ICA Workshop on Street Networks and Transport
August 23-24, 2013, Dresden, Germany
https://sites.google.com/site/icaworkshop2013/

Program
+
Abstracts

International Cartographic Association
Commission on Geospatial Analysis and Modeling

Final Program
ICA Workshop on Street Networks and Transport
August 23-24, 2013, Dresden, Germany,
https://sites.google.com/site/icaworkshop2013/

The workshop will be held in the 1st floor, room number: 105; see details on the campus map at the above workshop site. Feel free, if you like, to bring your related posters, papers or preprints into the workshop. We will make a few poster stands available for you to post related stuff to better facilitate discussions and view exchanges.

You are required to upload your PPT slides into the designated computer before your session to ensure it works perfectly. We have a very restricted time schedule, so cannot afford any technical failure!!!

23 August, Friday

13:00 – 13:45   **Registration and to know each other**

13:45 – 14:00   **Opening remark** (Chair: Bin Jiang)

14:00 – 15:00   **Session 1: Street networks and disaster management** (Chair: Atsu Okabe)
Atsuyuki Okabe and Wataru Morioka, Aoyama Gakuin University, Japan
A GIS-based method for converting area-based data to network-based data and its application: Estimating the number of refugees who would walk to the nearest shelter following a large earthquake

Zhe Zhang and Kirsi Virrantaus, Aalto University, Finland
Use of Decision-Making Approach in Analysis of Vulnerability of Street Network for Disaster Management

15:00 – 15:30
Coffee break

15:30 – 17:30   **Session 2: Simulations on street networks** (Chair: Xiaobai Yao)
Xuebin Wei and Xiaobai Yao, University of Georgia, USA
A Random Walk Algorithm to Quantify Spatial Importance in a Road Network

Maxime Sainte-Marie, Université du Québec à Montréal, Canada
The Road to Direction: An Agent-Based Simulation of Human Movement using Directed Street Topologies

Stuart Thom, Ordnance Survey, UK
Generalisation of Roads

Bin Jiang, University of Gävle, Sweden
Ht-index for Quantifying Scaling Hierarchy of Street Networks

24 August, Saturday

9:00 – 10:00   **Session 3: Visibility over street networks** (Chair: Dafna Fisher-Gewirtzman)
Asya Natapov, Daniel Czamanski and Dafna Fisher-Gewirtzman, Technion - Israel Institute of Technology, Israel
Visibility of Urban functions within Street Network
Dafna Fisher-Gewirtzman, Asya Natapov and Liran Malka, Technion - Israel Institute of Technology, Israel

Street Network and 3D Visibility Analysis of Urban Environments

10:00 – 10:30
Coffee break

10:30 – 12:00   **Session 4: Structure and dynamics of street networks** (Chair: Nahid Mohajeri)
Nahid Mohajeri, University College London, UK
The Evolution and Complexities of Urban Street Networks

Jorge Gil, Delft University of Technology, the Netherlands
Analysing the Configuration of Integrated Multi-Modal Urban Networks

Yoav Lerman, Yodan Rofè and Itzhak Omer, Tel-Aviv University, Israel
Using Space Syntax to Model Pedestrian Movement in Urban Transportation Planning

12:00 - 13:00
Lunch break

13:00 – 15:00   **Session 5: Evacuation, routing and accessibility** (Chair: Toshihiro Osaragi)
Toshihiro Osaragi and Ren Shimada, Tokyo Institute of Technology, Japan
Estimation of Spatiotemporal Distribution of Automobile Users with Detailed Personal Attributes for Disaster Mitigation Planning

Anita Graser, Markus Straub and Melitta Dragaschnig, Austrian Institute of Technology, Austria
A Comparative Study of the Street Networks of OpenStreetMap and the Official Austrian Reference Graph for Vehicle Routing

Seungjae Lee, Byungwook Lee, Jooyoung Kim and Shinhae Lee, University of Seoul, Korea
A Novel Accessibility Measure Using Travel Time and Space Syntax Indices

Micah Brachman and Suzana Dragicevic, Simon Fraser University, Canada
Modeling of Emergency Evacuations in an Urban Setting: A Network Science Approach

