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<td>Won Do Lee (Master)</td>
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<td>Chang-Hyeon Joh (PhD)</td>
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<td>Rocio de Oña López (PhD)</td>
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<td>Davy Janssens (Professor)</td>
<td>Transportation Research Institute (IMOB), Belgium</td>
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<td>Ansar Yasar (Professor)</td>
<td>Transportation Research Institute (IMOB), Belgium</td>
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<td>54</td>
<td>Yongjun Shen (Researcher)</td>
<td>Transportation Research Institute (IMOB), Belgium</td>
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</table>
55. Ali Pirdavani (Postdoc)
Transportation Research Institute (IMOB), Belgium .............................................................. 63

56. Luk Knapen (PhD)
Transportation Research Institute (IMOB), Belgium .............................................................. 64

57. Lieve Creemers (PhD)
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1. Mahmood Rahmani (Master)

*KTH Royal Institute of Technology, Sweden*

I am a PhD student at KTH Royal Institute of Technology, Sweden. My research project is about travel time estimation/prediction in urban traffic networks, supervised by Prof. Koutsopoulos. I am also a student at The Swedish National Graduate School of Intelligent Transport Systems. My background is software engineering.

The main research challenge I would like to touch up on is how to develop data-driven traffic models used for traffic control. The use of probe vehicles in traffic management is growing rapidly. The reason is that the required data collection infrastructure is increasingly in place in urban areas with a significant number of mobile sensors constantly moving and covering expansive areas of the road network. I am interested in learning more about ways of handling and benefiting from such big data. For my research, I have access to a dedicated blade center with 160 CPUs. I am hoping that the equipment can be also useful in my education about big data processing.
I recently started my PhD at EPFL at the Transport and Mobility Laboratory (TRANSP-OR) directed by Prof. Michel Bierlaire. My research will focus on exploiting and incorporating data from new non-invasive sensing systems (e.g. smartphone, GPS and WiFi data) for the advancement of discrete choice models (DCMs), with a particular focus on route choice models. Currently, most research efforts employing sensing data mainly focus on identifying the traveled path (e.g. map-matching algorithms) or mode of travel. Yet, the availability of data from such emerging non-invasive technologies has not been capitalised for the development of mathematical tools to improve understanding and modeling of travel behavior. Formulating appropriate methodological frameworks to incorporate the rich information obtained from the sensing data in DCMs is an interesting research question that is expected to help bridging the gap between behavioral theory and statistical modeling.
Pedestrian flow characteristics based on individual trajectories

Traditional way to measure the pedestrian dynamics is through the fundamental diagram, which provides the relation between the flow characteristics, such as pedestrian speed, density and flow. Nevertheless, the large differences are present regarding this fundamental relation in the specifications of various experimental studies, guidelines and handbooks, suggesting that pedestrian dynamics are still not well understood. Therefore, it is necessary to develop better data analysis methods based on precise empirical data, such as the trajectories of individuals. Owing to a close collaboration between Swiss Federal Railways (SBB CFF FFS) and École Polytechnique Fédérale de Lausanne (EPFL), we are able to study pedestrian dynamics on the basis of microscopic pedestrian data, collected at Lausanne train station using cutting-edge sensors for people tracking. Given the fact that the space decomposition and time aggregation are certainly the essential aspects affecting the pedestrian dynamics analysis, we are interested in investigation of the impacts of underlying different spatio-temporal representation on aforementioned pedestrian flow quantities, on the basis of individual pedestrian trajectories. Empirical observations, obtained based on the spatial decomposition at an individual level (Voronoi diagram), show that traditional deterministic fundamental diagrams are not sufficient to include observed widely scattered speed-density relationship. The underlying mechanism behind the observed scattering phenomenon is frequently the effect of a large number of factors (personal characteristics, geometric settings, environmental conditions, etc.), clearly suggesting that observed randomness of a real-world pedestrians’ motion behavior has to be taken into consideration in order to improve the modeling of pedestrian dynamics.

Biography and current work

Marija Nikolic is a PhD student under the supervision of Professor Michel Bierlaire at Transport and Mobility Laboratory, École Polytechnique Fédérale de Lausanne (EPFL). She has a Master degree in Electrical and Computer Engineering from the Faculty of Technical Sciences, University of Novi Sad, Serbia. Before starting her PhD, she worked as a software engineer in the software industry. Marija’s research interest involves modeling of pedestrian dynamics.
4. Jia Hu (Master)  

*University of Virginia, USA*

My research interests include highway safety, freeway operation, travel time reliability, Intelligent Transportation Systems (ITS), public transportation and microscopic traffic simulations.

Up to now, most of my research is related to traffic operation using VISSIM as the microscopic simulation tool. It is my interest to evaluation different connected vehicle technologies regarding improvement on mobility and travel behavior. Recently, I start implementing algorithmic and intelligent analysis on multi-sensor heterogeneous traffic data using big data source. I am open to different simulation method and willing to learn more.
Studies have shown that the amount of cars that are cruising for a parking place can exceed 1/3 of all traffic in large crowded city centers (Shoup, 2005). By either decreasing the amount of cars cruising for parking or decreasing the cruising time itself, it is possible to reduce the unwanted effects, being pollution and waste of resources (time and fuel). Information provision to drivers can potentially be beneficial for the overall system and its individual drivers once it is collected. Information provision on occupancy in parking lots is not a rarity anymore. However, information on availability of single on-street parking places is not regularly available. As availability of on-street parking places is subject to frequent changes the gathering and disseminating of this information needs to be dynamic and fast. For this reason the method for collecting this data and disseminating it, to drivers requesting it, is an important issue.

Using an spatial parking simulation, called PARKAGENT, I research the possible use of VANETs (vehicular ad-hoc networks) for disseminating information on on-street parking places.
The society in many countries faces big challenges in distributing electrical energy as renewable energy sources begin to undertake traditional energy production and energy consumption only will rise in the future. It has been commonly accepted that smart grid will lay the foundation for such a solution. The challenges are extensive since it requires a revolution in the electrical domain as well as in the customer domain. There are two primary goals: The first one is to minimize the overall energy usage by measuring and visualizing the energy consumption so the consumer can react if unnecessary consumption is been used, either manually or having a intelligent system that reacts on behalf of the consumer. Secondly, shift energy consumption to hours where energy production is cheap. This could be at hours where the renewable energy sources generate the majority of the energy. It demands for intelligent services that are able to distribute real-time electricity prices and demand-side devices which are able to react upon.

My research concerns the system design and communication aspects of an intelligent home automation for the future smart grid services. Specifically, it will focus on interoperability within the demand-side network infrastructure and address the problem of an optimal distribution of intelligence. This includes an investigation of energy efficient approaches for collecting data with an Home Area Network (HAN) and exploit measurement data to find patterns that can advance forecasts which ultimately can assist other methods in solving the above-mentioned goals.

Currently, the research has explored state-of-the-art system architectures and investigated recent, but recognized, international standards (e.g. SEP 2.0) that treats the communication and interface aspects within the HAN. I am designing lightweight IPv6-based protocols using RESTful interfaces and exploring various ways to store and forward data without violating privacy and security concerns.
I’m Phd student from Sao Carlos School of Engineering - Department of Transportation Engineering and my research is about investigation of travel patterns, specifically sustainable travels (bicycle and walking trips).

Congestion and mobility problems are affecting many types of cities, like large and medium-sized cities and, in some cases, even smaller towns. Under several circumstances, however, only planning more efficient travel patterns could substantially mitigate the problems.

