the near future, vehicles, travelers, and the infrastructure will collectively have billions of sensors that can communicate with each other. This environment will enable numerous novel applications and order of magnitude improvements in the performance of existing applications. However, information technology (IT) has not had the dramatic impact on day-to-day transportation that it has had on other domains such as business and science. In terms of the real-time information available to most travelers, with the exception of car navigation systems, the transportation experience has not changed much in the last 30-40 years. During this same time, the miniaturization of computing devices and advances in wireless communication and sensor technology have been propagating computing from the stationary desktop to the mobile outdoors, and making it ubiquitous. Future transportation systems, due to their distributed/mobile nature, can become the ultimate test-bed for this ubiquitous (i.e., embedded, highly-distributed, and sensor-laden) computing environment of unprecedented scale.

Dagstuhl Seminar Proceedings 10121
Computational Transportation Science
http://drops.dagstuhl.de/opus/volltexte/2010/2723

Information technology is the foundation for implementing new transportation control and management strategies, particularly if they are to be made available in real-time to wireless devices such as cell phones and PDAs, traffic lights or dynamic signs. A related development is the emergence of increasingly more sophisticated geospatial (including spatiotemporal) information management capabilities.

Keywords: Computational Transportation Science

Joint work of: Geers, Glenn; Sester, Monika; Winter, Stephan; Wolfson, Ouri

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2722

The Map in CT*

Claus Brenner (Leibniz Universität Hannover, DE)

In this talk, an experiment regarding a special map is presented. In the first step, using LiDAR, a map of (georeferenced) 'poles' (linear upright features, such as signposts, traffic lights and trees) is derived for a larger city scene. In the second step, this map ist used to localize a robotic vehicle. As is shown, the method can improve over GPS positioning. Furthermore, it is independent of GPS positioning, which will be necessary for future autonomous systems (required to feature several independent positioning methods).

The general message of this talk is:

- (a) Future maps, as required in CTS, may be dramatically different from our current notion of (general purpose) maps, and will be typically designed to meet a very specific purpose,
- (b) Maps will not be static and should be in a process of permanent update. Mapping will not only use specialized mapping devices, but the trajectories and sensor data of the users themselves,
- (c) The roles of CTS could be: (1) to provide the necessary computational infrastructure, (2) to address safety and reliability, which are far from truly 'autonomous' systems nowadays, and (3) to support the transition from 'database' systems to (permanently updating) 'data stream' systems.

Keywords: LiDAR, Laser Scanning, SLAM, Landmarks

Traffic State & Queue Length Estimation

Claudia Dittrich (TU München, DE)

I present ideas for queue length estimation at a signalized intersection. The application context, in which it will be used, is the optimal speed advisory, developed by Audi within the project Travolution.

Some Research Qustions for Computational Transportation Science

Glenn Geers (NICTA - Kensington, AU)

I wrote this a couple of years ago and presented it at the First Workshop on CTS in Dublin.

I'm uploading it as a conversation starter.

Keywords: CTS

Full Paper:
http://www.nicta.com.au/research/research_publications/show?id=985

See also: @inproceedings1594981, author = Geers, D. Glenn, title = Some research questions for computational transportation science, booktitle = Mobiquitous '08: Proceedings of the 5th Annual International Conference on Mobile and Ubiquitous Systems, year = 2008, isbn = 978-963-9799-27-1, pages = 1–5, location = Dublin, Ireland, doi = http://dx.doi.org/10.4108/ICST.MOBIQUITOUS2008.3830, publisher = ICST (Institute for Computer Sciences, Social-Informatics and Telecommunications Engineering), address = ICST, Brussels, Belgium, Belgium,

Analysis of dynamic traffic equilibrium with departure time choice

Benjamin Heydecker (University College London, GB)

We present and analyse a model of the combined choice of departure time and route in a congested road network. Using the property of equilibrium solutions that for each origin-destination pair the total cost associated with travel is identical for all travellers, we establish a general result that relates assignments to various components of cost. The analysis is developed to include time-varying tolls and to establish a formula that will induce any specified inflow profile as an equilibrium. We introduce an iteration operator to calculate equilibrium inflow profiles, and present the results of example calculations for a range of test problems

Keywords: Dynamic traffic assignment; departure time choice; equilibrium assignment; network analysis

Joint work of: Heydecker, Benjamin; Addison, Puff

Analysing abundant data

Benjamin Heydecker (University College London, GB)

With streams of abundant data becoming available, we need new approaches to management and processing.