15:00 – 15:30
Coffee break

15:30 – 17:30   **Session 6: Cognition, design, and BIG data** (Chair: Itzhak Benenson)
Lars Marcus and Meta Berghauser Pont, Delft University of Technology, the Netherlands
Cognitive Networks: Towards an Architectural Model of the City

Giuseppe Roccasalva and Amanda Pluviano, Polytechnic University of Turin, Italy
Open Syntax Computing: Enabling Geography of Communities

Johannes Scholz, Research Studios Austria, Austria
Shortest Paths from a Group Perspective - A Note on Selfish Routing Games with Cognitive Agents

Itzhak Benenson, Dimitry Geyzerskiy, Karel Martens, and Yodan Rofe, Tel Aviv University, Israel
Big Data Analysis for the High-Resolution View of Urban Public Transportation Accessibility

17:30 – 18:00   **Workshop wrap up**

23 August, Friday

14:00 – 15:00   **Session 1: Street networks and disaster management** (Chair: Atsu Okabe)

A GIS-based method for converting area-based data to network-based data and its application: Estimating the number of refugees who would walk to the nearest shelter following a large earthquake

Atsuyuki Okabe* and Wataru Morioka**
* atsu_okabe@sccs.aoyama.ac.jp **wmorioka.wm@gmail.com
Aoyama Gakuin University

Abstract
This paper proposes a GIS-based method for converting *area-based data* (a set of attribute values of events aggregated over subareas of an area) to *network-based data* (a set of attribute values of events on and alongside a network). The need for such a conversion method is based on a recent change from the traditional *planar spatial analysis* (i.e., the analysis using area-based data with Euclidean distances) to *network spatial analysis* (i.e., the analysis using network-based data with shortest-path distances), which can be applied to the analysis of events occurring on and alongside networks. At present, the amount of network-based data is small, so having a conversion method that would allow access to the large stock of area-based data for network spatial analyses would be beneficial. The second half of this paper illustrates how the conversion method can be applied. A type of area-based data called "floating population statistical data" that provide hourly information about temporary visitors to subareas in a region are used. These area-based data are converted to network-based data, which are then used to develop a GIS-based method for estimating the number of refugees who would walk to the nearest shelters on a particular day at a specific time when a large earthquake occurs.

Key words: area-to-network data conversion, network spatial analysis, network Voronoi diagram, GIS, earthquake

Use of Decision-Making Approach in Analysis of Vulnerability of Street Network for Disaster Management

Zhe Zhang1 and Kirsi Virrantaus2
1,2Department of Real Estate, Planning and Geoinformatics, Aalto University, Finland
Correspondence: 1Zhe Zhang: e-mail: zhe.zhang@aalto.fi

Abstract
Disaster management with respect to urban structures has received more attention in recent years. In disaster management, the most vulnerable structures in a modern society are the critical networks, such as transportation networks etc. The vulnerability analysis of spatial networks should not only depend on the topological structure; some nontopological attributes, such as population information, should also be considered. Therefore, the vulnerability analysis of critical networks can be considered as a multipleattribute decision-making (MADM) problem in which the most vulnerable location in the network should have the highest overall score on the basis of the evaluation criteria. Technique for Order Preference by Similarity to an Ideal Solution (TOPSIS) is one of the MADM techniques which can be used to aid selection in conditions of multiple criteria. In this paper, TOPSIS methods were used to combine the topological (betweenness value) and non-topological attributes (population information) of a transportation network for vulnerability analysis in the event of a disaster. The results of the models were compared numerically and also visually with an MADM weighted sum aggregation model with the help of Geographical Information System (GIS) tools. The results showed that these two models produced similar results.