For this planning, it’s necessary to study and understand how people do all theirs transfers around the urban context. This comprehension is possible through the use of models of urban transport and of land use. Therefore, in my research I’m studying this kinds of models and which of them is more appropriate for finding travel patterns.
Collecting, representing, and understanding human mobility patterns is becoming increasingly important for research, public policy, and private sector businesses. As we continue to generate mass amounts of spatially referenced data at increasingly fine temporal and spatial resolutions, an explicit focus on GPS traces, personal paths, human mobility-based behaviour, spatial interaction, and the various global/local scales of these data is essential. The main aim of this research is modelling the determinants of spatial interaction based on GPS data. Additionally this research will be used to explore ways of adding value to GPS traces in terms of inferring various trip-making behaviours via spatial and analytical methods. This work is part of GEOCROWD’s Initial Training Network, under FP7 – People – Marie Curie Actions by the European Commission: “Creating a Geospatial Knowledge World”. The specific contributions of this project to the larger program will include transforming VGI data into meaningful chunks of information obtained with simplicity and speed, comparable to that of Web-based search.
Estimation of travel demand is a key task in travel demand management and transportation planning. Traditionally, the necessary data for travel demand modeling is collected by means of cross-sectional household surveys supplemented by various counting surveys. These polls are extremely expensive and hence restricted to relatively small sample sizes.

Today’s vast use of cell phones generates network communications which provide samples of the whereabouts and movements of large parts of the population. Since this data is collected by network providers using technological infrastructure that is already in place, this paves the way to efficiently obtain mobility data with little additional effort. As a consequence, novel techniques are needed to provide transportation planning systems with knowledge about individual mobility behavior extracted from the vast amounts of raw cell phone data at a high level of abstraction and aggregation, thereby simultaneously protecting sensitive personal information.

In order to enable interoperability with a transportation planning system, the data has to be translated into the domain ontology of travel demand modeling. In particular, the data needs to be translated into useful knowledge about

1. the meaning and location of frequently visited places in people’s lives (e.g. “home” or “work”)
2. the meaning and purpose of trips, their origins, destinations, the chosen route and mode of transport as well as their frequency and duration
3. participation of individuals in out-of-home activities, their frequency, location, duration, sequencing and scheduling
4. mobility- and activity-behavioral patterns and categories and their relation to sociodemographic attributes

Intelligent inference algorithms are developed to semantically analyze and enrich the cell phone trajectories by combining them with additional data such as land use plans, points of interest and sociodemographics and by applying background knowledge. Patterns and dependencies in the data are discovered and exploited to fill in missing information and to project the observations to the entire population. This also includes techniques to complement and enrich the massive but low-quality telecom data with semantically richer and more accurate mobility survey datasets of limited size. In order to translate the research results into possible future exploitation and to conduct a thorough evaluation of their applicability they are integrated with a professional software system for transportation planning. The results are validated using a variety of data sources including traffic detectors, probe vehicles and mobility data collected from approximately 200 participants using specialized software installed on smartphones.
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11. Michael Zilske (Dipl.-Inform.)

*Technische Universität Berlin, Verkehrssystemplanung und Verkehrstelematik, Germany*

Our group creates models and software for the agent-oriented simulation of urban traffic systems. These models are data hungry. My research interest is what can be done to rely less on expensive data like household surveys, and make more use of opportunistically collected data like mobile phone trajectories or social network check-ins, even when they are only available in a reduced form for privacy reasons. The idea is to delay the imputation of mobility plans (with modes of transport and activities) from trajectories until the simulation is up and running. The simulation can then favor those mobility plans consistent with the trajectories which best fit other available data, such as traffic counts.

I have a strong interest in open-source software development, open data communities (like OpenStreetMap), and software integration (coupling our simulation software to an open source trip-planner, attaching new data sources).
12. Tien Dung Tran (PhD)

*Technische Universität Berlin, Verkehrssystemplanung und Verkehrstelematik, Germany*

The bike service is developed in the world. In France, we find the first success in the city of Lyon. Here, the system of self-service bicycle Vélo’v is implemented since 2005. Vélo’v trips are recorded and form a large database. Exploitation of this database will allow us to receive knowledge about the system. In combination with the socio-economic, geographic and other factors, we can create a model stations Vélo’v to know the functioning of Vélo’v stations.
13. Rob Willems (Master)
   Statistics Netherlands (CBS), the Netherlands

Statistics Netherlands publishes a series of statistics on traffic and transportation. Modern techniques as AIS and GPS provide an opportunity to speed up, refine and improve those statistics. But in order to use the new data, one has to know their nature (often Big Data) and to know how to cope with them (e.g. visualization). On top of that: Statistics Netherlands would like to use a more model based approach to statistics, hence our interest in modelling of traffic etc.
14. Fjo De Ridder (PhD)

*VITO, Belgium*

No abstract submitted.
15. Jayanth Raghothama (M Tech)

*KTH Royal Institute of Technology, Sweden*

There is a long history of the use of simulations and models in transportation planning and analysis. Transportation systems are complex in nature, characterized by emergent properties from the interplay of a large number of actors, individual and institutional. Further complexities are added by multiple modes of transportation, multiple levels of decision making, multiple institutions with sometimes conflicting goals, and the need to plan for more sustainable systems. Managing these complex policy challenges requires tools that are capable of capturing these complexities. We present a framework that combines elements from gaming simulation, design and transportation modelling that can enable researchers to ask questions of increasing complexity. The framework allows researchers to design games for policy analysis and design, and connect these games to a federation of integrated transport simulations. These simulations are driven by large data feeds, and provide feedback to the players of the game. The framework is designed in a generic manner, to enable users to rapidly build different games and integrate different simulations based on the questions being asked. The framework allows the user to ask questions on a more complex, comprehensive and detailed scale than previously possible.
I work as a researcher in the European research project EUNOIA (www.eunoia-project.eu). The goal of EUNOIA is to take advantage of smart city technologies and complex systems science to develop new models and tools empowering city governments and their citizens to design sustainable mobility policies. EUNOIA pursues advances in three complementary directions:

1) Use of data. The massive penetration of ICT is modifying social relationships and travel behaviour, and at the same time is providing us with a huge amount of heterogeneous data: intelligent transport systems, Internet social networks, mobile phone call logs, e-transactions. EUNOIA is investigating how to exploit these data to characterise mobility and location patterns in different European cities.

2) Urban transportation models. EUNOIA is investigating the interactions between social networks and travel behaviour, e.g. the influence of social networks on the planning of joint trips. This is expected to enable a more comprehensive assessment of mobility policies, particularly of new services emerging around the idea of a shared access to resources, such as car sharing. The new travel behaviour models will be integrated into the agent-based travel demand simulation tool MATSim.

3) Link between modellers, decision makers, and societal actors. EUNOIA will develop tools, e.g. 3D visual analytics, allowing stakeholders’ interaction with the simulation results, as well as a methodology for collaborative, multi-stakeholder policy assessment.

The models and methodologies developed by EUNOIA will be tested and refined through several case studies conducted in close cooperation with policy makers and mobility stakeholders from the three cities participating in the project: Barcelona, London, and Zurich.

At the DATASIM Symposium I would be interested in presenting the work we are currently conducting on the analysis of mobility patterns from phone call data and credit card data.
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18. Harshavardhan Ravichandran (MS in Transportation)
Massachusetts Institute of Technology, Cambridge, USA

My research has thus far been in the area of public transportation planning and operations. I am interested in learning more about the ways big data can inform public transportation service planning. Specifically, I am interested in learning more about how we can make use of smart-card/fee data to make improve the process of network planning, especially for bus networks which are fairly reconfigurable.