This presentation shows how statistical methodology can be applied to filter and model both the systematic and the stochastic parts of such data. It concludes with a prospective view of statistical modelling that might be used in CTS

Keywords: Statistics, data, abundant, arima, starima, hglm, glm

Dynamic equilibrium network design

Benjamin Heydecker (University College London, GB)

Optimal design of a transport network subject to dynamic equilibrium traveller response to changes. This is a non-convex optimisation problem because the equilibrium behaviour is expressed as a non-linear equality constraint.

This formulation builds on earlier work on:
dynamic travel equilibrium
equilibrium constrained network design

Keywords: Equilibrium network design, dynamic traffic assignment; network analysis

See also: HEYDECKER, BG (2002) Dynamic equilibrium network design. In: Transportation and Traffic Theory in the 21st Century (ed MAP Taylor). Oxford: Pergamon. ISBN: 0-08-043926-8, 349-70.

Mobility, Data Mining and Privacy

Bart Kuijpers (Hasselt University - Diepenbeek, BE)

We present the FET-Open project MODAP (Mobility, Data Mining and Privacy) which is a follow-up project of another FET research project GeoPKDD (Geographic Privacy-aware Knowledge Discovery and Delivery).

Keywords: Mobility, Data Mining, Privacy

Decentralized Spatio-temporal Data Mining in CTS?

Patrick Laube (Universität Zürich, CH)

Urban mobility is captured in the movement trajectories of people walking, driving their cars and riding public transport. For designing and optimizing a intelligent transportation systems, precise knowledge about urban mobility is required. Mobility pattern mining is an efficient CTS means for deriving high-level mobility process knowledge from low-level trajectory data. In recent years geographical data mining community has seen a growing interest in formalizing generic movement patterns and then developing algorithms for their efficient detection.

Most recently, the concept of mobility pattern mining was ported into wireless sensor networks and decentralized spatial computing. This talk exemplified how mobile autonomous agents only sensing their local environment learn through collaboration about the presence or absence of larger scale movement patterns they could not perceive on their own. The presented solution requires an intrinsic temporal deferral for pattern mining, as sensor nodes must be enabled to collect, memorize, exchange, and integrate their own and their neighbors' most current movement history before reasoning about patterns ("information grazing"). The talk makes a strong case for decentralized mobility pattern mining in CTS for reasons of scalability, privacy, ad-hoc processing.

Full Paper:
http://www.geo.unizh.ch/~plaube/

Transparent transportation and mirror worlds

Harvey J. Miller (University of Utah, US)

Our current transportation systems are unsustainable. In many places, we have evolved a transportation monoculture that forces people to adapt to the system rather than a system that adapts to them. A transportation system should be transparent: flexible, responsive and user-friendly such that that it requires less attention than the activities and processes it facilitates. A transparent transportation system allows the user to think primarily in terms of where they want to go and peripherally in terms of how they will get there. This type of system can potentially match supply to demand more closely than our current rigid and disjointed system, allowing greater efficiency and (if combined with the appropriate motive technologies) sustainability.

A transparent transportation system would be more sophisticated to plan, deploy, manage and navigate than our current systems. They will consist of many more providers and stakeholders. The role of the public sector role will be complex and multifaceted. Also, it must be easily understood and navigated by users, and adaptive to their needs.

This lecture will describe transparent transportation systems and the integral role of geographic information science and geospatial technologies. Critical are the science and technologies for capturing, managing and extracting knowledge from spatio-temporal and mobile objects data, as well as urban simulation, virtual reality and augmented reality. These technologies can converge to create a Şmirror worldŤ: a virtual environment closely coupled to the real world. Transportation mirror worlds can create an environment that facilitates greater engagement and cooperation in real-world transportation systems.