Keywords: Multiple-Attribute Decision-Making, TOPSIS, spatial network vulnerability analysis, GIS, disaster management

15:30 – 17:30   **Session 2: Simulations on street networks** (Chair: Xiaobai Yao)

A Random Walk Algorithm to Quantify Spatial Importance in a Road Network

Xuebin Wei and Xiaobai Yao
Department of Geography
University of Georgia
Emai: {xbwei, xyao}@uga.edu

We propose a new network index at the nodal and link level, dubbed random walk values (RWV), to quantify the abstract concept of spatial importance at individual nodes and links. The index considers not only spatial structural characteristics but also road characteristics (e.g. capacity). We develop the corresponding simulation-based algorithm to derive RWVs. The index is compared with other popular network measures. It was concluded that the RWV can serve as a better indicator of spatial importance and a better predictor of socioeconomic variables in urban environments. The prediction power of RWV is evidenced in a case study of housing prices in Wuhan, China. The case study suggests that RWVs can be used as a good substitute for other important socioeconomic variables, such as population density and job density, to estimate housing prices. This is significant for many studies when data for such predictors are not available or for studies of predicting future scenarios.

Keywords: Network; Random Walk Value; Simulation; Urban Studies

The Road to Direction: An Agent-Based Simulation of Human Movement using Directed Street Topologies

Maxime Sainte-Marie
Ph.D. Candidate, Cognitive Computer Science,
Laboratoire d'Analyse Cognitive de l'Information (Cognitive Information Analysis Lab)
Université du Québec à Montréal (UQAM)
Suite W-5353
P.O. Box 8888, Downton Postal Station
Montreal, Quebec, Canada
H3C 3P8
Email: msaintemarie@gmail.com

In road systems as in many other real-world networks, asymmetry constitutes a key structural property: some streets allow vehicles to circulate in both ways while others, called "one ways", are strictly unidirectional. In the different street-based and topology-based representational methods developed by and around the Space Syntax program, however, road direction has generally been overlooked. Using the agent-based simulation possibilities offered by the NetLogo platform, the following research attempts to address this specific issue, by evaluating the impact of road direction on street topology and its relation to human movement.

Keywords: Street networks, topological analysis, road direction, human movement, agent-based simulation.

Generalisation of Roads

Stuart Thom
Research Department, Ordnance Survey,
Adanac Drive, Southampton, SO16 0AS, UK
stuart.thom@ordnancesurvey.co.uk

Abstract
This paper presents an overview of several generalisation operations performed on OS Integrated Transport Network™. Firstly the collapse of road sections and the storing of the results in a multi-representation database (MRDB) are reported. Secondly contextual displacement of road sections is shown. Finally calculations of the minimum width of roads using road sections and their underlying road polygons (from OS MasterMap® Topography layer) are described and the resulting data enhancement depicted.

Keywords: Map generalisation, Road network, Collapsing, Displacement, Road width, OS ITN®.

Ht-index for quantifying fractal or scaling structure of street networks

Bin Jiang
Division of Geomatics, KTH Research School
Department of Technology and Built Environment
University of Gävle, SE-801 76 Gävle, Sweden
Email: bin.jiang@hig.se

In this paper, I introduce a new index, ht-index, to quantify the fractal or scaling structure of geographic features, or street networks in particular. A geographic feature has ht-index h if the pattern of far more small things than large ones recurs (h-1) times at different scales. The higher the ht-index, the more complex the geographic feature. After introduce some basic concepts such as scale, scaling, Euclidean and fractal geometry, I showcase the application of the ht-index for Swedish street networks. I further discuss some deep implications of the ht-index for better characterizing geographic forms and processes, and argue that scaling should be formulated as a law of geography.

Keywords: Scaling of geographic space, fractal dimension, Richardson plot, nested rank-size plots, and head/tail breaks

24 August, Saturday

9:00 – 10:00   **Session 3: Visibility over street networks** (Chair: Dafna Fisher-Gewirtzman)

Visibility of urban functions within street network

Asya NATAPOV, Daniel CZAMANSKI and Dafna FISHER-GEWIRTZMAN
Faculty of Architecture and Town Planning, Technion –Israel Institute of Technology, Haifa 32000, Israel; correspondence email: asya@tx.technion.ac.il

Abstract
This paper investigates the role that visibility plays in determining the frequency of visitors of food and drink public facilities in Tel Aviv-Yafo, Israel. We test the hypothesis that visibility of a location within city street network affects its performance. We recognize that the location related visibility is not the only determinant. There is also a need to consider economic, geographic and cultural constrains. The study presents urban space as a mathematical graph, where functional locations are incorporated under realistic conditions of the built environment. Two visibility graphs are created - the street network graph and the integrative visibility graph (IVG). IVG is a novel graph-analytic method based on visual analysis of urban functional locations. To test the impact that visibility has on visitor behavior, we apply complex network analysis. Our results illustrate how the centrality values of street networks are interrelated with the locations of urban functions. This relationship assures the use of visual accessibility as a linkage between built-up environment and urban functional patterns. In addition, we illustrate that the street network visibility graph and the integrative visibility graph demonstrate small world properties. Furthermore, our results reveal that in contrast to an exponential distribution of the street network visibility graph, the visibility degree distribution of the

integrative graph exhibits a power law distribution.