One of my previous projects involved estimating the load on London Underground trains using their Oyster smart-card data. This is challenging because many OD pairs have multiple feasible paths. The approach that was taken was to build a route choice model using survey data and then applying that route choice model to the smart-card data to estimate loads.
19. Camille Kamga (PhD)

*University Transportation Research Centre, New York, USA*

I am using large set of transportation data to analyze urban mobility. The data are from GPS from vehicle, sensors on the roadway and transit ridership. My studies are to look at travel times, disruption of the systems, analyzing accessibility, trends.
20. Martin Kracheel (Master, currently PhD candidate)

*University of Luxembourg / SNT, Luxembourg*

My PhD project is part of a nationally funded project (I-Gear.lu) that aims at reducing the social, economic and environmental problems caused by traffic congestion in Luxembourg by changing commuters’ mobility behaviour with the help of Pervasive Gaming. Small mobility behaviour changes are expected to reduce the overall road traffic congestion, during peak traffic times. We therefore capture the actual mobility behaviour by means of driver diaries, a mixed methods approach including an online survey and a mobile application, in order to offer appropriate alternatives and hereby changing the routine traffic behaviour within the frame of a game.
I have a rather broad background in agent-based computing and simulation modelling which I started applying to transport/mobility modelling in the last two years. My current interests are more on the software engineering and applied artificial intelligence side and include:

1) Modular framework for fully agent-based simulation modelling of multimodal transport systems - how to design the simulation framework so that it facilitates the modelling of a wide range of transport systems, including those with high importance of ad-hoc interactions and just-in-time (within-a-day) decision making. Approach taken: fully agent-based design, representing each entity in the system an autonomous agent inhabiting a simulated physical environment, with asynchronous decision logic and well defined interfaces between the agents and the environment (sensors/perceptions and actuators/actions).

2) Simulation testbeds for the evaluation of novel ICT-enabled mobility management schemes (real-time on-demand transport, peer-to-peer car sharing, dynamically priced taxis etc.) - how to provide a simulation infrastructure and tools for assessing the performance of ICT-enabled mobility management schemes under different conditions. Approach: combination of an extensible fully agent-based core simulation framework (see above) with the added support for agent-based coordination and negotiation techniques. Also includes design of (simulation) experiments methods.

3) Agent control architectures for agent-based activity-centric mobility models - how to represent decision making behaviour of agents in mobility models in a computationally effective yet psychologically plausible way (route planning, activity scheduling). Approach taken: combination of AI planning and scheduling methods with cognitive architectures. This is still more of a future work agenda that research with much progress so far.

4) Big data-driven construction and calibration of agent-based mobility models (from floating car data and mobile network data) -- how to use large amounts of floating car and mobile network data to derive and/or calibrate (agent-based) mobility models. No clear approach yet -- this is a new challenge currently tackled, the current plan is to rely on a combination of statistical and machine learning techniques.
Multi-Agent Based Simulation of Commuting in Urban Areas

Transportation policies and infrastructure investments can have substantial consequences on the society and travelers’ behavior. Thus it is very important to assess the impacts of such changes before implementation. One way for doing such impact assessment is to perform experimental studies in real world to get high realistic results of the evaluation. However, there are some constraints associated to the real-world experimental studies, e.g. they are very expensive and time-consuming and sometimes infeasible. In this project we try to address the challenges stated above by developing a simulation tool in order to estimate the effects of applying different transportation policies or investments. The tool can act as a decision support system for policy makers in order to investigate several what-if scenarios. Some sample policies that can be investigated by the tool can be: Changed schedules (e.g., bus and train), Pricing schemes (e.g., ticket prices, etc.), Taxes and fees (e.g., congestion fees, fuel taxes, etc.)

We model all “commuters” in an urban area on an individual level. In order to model the commuters in such a detailed level, we include the information regarding commuters’ life-style and travel behavior. Examples of such information are: socio-demographic information, mobility tool ownership data (car ownership and public transport season ticket), etc. Furthermore, the model includes all possible modes of transportation for a commuter to produce more realistic results. This decision is made to support how commuters choose their transport mode in reality, where they can decide to switch to another mode of transportation is special circumstances. The output of the model is choice of transportation (which might be a chain of switching between different transport modes), start and end time of the travel, and cost of the travel for each agent. The output data will be calculated for every single agent, but the results can be aggregated to show a general overview of the modal share, travel time and cost for commuters.

The results from the simulation will be sent to a visualization module which is developed in this project in order to make the results more understandable for the users (policy makers or transport planners).
23. Michal Certicky (RNDr.)

*Czech Technical University, Agent Technology Center, Czech Republic*

I have a rather broad background in agent-based computing and various different areas of AI which I started applying to transport/mobility modelling this year. My research interests are currently switching from theoretical towards more applied AI, while I’m starting to work on:

1) Modular framework for fully agent-based simulation modelling of multimodal transport systems - designing the simulation framework so that it facilitates the modelling of a wide range of transport systems, including those with high importance of ad-hoc interactions and just-in-time (within-a-day) decision making. Approach taken: fully agent-based design, representing each entity in the system an autonomous agent inhabiting a simulated physical environment, with asynchronous decision logic and well defined interfaces between the agents and the environment (sensors/perceptions and actuators/actions).

2) Simulation testbeds for the evaluation of novel ICT-enabled mobility management schemes (real-time on-demand transport, peer-to-peer car sharing, dynamically priced taxis etc.) - how to provide a simulation infrastructure and tools for assessing the performance of ICT-enabled mobility management schemes under different conditions. Approach: combination of an extensible fully agent-based core simulation framework (see above) with the added support for agent-based coordination and negotiation techniques. Also includes design of (simulation) experiments methods.

3) Agent control architectures for agent-based activity-centric mobility models - how to represent decision making behaviour of agents in mobility models in a computationally effective yet psychologically plausible way (route planning, activity scheduling). Approach taken: combination of AI planning and scheduling methods with cognitive architectures. This is still more of a future work agenda that research with much progress so far.

4) (Big) data-driven construction and calibration of agent-based mobility models (from floating car data and mobile network data) -- how to use large amounts of floating car and mobile network data to derive and/or calibrate (agent-based) mobility models. No clear approach yet -- this is a new challenge currently tackled, the current plan is to rely on a combination of statistical and machine learning techniques.
Since 50’s the model of urban growth has been characterized by a great extension of the low density urban areas, inducing a reduction of natural areas and an high fragmentation of territory. As a consequence, the traditional landscape has been lost. This growth model is based on the major use of private transportation, producing thus high levels of air pollution and of non-renewable fuel consumption, with evident negative actions on human health. On these basis, my research is focused on application of the complexity theory in order to understand great parts of internal dynamics characterizing shape, structure and functions of the urban connective tissue. Therefore, actions carried out on the urban connective tissue implies also a change of its structure and processes and, as a consequence, of the modal repartition of urban traffic flows. Another innovative factor, that will be considered in this research, is given by the use of network entropy for calculation the organizational level and efficiency of the urban network devoted to the mobility. Often, environmental impact assessment is utilized for testing mitigating actions done in order to reduce traffic flows and to ameliorate air quality in to urban area. However this approach has an high request of qualitative and quantitative data, which are strongly interlinked each other. By considering the system entropy, one may evaluate how a variation of the network structure is occurring for modifying its inter-connection level with respect to a previous system state. A different entropy value is quantified by comparison with the street network quality before and after any intervention done on the network. The last important factor is given by interface between the Geographic Information System (GIS) and cellular automata in order to develop an integrated system able to create and manage dynamic models of urban networks. This tool will allow to optimize the street network (responding to specific environmental needs) and to calculate the reduction of network entropy in relation to the increase of network efficiency.
The most recent research into commuting characteristics shows that over 81% of the Flemish labour force work at less than 30km from their workplace (Cools et al., 2010). The same likely holds for most other activities, for which the trip distance is usually even shorter than for labour. Still, the majority of people still prefer to use the car, even for short trips.

On the one hand, Flemish, provincial and municipal authorities encourage the functional use of the bicycle, among others by building adequate bicycle infrastructure. On the other hand the electric bicycle makes cycling available to a larger group of potential users, while at the same time increasing potential reach and travel speed. Finally, recreational cycling is on the rise, herewith also increasing the interest for functional use of the bicycle. These aspects combined make functional use of the bike more attractive and increased bicycle use in Flanders can therefore be expected.