Keywords: Transparent transportation, mirror worlds, cooperation, particpation, crowdsourcing

Data needs for "lightweight" behavioral microscopic transportation systems simulations

Kai Nagel (TU Berlin, DE)

Explain what is needed as input data for a transportation systems simulation that is based on individual travellers and their behavior. In particular, explain what seems to establish itself as "standard routes", and what is needed to make this even more "standard".

Evacuation Route Planning: Novel Spatio-temporal Network Models and Algorithms

Shashi Shekhar (University of Minnesota, US)

Efficient tools are needed to identify routes and schedules to evacuate affected populations to safety in face of natural disasters or terrorist attacks. Challenges arise due to violation of key assumptions (e.g. stationary ranking of alternative routes, Wardrop equilibrium) behind popular shortest path algorithms (e.g. Dijktra's, A*) and microscopic traffic simulators (e.g. DYNASMART). Time-expanded graphs (TEG) based mathematical programming paradigm does not scale up to large urban scenarios due to excessive duplication of transportation network across time-points. We present a new approach, namely Capacity Constrained Route Planner (CCRP), advancing ideas such as Time-Aggregated Graph (TAG) and an ATST function to provide earliest-Arrival-Time given any Start-Time. Laboratory experiments and field use in Twincities for DHS scenarios (e.g. Nuclear power plant, terrorism) show that CCRP is much faster than the state of the art. A key Transportation Science insight suggests that walking the first mile, when appropriate, may speed-up evacuation by a factor of 2 to 3 for many scenarios. Geographic Information Science (e.g. Time Geography) contributions include a novel representation (e.g. TAG) for spatio-temporal networks. Computer Science contributions include graph theory limitations (e.g. non-stationary ranking of routes, non-FIFO behavior) and scalable algorithms for traditional routing problems in time-varying networks, as well as new problems such as identifying the best start-time (for a given arrival-time deadline) to minimize travel-time.

Keywords: Evacuation, routes, spatio-temporal networks

Joint work of: Shekhar, Shashi; George, Betsy; Kim, Sangho; Lu, Qingsong

Full Paper: http://drops.dagstuhl.de/opus/volltexte/2010/2721

Full Paper:
http://www-users.cs.umn.edu/~shekhar/talk/evacuation.html

Vehicle Communications. Spoilt for choice

Christopher J. Skinner (Display Ltd. - Cremorne, AU)

Innovation in the world of intelligent transport systems and smart vehicle systems (aka telematics) is sometimes slow-moving and at other times there is dramatic progress. The latest major development area - dedicated short range communications or DSRC - is no exception.

However, it has become apparent that DSRC is different in several respects when compared with other Intelligent Transport Systems and telematics innovations.

There are three advanced communities involved, yet none of them has a comprehensive knowledge of the others and there is no forum for them even to share their concerns and research plans. These communities are:

- The vehicle designers and on-board systems integrators;
- The road network designers and operators responsible for all visual signage;
- Telecommunications network operators who have never before been involved with vehicles.

Keywords: Wireless vehicular communications; road safety and efficiency

See also: Thinking Highways Vol 4 No 4

Engineers Know How to make ICT Work

Christopher J. Skinner (Display Ltd. - Cremorne, AU)

The traditional principles of engineering could be applied more fully to large complex information and communications technology [ICT] projects to produce a higher success rate.

There are still far too many big ICT projects that fail to meet all of their performance and price targets and a significant minority that are abandoned before completion.

One of the contributing factors is the level of complexity of the project that once it exceeds an intrinsic threshhold leads to unpredictable and emergent behaviour, making the attainment of the required behaviour difficult, if not impossible. This applies in large scale transportation and supply chain projects as much as any other. The author's hypothesis is that the diligent application of traditional engineering development principles would increase the probability of success. In particular this would require the full suite of analytical and modelling techniques to be applied to predict behaviour at manageable scale before embarking on larger or full-scale development. The current state of development of this predictive approach for ICT projects is reminiscent of aeronautical enineering in its first few decades of development.

Keywords: Engineering principles, complexity in ICT projects

Modeling and Simulation of Human Movement Behavior

Sabine Timpf (Universität Augsburg, DE)

Talk about research on modeling human geospatial behavior showing the importance of ontologies and activity modeling as well as thinking about information provision to the user from a cognitive perspective

Keywords: Behavior modeling, activities, ontologies, information