However, cyclists are also more vulnerable, certainly if the e-bike renders cycling also interesting for less skilled persons (elderly people). It is therefore of paramount importance to gain insight into the potential safety impact of a modal shift towards more functional use of the (electric) bicycle. Clearly, the gain in sustainability of such transition should not lead to higher price in terms of casualties. An instrument is needed that allows policy makers in Flanders to anticipate the safety impact of increased functional cycling, and evaluate ex-ante their policy measures aimed at making cycling more attractive and safe (locations and types of infrastructure adaptations).

Above all, it is important to identify the locations where investment in cycling infrastructure would be most valued, hence improving the overall utilization of the cycling network in the region. This involves understanding travel behavior of cyclists or of potential cyclists, and factors influencing cyclists’ decisions on destinations, whether to bike or not, and on route choices.

The aim of my phd research is to shape an image of the policy and infrastructure requirements needed to safeguard the numerous positive effects of a possible breakthrough of electric bikes as a basic link of a sustainable mobility system. Indeed, electric bicycles have the potential of being an important driver in the transition towards sustainable mobility. However, it is important that this can take place under safe conditions. In fact, some research indicates that safety risks of electric bikes, depending on infrastructure characteristics, could yield a higher accident risk compared to ordinary bikes. Therefore, in this project a pool of e-bikes will be fitted with tracking and camera technology to obtain a deeper insight into the travel behaviour and (potentially dangerous) interactions with other road users for this group of bicycle users.

Moreover it is important understanding what kind of attributes could influence the route choice process and in particular what is the impact on route choice of safety factors (such as number and density of intersections with roads and bicycle tracks, riding on separated or shared lanes, quality of road surface etc.) and vice versa: of route choice on actual risk incurred. Considering that discrete choice theory (random utility theory) is based on the hypothesis that every individual is a rational decision-maker, generally, in route choice models, he/she tends to minimize time and travelled distance. In the case of bicycle routes choice, the main determinant is conventionally distance. Our argument is that other factors will be equally significant, in particular safety factors (at least in a case study where slope and landscape attractions are not too significant).
26. Michael Heilig (Dipl.-Ing.)

*Karlsruhe Institute of Technology (KIT), Institute for Transport Studies, Germany*

**Modelling Innovative Mobility Systems in Agent-Based-Simulation**

*Michael Heilig, Jörn-Ole Schröder*

*Karlsruhe Institute of Technology (KIT), Institute for Transport Studies*

Different studies assume that mobility behaviour of individuals will change within the next years. The changing mobility behaviour of people in combination with information and communication technology results in changing use patterns: multimodal as well as intermodal use of transport modes are getting more and more important [1]. Public transport services, used in combination with innovative concepts of eMobility and flexible vehicle sharing services gain importance, the possession of an own car becomes however less important.

To model changes in mobility behaviour, the Institute for Transport Studies at the Karlsruhe Institute of Technology (KIT) develops the agent-based-simulation software “mobiTopp” over the last few years [2]. For a given planning area, the software simulates the trips of all persons within one week. Recently, the model has been applied for two large example areas in Germany: The Stuttgart area with more than 2.7 million inhabitants and the metropolitan area of Rhine-Neckar with 2.4 million inhabitants. For the travel demand simulations “mobiTopp” generates consistent household data with persons representing the characteristics of the real population in the planning area. The collected input data results from regional household surveys as well as information from the German Mobility Panel, which is an annual survey in Germany, designed and scientifically supervised by the Institute of Transport Studies at KIT [3].

“mobiTopp” contains trip generation, trip distribution and mode choice. In the first step, the software builds a synthetic population for each cell based on census data and the classified households. Households are classified by the number of persons, the number of cars available in the household, its income and the availability of season tickets. Further, activity patterns gained in the survey are assigned to the households based on their classification. Trip distribution is realised by a modified gravity model. The location of fixed destinations of persons like home and workplace, which were assigned for every person, affect the choice of flexible destinations. The discrete choice model for the mode choice is affected by many factors such as day of the week, car availability, trip time and trip cost. Each trip is represented by a main mode. Due to the simulation of one week, the model is able to show changes in travel demand and travel behaviour, for example the multimodal travel behaviour within one week.

Our current work on two research projects allows for further extensions and improvements of the existing software. There are two important developments which have to be integrated into the model. On the one hand the implementation of intermodal trips and on the other hand the implementation of eMobility and other new innovative mobility systems.

The project “I-eMM – Intermodal eMobility Management” aims to model intermodal trips. In contrast to multimodal behaviour that is described as the usage of different modes in different trips by the same person an intermodal trip is understood as the usage of several transport modes during one single trip. The modeling of intermodal trips is needed in order to integrate electric vehicles (e.g. bikes, cars, segways) into the sequence of stages of persons between their public transport station.
and their origins and destinations. In addition the implementation of intermodal trips allows more accurate representation of individual mobility behaviour in agent-based simulation models.

The project “eVerkehrsraum Stuttgart” contains the implementation of eMobility as well as new and innovative mobility systems like car-sharing into the existing model of the Stuttgart area. To show the use patterns of electric vehicles used for car-sharing, for example, we have to add car agents and recharging infrastructure to the model as well as intermodal trips.

Especially the modelling of intermodal trips and car-sharing in a multi-agent traffic-simulation is still an open field. So, for modelling intermodal trips and car-sharing systems in a urban region, there are many problems to solve. We would like to attend the Summer School on ‘Mobility modeling and big data sources’ at the Transportation Research Institute (IMOB) of Hasselt University to improve our knowledge on the topics mentioned above and to learn about new approaches in multi-agent simulation tools and in modelling intermodal trips.

**Literature**


Modelling Innovative Mobility Systems in Agent-Based-Simulation

Michael Heilig, Jörn-Ole Schröder
Karlsruhe Institute of Technology (KIT), Institute for Transport Studies

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Literature


As the rise of urban population, goods delivery services result into more congestion, pollution, and reduction of service level. Furthermore, monitoring activities on roads becomes more difficult because of the lack of number of vehicles and people equipped with a location-based-detection device (e.g., GPS). Fortunately, the availability of call detail records (CDRs) coming from telecommunication industry allows us to study human mobility patterns at large-scales. This research aims to study green urban delivery system in a smart city framework using CDRs. For this purpose, we propose a two-step framework in which we first study human mobility behaviors by mining massive CDRs. Second, we investigate the concept of crowdsourcing in integration of transportation modes including passengers, pedestrians, public transportation, car-sharing, and private vehicles. Simulation-based optimization models will be built in order to minimize carbon emissions (CO2) while maximizing service level. Numerical experiments will be conducted to compare the performance of the proposed model with the existing models regarding economic and environmental aspects.

**Keywords**: smart city, green urban delivery, human mobility, crowdsourcing
The increasing growth of the number of the smart devices has provided scientists with large datasets, the correct manipulation of which can lead to the extraction of human behavior patterns, to the identification of outliers and to the better understanding of human nature and need. Our target is to develop a framework that can be applied on (two or more) correlated datasets when one of these datasets is multidimensional and extract outliers. An example of such a multidimensional dataset is one consisting of time-series.

The main problems that we face with these datasets are their volume and the uncertainty of the correlation that could be achieved. These problems could be possibly solved and checked respectively by applying the framework in a cloud-computing paradigm such as MapReduce. Although this manipulation divides the data in chunks the handling of which is easier, new aspects such as the computational cost, have to be taken under consideration. By the term “computational cost” we mean the time needed to fulfill the task. By investigating these aspects, the framework could lead to great advantages, achieving efficiency and effectiveness clustering with respect to the accuracy of the outlier extraction and the computational cost.

The results of our work could be used for identifying similarities in records or events that initially seem to be different, the characterization of an outlier and in many cases early planning (e.g. transportation).
Describe a method for using a dual roadside seismic sensor to detect moving vehicles on roadway by installing them on a road shoulder. Seismic signals are split into fixed time intervals in recording. In each interval, the time delay of arrival (TDOA) is estimated using a generalized cross-correlation approach with phase transform (GCC-PHAT). Various kinds of vehicle characterization information, including vehicle speed, axle spacing, detection of both vehicle axles and moving direction, can also be extracted from the collected seismic signals as demonstrated. The error of both vehicle speed and axle spacing detected by this approach has been shown to be less than 20% through the field tests conducted on an urban street. Compared to most existing sensors, this new design of dual seismic sensor is cost effective, easy to install, and effective in gathering information for various traffic management applications.
31. Jianxun Cui (PhD)

Harbin Institute of Technology, China

Traffic demand modeling based on Multi-agent tech; spatial-temporal trajectory data mining.
In order to estimate the signalized intersection control delays to transit vehicles, we use sub-sample GPS data sampled by bus to analyze the immanent relations among basic parameters in traffic flow, and propose a novel method to calculate control delay at intersection. The main challenge of our research is the sampling interval of the GPS data is 30 second and it is difficult to analyze the vehicles’ traveling process in detail. Based on our investigation, it was found that when a vehicle arrive an intersection at red light, it will move at a constant speed for a while and then begin to uniformly accelerate to stop, when the green light turn on, it begin to uniformly accelerate to a higher speed, then keep that speed to travel.
33. Haiqiang Yang (Master)

*Harbin Institute of Technology, China*

Data mining and process mining to extract information from big data. The data which record the movement of humans and other moving objects in the form of trajectory is being accumulated at an extremely fast rate, knowledge discovery from these data for recognizing activities has become an important problem. The discovered activity patterns can help us analyze traffic in a large city.
34. Jiang Huifu (Master)

*Harbin Institute of Technology, China*

My research focus is on "Spatio-temporal data modelling in public transport network" and "Discovering spatio-temporal causal interactions in taxicab location data".

I propose a suitable spatio-temporal data model in large city in China, through the space and time between the logic of sorting out to establish the overall level of bus network and the transfer links to form the dynamic network, and in accordance with the composition of the different mode of operation can be divided into various different levels, this model is a higher model that established on a consolidated network. My research on taxicab location data mining has just started, I'd like to detect flawed urban planning using the GPS trajectories of taxicabs traveling in urban areas, the detect results can evaluate the effectiveness of the carried out planning, such as a newly built road in a city, and remind city planners of a problem that has not been recognized when they conceive future plans.
Meteorological Factors is a considerable source of freeway accident risk. However, relatively few studies have considered the impact of their temporal evolution on the causes of freeway traffic accidents. This study aims at exploring the causes of freeway traffic accidents regarding the temporal features of meteorological factors. Firstly, impulse response function analysis and variance decomposition are utilized to quantify the lagged effect of meteorological factors on freeway traffic accidents. Then, an assessment model for freeway traffic accident-causing, which based on the DEA model for time series, is established for the synthesized impact analysis of multiple factors. Finally, the multivariate meteorological time series are processed based on phase space reconstruction, furthermore a subsequence-partition method based on adaptive sliding window and a similarity algorithm are also proposed for the mining of frequent patterns in multivariate time series. Therefore, the hidden rules can be identified according to the similarity accident-causing mechanisms led by the temporal evolution of meteorological Factors, It is hoped that this study will shed light on the existing traffic accident-causing theories, and our result will be helpful in the improvement of highway traffic safety microscopic theories and methods, as well as an overall enhancement of the transportation security and emergency response capability.
Brain activity measurement could contribute not only to the study of brain anatomy and functional connectivity, but also to the deeply analysis of neural information processing process, which would be essential for revealing higher brain function and understanding brain disease mechanism. Human brain activity measurement has important scientific significance and application value. Functional near-infrared spectroscopy (fNIRS) technique has tremendously potential technique for brain activity measurement because it can provide a high time resolution, reasonable spatial resolution and possess other advantages such as safety, portability, easy implementation, low cost and low power consumption. However, the physiological interference, motion artifacts, layered heterogeneous characteristics etc. increase the difficulty of accurate brain activity detection, which restricted thorough application research and development. In view of the above problems, it can be solved based on different sensitive depth of brain activity detection method, developed a set of complete function, low cost, portable near infrared detection system. The research results will improve the accuracy and reliability of brain activity measurement based on continuous wave near-infrared spectroscopy and promotes its application in other field.
37. Won Do Lee (Master)

*Kyung Hee University, Seoul, Korea*

Big data becomes the mega-trend of all kinds of research field. Especially in travel research, big data give us high precision of observation such as travel time (hh:mm:ss) and trip trajectory (mode chain and distance) from passengers records. Big data of SMA however has a limitation where we do not know traveler’s trip purposes.

This study aims at analyzing and comparing two kinds of data sets, namely household survey data and bus card data, in which we included only students (elementary, middle and high schools) in the analysis. They limit themselves in the kind of activities and travel modes that they participate and take during the day. Mostly they are school-related activities and public modes.

The result should show that the two data sets have similar characteristics. Bus card data however provides more information of trip details, whereas household survey data gives more personal information. This difference suggests interesting implications, and the paper will discuss them in both academic and policy points of view.
Travel demand derived from activity participation needs to be studied through activity-based simulation systems for the purpose of transportation planning emphasizing transportation demand management at both the local and national levels. A test-bed research has been required for developing a platform of activity-based travel demand forecasting in the Korean context. Given that no truly activity-based simulation systems available, it is worthwhile adopting existing model systems as a test bed. The only truly operational activity-based model systems have been developed and available in European context such as Albatross in the Netherlands and Feathers in Belgium. The current research aims at developing a prototype of implementation of Feathers and Albatross systems on the data of Seoul Metropolitan Area (SMA) and identifying the procedural requirements for adopting overseas model systems, together with actually analyzing activity travel patterns in SMA.
I am Rocío de Oña López, civil engineering from the University of Granada, Spain. I am working as a researcher at the department of civil engineering in the department area of Transportation of this University. This year, in May of 2013, I have just finished my PhD Thesis titled “Analyzing service quality in public transportation using decision trees”.


My main research interests are different ways of analyzing service quality in public transportation (bus, rail, etc) and how to develop and treat data collected in surveys. In the PhD Thesis I have studied in depth decision trees as an interesting methodology for analyzing service quality in public transportation from the passenger’s point of view, using for this purpose the data collected in various customer satisfaction surveys. I have analyzed different modes of public transportation (a metropolitan bus public transport in Granada, Spain, and a suburban rail public transport in Milan, Italy) using decision trees because of its easiness of understanding, the possibility of extracting the importance of the service aspects used as independent variables, and the powerful and useful decision rules provided by the methodology.

Passenger’s opinions about service quality are very heterogeneous among passengers, so stratifying the sample of users in more homogenous groups of passengers could help to reduce this heterogeneity presented in their perceptions. So, I have analyzed different groups of passengers using as stratification criteria the gender, the age or the trip purpose.

I have detected some problems that decision trees present with imbalance dataset, and I would like to learn how to solve them. Moreover, I am very interested in knowing other data mining methods, such as artificial neural networks, cluster analysis and so on. In addition I have worked with factorial analysis and structural equation models for analyzing service quality.

Calculate the coverage areas of public transportation is another research line. I have applied the Transit Capacity and Quality Service Manual in the metropolitan bus public transport of Granada. Also, other methodologies for calculating coverage areas (circular vs. polygons) have been applied to this area. A comparison between various of these different techniques has been carried out. Finally, regression analysis and logit and probit models are methodologies of my interest for analyzing different aspects of transportation.
40. Oh Hoon Kwon (Master)

Department of Civil and Environmental Engineering, Korea Advanced Institute of Science and Technology (KAIST)

Current research: I am studying on factor and pattern analysis of road traffic accidents using data mining techniques. Identifying factors that contribute to traffic accident severity has been a focus of traffic safety study for many decades. One of the most widely adopted methods is the statistical regression model such as logit and probit models, assuming a functional form and independency among factors. However, recently classification models of data mining techniques have been applied to redeem the weaknesses of the regression models. My study identifies the most significant factors that influence the injury severity of accidents and the latent dependencies between the factors by using classification models such as decision tree and Bayesian classifiers. I use the large scale traffic accident data that include information of all traffic accidents which occurred on roadways. The data fields contain human factors (age, gender, race, violation, etc.), vehicle factors (vehicle type, vehicle make, vehicle year, etc.), environmental factors (weather, road condition, time, location, etc.), and others related to accidents. I expect the results of the study can facilitate building other models for analysis of traffic accidents and establishing efficient strategies to improve traffic safety.

Research Interest: My research interest is the application of data mining techniques to transportation studies. Large scale data on transportation can contain: sensor data including speed, vehicle density, and traffic flow; travel OD data; and safety data including road traffic accident data and aviation accident/incident data. Using these data and data mining techniques (clustering, classification, and time series analysis etc.), I would like to identify useful knowledge such as travel time estimation and risk assessment of accident.
Recently, I am working on the project DOPIKOT, „Improvement of travel survey accuracy and effectiveness using information and communication technologies”. Main objectives of the project are to design and test mobile device (GPS, Wi-fi, GSM, accelerometer) for passive monitoring of respondents in travel surveys and to create guidelines for travel survey reflecting use of these devices.

During the project there will be collected longitudinal mobility data (n=1000; two weeks period), primarily for the methodological and device testing purposes. However, the quality of the data, its accuracy, and longitudinal nature also offers the good opportunity for the testing of new analytical approaches to travel behavior. The intra- and interpersonal mobility patterns, complemented by the GIS data, can be studied in higher detail and complexity levels at the same time.

On the one hand, we will use the outcomes of such study for the improving of the mode detection and purpose identification algorithms used for raw mobility data automatic interpretation. On the other hand, such study would also give valuable inputs to multi-agent simulation platform developed in other CDV project called RODOS.

Main challenges for current research are:

- Trajectories segmentation
- Semantic approach towards spatio-temporal trajectories
- Map matching and purpose (activity) identification
Currently employed as a researcher at Transport Research Center I am working on developing the international cross-border transport model for CENTROPE region (Austria, Slovakia, Hungary and Czech Republic). I find the main challenge in this project in modeling of different national travel behavior and particularly in cross-border mobility on the AT-CZ border. These two countries are geographically and historically very similar, however several barriers (language, social, economic, etc.) can be found even after the Schengen Agreement from 2004. These require special focus in travel demand modeling.

Work on the project Transport model At-CZ is still in progress. Current version of the transport model uses activity chain based model (VISEM, PTV VISUM), actual socio-demographic data and covers both public and private mode of transport. Household travel survey focused on activity-travel patterns of population in the South Moravia region was conducted as a part of the project. Furthermore, other supplementary surveys focused on travel behavior are planned to be done in 2013.

The future research of our institute is aimed to integration of activity based approach into multi-agent simulation platform developed within a large scale national research project called RODOS. Personally, I find it very interesting to compare macroscopic (zone-based) models and multi-agent approach in various contexts. Be part of the DATA SIM Summer School would benefit me to familiarize myself with new sources of mobility data and their use in traditional as well as in advanced approaches in travel demand modeling area.
43. Evi Dons (PhD)

Transportation Research Institute (IMOB), Belgium

Not applicable. I will only attend the lectures in the morning.
44. Seddigheh Babaee (PhD)

*Transportation Research Institute (IMOB), Belgium*

The main purpose of my research is to investigate drivers’ behavior by using the data from a driving simulator, in order to distinguish the best drivers and identify the problematic behavior of ‘underperforming’ drivers. To this end, 129 participants with different age and gender were enrolled to take part in a particular simulator scenario (i.e., curve taking) and their speed, acceleration and lateral position, the three most important driving performance indicators based on literature review, were monitored at various points (before, during and after the curve) while driving a STISIM simulator. As a widely accepted tool for performance monitoring, benchmarking and policy analysis, the concept of composite indicators (CIs), i.e., combining single indicators into one index score, was employed, and the technique of data envelopment analysis – an optimization model for measuring the relative performance of a set of decision making units, or drivers in this study – was used for the index construction. Based on the results, it will be possible from the model, rank all drivers and gain valuable insight, by comparing the relative performance of each driver.
My research work aims to develop a dynamic activity scheduling/rescheduling framework with feedback from information propagation between agents. This research work aims to find how does information flow take place between agents to reschedule their daily activities. While executing the daily schedules, information between agents can play an important role in order to make decisions after learning from each other. After building their social network while living, working, and traveling together agents can interact with each other in their social network. They can communicate with each other to spread the information from their experience to the other agents. This information can be used as feedback to the schedule executor in order to give a chance to the agents to adapt their schedules to comply with the new information. This research work aims to investigate the scheduling/rescheduling behavior as an effect of information propagation between people at microscopic level. Investigation at microscopic level is proposed in order to avoid the combinatorial problem.
46. Sungjin Cho (PhD)

*Transportation Research Institute (IMOB), Belgium*

As the first and main research topic for my PhD, I have tried to apply the FEATHERS framework, which is an activity-based transport demand forecast model, for a study area (the Seoul metropolitan area) during the first term of my PhD. For that, I first collected all types of input data for implementing the FEATHERS framework, which includes an activity-trip diary, population data, and information about network system and land-use in the study area. After data collection, I developed python software for data preprocessing which is to transfer Seoul data to feasible input for the FEATHERS framework since I had to find a solution to a number of issues on Seoul data e.g. zoning system, data structure, and transportation system. In addition, I also designed and made synthetic population software (IPU) in python to generate synthetic population for the study. After finishing the data preprocessing, I currently moved on the implementation step. These days I am working on the FEATHERS implementation using the Seoul data.

I have been working on an agent-based carpooling simulation. Our goal in this research is to develop an agent-based carpooling simulation software to analyze who, where, how people do carpooling with whom, based on their activity-trip behaviors in response to changes in social constraints, e.g. new transport policy and land-use change. In order to reach a goal, we first specified the components of the agent-based model, e.g. agents and environment, and then we built a modeling concept on the high level by designing an agent’s active rule, interaction and negotiation. Now, we are studying further details of the negotiation mechanism.
47. Katrien Declercq (Researcher)

Transportation Research Institute (IMOB), Belgium

Not applicable
Background:
Modeling freight traffic allows policy makers to obtain a complete picture on the size and distribution of traffic on the network. Since freight traffic shares the same road network with passenger traffic, modeling freight transport is a necessity. Freight traffic modeling has been historically tried first using traditional four steps models. those models fail to capture important aspects of freight traffic like modal choice and provide rather an abstract view of good movements throughout a given geographical area. The more recent approach is to use microsimulation techniques to capture behavior aspects of the decisions sequences leading to the freight traffic resulting. Microsimulation approaches allow detailed representation of the behavioral aspect along the logistics chain. It also allows to accurately model the demand causing that traffic as freight traffic is demand driven.

Problem definition:
Till now, the aggregate-disaggregate-aggregate (ADA) model was used to model freight traffic in Flanders. However, this model has some limitations and more importantly the input to this model is believed to be outdated data suffering accurate representation of production-consumption (P\C) estimates throughout Flanders. The current work aims at applying microsimulation techniques and innovative empirical relations to model demand and supply of goods among Flanders regions. Then, converts these demand and supply estimates into transported loads assigned to different modes of transports and links connecting these regions. Policy sensitive and capacity awareness are requirements of the resulting model.

Project goal:
The aim of this project is to develop a conceptual model for freight transports in Flanders. The model shall be able to accurately simulate goods production and consumption relations on a micro level, convert those goods to loads and simulate their complex transport chains from different source to destination nodes. The model will be a tool for policy makers to evaluate current and projected freight traffic size and distribution on the transportation network in Flanders. Thus, the model shall be policy sensitive to certain policies of interest like fuel price fluctuations and CO2 emissions as an example. Additionally, the model shall be able to be aware of network capacity constraints as opposed to the infinite capacity available approach being the case for now.

Methodology:
One primary scientific value of this project is to develop a new innovative mechanism to model demand and supply relations on a disaggregate level. This means fir to firm interactions will be modeled and the resulting flows shall meet realistic predicted flows when aggregated. To do this a method called Iterative Proportional Fitting (IPF) will be used to generate a synthetic firm population using a real firm sample extended to maintain real firm characteristics. This will be the basis to model
supply and demand or production and consumption estimates and is a bottom up approach as opposed to the current top down approach being used. Next is to define an empirical scientific basis for matching supply and demand sides. A parameterized Radiation model will be developed for this purpose. The use of the Radiation model to make goods movement estimates is recently introduced. However, this is done at a rather generic level and limited to non-parameterized version of the model. Therefore, customizing this model to meet the specific requirements within a freight model framework will be a valuable scientific addition. After defining source, destination and goods size, usually in Tons, the next step is convert this to loads ready for transport. Usually to twenty foot equivalent units (TEUs). Next important step is to develop a mechanism will be able to assign TEUs to different modes and links in an optimized way taking into account capacity constraints and different policies like accessibility related policies. Agent based simulation techniques will be used to implement such requirements mainly due to its ability to represent individual agents with their respective roles and interaction mechanisms. The result is an optimized, capacity aware and policy sensitive demand and supply pairs set, ready for traffic assignment step.
The annotation of GPS data with activity purposes using multiple machine learning algorithms

Current simulation systems in social sciences and the transportation area are based on either traditional surveys or on full (activity) diaries to model the individual behaviour of the agent in the system. Collecting these data either in paper-and-pencil format or by means of computer-aided technology such as for instance small hand-held computers is a demanding and burdensome task for respondents. The reason for this is that data about the principal choice dimensions underlying the simulation model have to be collected. Indeed, more advanced simulation models in the transportation field, like the activity-based transportation model, fully reflect spatial and temporal constraints and opportunities. They model interactions among agents, capture time use and allocation behavior, and consider activity participation along a continuous time dimension.

The spatial and temporal dimensions require special attention because previous research suggests that there is a bias in reporting these dimensions and one may get a fake idea of precision: while a location and time record may be available in the data, the level of precision remains unknown. In this research, it is our objective to evaluate whether GPS data can be annotated or semantically enriched with different activity categories, such that this source of data can be used in the future in simulation systems. The basic objective of the semantic enrichment process is to introduce a domain-dependent characterization of movement data and patterns.

There is a rich literature, originating from the artificial intelligence field, on developing methods that try to automatically infer people’s behaviour. The problem with most of these approaches is twofold, (i) the lack of validation and (ii) the spatial transferability. The first problem stems from the fact that one must have both diary and GPS data for the same set of respondents. However, if available, both data can be used: the GPS traces for annotation and the diary data as an independent validation source. The data used for this study stems from a mixed-mode survey design, in which two types of data collection methods were used, namely a paper-and-pencil activity-travel diary survey and a corresponding survey in which GPS-enabled PDA’s were used. The second problem stems from the fact that geographic information (like points of interest) is often used during the annotation process which limits transferability. In our research we proposed a set of new approaches which are all independent of additional sensor data and map information, thus significantly reducing additional data collection costs and making the set of techniques relatively easily transferable to other regions.

A group of state-of-the-art machine learning methods, including Multiclass Support Vector Machine (SVM), Multinomial Logistic Regression (MNL), Decision Tree (DT), and Random Forest (RF) will be adopted. The differences among these algorithms mainly lie in the way the classification task is approached, the structure of the learning function, and the procedure for determining the optimal function parameters. As each learning algorithm has its strengths and limitations, it is a priori unknown to know how every classifier performs for this learning task. In my research, a detailed comparison of the different learning algorithms at the level of the training data, the validation data and the test data will be made. Furthermore, this research shows that through the use of probability and majority matrices, a probability or a single activity type can be labelled to a specific GPS trace.
50. Joram Langbroek (PhD)

Transportation Research Institute (IMOB), Belgium

- cost-effectiveness of investments in public transport accessibility for persons with physical limitations
- public transport organisation
- social exclusion
- social value of being able to use public transport instead of paratransit
- minimal requirements for public transport systems with regard to "accessibility for all"
51. An Neven (PhD)

Transportation Research Institute (IMOB), Belgium

An Neven - PhD research: Explaining the changed activity and travel behaviour of persons with
disability by means of functional limitations, socio-economic and environmental factors

1. Persons with disease-related disability experience several physical and cognitive problems which
can influence their travel behaviour. In a first (pilot) study, we aimed to document the number of
activities, the activity type and the transport mode of the related trips that are daily made by
persons with Multiple Sclerosis (PwMS). 36 PwMS and 24 age-sex matched healthy controls were
studied, using activity-related travel diaries and GPS tracking devices. PwMS were further divided in
three subgroups based on their ambulatory dysfunction. The results showed that PwMS with mild
ambulatory dysfunction showed similar travel characteristics to healthy controls, with few
restrictions during travelling. Statistically significant changes in activity and travel behaviour were
detected in the moderate and severe MS subgroups compared with healthy controls: driving
independently became less frequent; significant more trips were made with company and the
duration of performed activities had increased.

2. In a large-scale study, we aimed to assess the specific and relative impact of disease-related
psychological, cognitive and physical factors on the activity and travel behaviour in MS in patient
profiles with various disability severities, as well as socio-demographic and environmental impact.
108 PwMS were studied, using self-report activity-related travel diaries and objective GPS tracking
devices during 7 consecutive days. Both physical and cognitive function tests were applied to
investigate their impact to the number of daily trips made, as well the transport modes used
(in)dependently. Results showed that travel behaviour in MS correlated with as well clinical
(especially physical) as non-clinical variables, while the magnitudes of the correlation coefficients
were dissimilar in the MS subgroups (based on ambulatory dysfunction). Multiple regression analyses
of the total MS sample showed that the daily number of trips in MS could be predicted for 39%. A
limited number of standard tests (i.e. T25FW, FAI) and other variables (i.e. disease duration, driving
ability, household size, housing type, degree of urbanization and distance to family) can predict the
overall community mobility in MS. It is important to take into account not only the clinical (physical)
characteristics, but as well the socio-demographic and environmental factors to predict the outdoor
activity-related travel behaviour in MS.

3. While demographic, household and trip-related factors of diary/ survey under-reporting and GPS
under-recording were already investigated, there is few data available about the reporting rate (and
associating data quality) of travel behaviour studies in persons with disease-related disability;
however such studies have increasingly being performed recently. In patient profiles with a severe
disability, cognitive dysfunctions (memory and/or emotional problems) might influence the accuracy
of self-report diaries with more potential bias in reporting results. Our study contributes to the field
by determining the influence of physical, cognitive or psychological impairments on the reporting
rate on both data collection instruments (self-report activity-related travel diaries and objective GPS
tracking devices) in our large-scale study in MS. Preliminary results indicate that clinical tests had
only limited influence on the reporting rate of the total MS subgroup, as well as in the three separate
subgroups. Educational background and the number of household members seemed to influence the reporting rate (similar as in studies with healthy persons), as well as some trip-related characteristics.

4. When studying the travel behaviour of a population group that might be experiencing physical difficulty when making (walking) trips, it is interesting to include data regarding their walking behaviour and location-based level of physical activity, which are not recorded in travel diaries. The validity of conventional used walking tests (mostly performed in a clinical setting) is uncertain within the individual’s usual environment, as different environmental factors can influence the walking performance, or what an individual effectively does in his environment. Therefore, a subset of 72 PwMS from our dataset also made use of a StepWatch Activity Monitor (pedometer) during the data collection period of 7 days, measuring their number of steps within a time interval of 1 minute. In a first step, we want to **investigate the daily walking mobility in MS**: does disability status have an influence on the (intensity of the) walking mobility, what is the day-to-day variability and between week and weekend days, and what is the influence of the time of the day on the intensity of the walking behaviour. Second, we want to investigate which environmental elements determine the travel/walking behaviour of people with various disability severities; by integrating the collected step data with the available (also collected) GPS data. By linking this step information with the geographic data of the trips (by use of the time attribute), a clear relation can be found between the number of steps and the geographic location. Hereby, we want to set up a database of all walking segments of the PwMS, with associated trip-related attributes such as maximal distance, company during the trips vs. alone, rest moments; as well as environmental attributes such as degree of urbanization, terrain characteristics, obstacles, etc. The innovative combination of the GPS logger and pedometer, the latter as objective measure of physical activity, also provides added value, since the number of steps could be used as indication for the travel mode involved (if these data was not reported in the travel diaries) and the duration of physical or walking activities, since PwMS may experience difficulties reporting these information. This research still needs to be worked out.

5. The travel behaviour of persons with disabilities (PWD) in Flanders using adapted transport is investigated, in order to determine the minimal resource requirements to offer round the clock on-demand transportation services, using a large number of individual transport providers of adapted transport. Hereby, a **microscopic simulation of the demand of PWD for adapted transport** was applied over the whole service area of Flanders. The first step consisted of creating a population of all PWD in Flanders, each person simulated by characteristics such as age, gender, living condition, income class, and others; as well as specific disability-related characteristics such as type of limitation and severity of disability. Next, all individuals of the population were simulated with a number of travel-related characteristics: probability of making a (type of) activity and trip, probability of using adapted transport, and destination choice. All individuals’ personal and travel-related attributes were used as inputs to generate the list of transportation requests of PWD in Flanders. To estimate the minimal resource requirements for this system of DRT services, a vehicle routing problem is solved for each of the transport providers individually (in cooperation with the research group of Logistics).

6. In the context of the same project, a self-administered survey was conducted in Flanders, involving 344 persons with disabilities and elderly persons. The objective of this study was to reveal their **transportation needs and wishes, as well as their payment and acceptance willingness of other transport alternatives**, if independent driving was not possible anymore. Currently, data is collected in the region of Brussels (and still needs to be analyzed).
52. Davy Janssens (Professor)

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Not applicable
53. Ansar Yasar (Professor)  
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Not applicable
54. Yongjun Shen (Researcher)

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Not applicable
55. Ali Pirdavani (Postdoc)

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Not applicable
Activity based models predict the daily agenda for each individual in a synthetic population in order to predict the travel demand. This microsimulation is aimed at evaluating effects of travel demand management (TDM) measures. Several techniques are being used: some of them use patterns detected in surveys and associate them with person and household characteristics. This results in statistics distribution functions that are used in MonteCarlo type simulations. The behaviour of the synthetic population corresponds with the one for the real population as far as a set of marginal distributions is concerned. The intention behind the behaviour recorded by the surveys however is not captured. Hence, it is difficult to estimate the reaction of individuals to specific TDM measures.

Furthermore, most (if not all) operational models consider individuals to act mutually independent except for sharing resources and needs within the household. Timing constraints however, often occur from cooperation.

The focus of our research is on the scheduling process performed by cooperating individuals. On one hand, the aim is to model the decision process itself as opposed to modeling the outcome of the decision process. This technique should make activity based models more suitable for TDM effect analysis since the relation between the inputs (state and context of the individual) and the output (effect of a schedule decision) can be modeled in a more accurate way. Example: a mode selection for the next activity to execute can depend on the timing of a specific activity later in the day.

The aim is to build a scheduler that can handle cooperation between people and that supports multimodality. Scheduling decisions will be taken during schedule execution: i.e. some travel and activity attributes will not be fixed at the beginning of the day. Both multimodality and cooperation result in combinatorial problems when evaluating alternative schedules. My research focuses on finding feasible approximate solutions to scheduling problems where cooperation is involved.

A first concrete experiment is used to estimate the problem size. A global web-based matching service for carpooling when commuting has been specified. Candidate carpoolers register their intention to carpool and their search for partners. The service combines trips that are suitable for matching and advises their owners to negotiate. The success probability for the negotiation shall be maximal in order for the service to be effective and trusted. This results in a star cover problem in a graph; this has been shown to be NP-hard. Furthermore, the graph characteristics change over time.
Schedules predicted by the FEATHERS activity based model are used to build a graph where the nodes represent the trips to combine in carpools. In order to estimate the computational effort required by the matcher, network characteristics have been calculated.

In a second case, evolution of carpooling agreements over time is studied by means of an agent based model. This model can be used to exercise the global matcher mentioned above. Schedule adaptation mechanisms are defined. The initial solo-driving schedule is to be adapted in order to cooperate. Pairs of trips are selected for cooperation based on similarity measures. Negotiation between two or more agents to form a pool is modeled as well as time and reputation dependent pool adhesion. The simulation aims to model long term relationships and cooperation. It models all details of the decision process that leads to carpooling (a special case of cooperation). The model will be used to investigate the relation between schedule flexibility, household income and the ability to carpool.

Finally, a scheduler is being designed. Instead of predicting all activity attributes at once, constraints for activities (order, time periods, locations, cooperation) will be predicted along with the activities to be executed according to a needs based concept. The decision process is to be modeled, not the outcome of the process. The reason for this is the required TDM sensitivity. Activity planners and schedulers that rely hard on patterns found in surveys without taking into account the intention of the individuals that lead to the observed pattern, risk to be insensitive to TDM. The intention of the individual and the constraints imposed by cooperation are essential to explain the final schedule. Because each individual has private intentions and cooperations, an agent based model is required. Each agent is assumed to optimize utility individually over a limited time horizon thereby negotiating with other individuals about cooperation and about (individually) executing tasks to resolve shared needs. The purpose of the research is (1) determining models for schedule adaptation in order to comply with spatio-temporal constraints (e.g. induced by cooperation or EV charging) (2) finding out the mutual effect of cooperation on the impact of travel demand measures.
Evaluating the impact of a new public transit system (light rail transit) using an activity based framework (demand side) and a public transit network for Flanders in OmniTRANS (demand side). The evaluation is based on a number of indicators, including the number of public transit trips, the distance traveled, the impact on modal choice, the modal shift to new public transport alternative etc... Moreover, LRT is a great potential for new urban developments in the vicinity of stations. In this context, it is also important to take these new spatial developments into account when evaluating the LRT system, which means that an integrated feedback is needed between the demand and supply side of mobility. Research initiatives are developed to take these interactions into account. Specifically, the following scenarios are evaluated for future years (2010 2020 2030 2040 2050).

- The trend scenario: which stands for a spatial development trend, coupled to a demand following regional public transport network.
- The design scenario: which stands for an optimized spatial development around the stations, coupled with a steering regional public transport network.
- Modeling multimodal access/egress modes using nested logit models and explicitly taking into account the correlated responses by means of a marginal effect model. This model will be used to perform a multimodal public transit.
- Identifying the determinants of light rail mode choice for medium/long distance trips. The data used for these analysis stem from a stated preference survey. The effects of various transport system specific factors (i.e. travel cost, in-vehicle travel time, transit punctuality, waiting time, access/egress time, transfers, and the availability of empty seats) as well as the travelers’ personal traits on light rail mode choice are analyzed, using an alternating logistic regression model which explicitly takes into account correlated responses for binary data.
- Exploring the knowledge and misperceptions of the concept Light Rail Transit in the context of implementing a new light rail system in a (sub)-urban region: Determinants of the cognitive mismatch between actual and perceived Knowledge. The success of a Light Rail system depends on a multitude of features, which can be broadly categorized into 4 classes: system-specific, socio-economic, policy-related and regional characteristics. In addition, it is reasonable to expect that there is an inter-personal cognitive aspect playing: the level of success of a new Light Rail system might depend on people's knowledge of the system. To investigate the knowledge, two separate binary logit models are estimated to identify the determinants that can be used to customize information campaigns in order to increase knowledge.