Street Network and 3D Visibility Analysis of Urban Environments

Dafna FISHER-GEWIRTZMAN, Asya NATAPOV, Liran MALKA and Igal TARTAKOWSKI

Abstract
The work reported in this paper is a contribution to the search for reliable evaluation method for visibility in urban environment. We examine three analyses models: 1. Point based visibility graph of street network (Jiang and Claramunt, 2002), 2. Voxel based volumetric visibility analysis (Fisher-Gewirtzman et. al., 2013) and 3. LOS based visibility analysis (Fisher-Gewirtzman and Elber, 2013). We compare between these models to explore their suitability to various spatial configurations. We describe the similarities and differences between each of the models and their suitability to various spatial configurations. In this study we carry out a test comparing the value of visibility degree centrality to other assessments of 3D visibility analyses.
Our results demonstrate that junctions with similar rankings in all three models were located in a fairly flat topography and all the junctions with different rank were located on the boarder of a tilted topography. Their visibility was influenced by the changing topography. This preliminary study will be followed with a more comprehensive research looking at a variety of urban, architectural and topographic conditions.
The findings inform planners and designers about factors that affect visibility of urban environment and present new ideas to improve the existing measurement tools.

10:30 – 12:00   **Session 4: Structure and dynamics of street networks** (Chair: Nahid Mohajeri)

The evolution and complexities of urban street networks

Nahid Mohajeri
Department of Geography, University College London, Gower Street, Pearson Building, London, WC1E 6BT, UK.
E-mail: nahid.mohajeri.09@ucl.ac.uk

Abstract
Street networks are among very few types of complex networks where the history of the network can be traced over long periods of time. Here I analyse the details of the evolution of the street networks Sheffield (UK), Khorramabad (Iran), and Kerman (Iran) over tens to hundreds of years. The results suggest that the spatial distribution of streets, in particular their lengths and trends and associated entropies, are strongly affected by the surrounding landscapes but in different ways. The length entropies are mostly controlled by the space available for the network growth, whereas the trend entropies are mostly controlled by the shapes of the constraining landscape features. Thus, the network of Khorramabad, located in a narrow crescent-shaped valley, shows the lowest increase in length entropy (space constraints) but the highest in trend entropy (shape constraints). By contrast, the network of Kerman, in a flat desert area with essentially no space or shape constraints, has the greatest increase in length entropy and the smallest increase in trend entropy over time. The network of Sheffield, a city subject to moderate landscape constraints of hills and valleys, has length and trend entropies that fall in between these extremes.

Analysing the configuration of integrated multi-modal urban networks

Jorge Gil
Department of Urbanism, Faculty of Architecture, Delft University of Technology
Email: j.a.lopesgil@tudelft.nl

Abstract
This article proposes urban network models as instruments to assess the sustainable mobility performance of urban areas, thanks to their capacity to describe the detail of the local environment in the context of a wider city-region. Drawing from the features of existing street network models that offer disaggregate, scalable and relational analysis of the spatial configuration of urban areas, it presents a multi-modal urban network model that describes the urban environment using three systems – private transport (car, bicycle and pedestrian), public transport and land use. This model can be used to analyse the proximity, density and accessibility characteristics of urban areas for the individual or integrated network modes and land use activities, using a range of distance types and other analysis parameters. An implementation of the multi-modal urban network model is created for the Randstad city region and is analysed to test its features and possibilities. In particular, the analysis of the configuration of the urban network according to different distance parameters, and the analysis of the integrated modes and land use, give indications to the successful use of integrated multi-modal urban networks to build a rich sustainable mobility profile of urban areas.

Keywords: street networks, transportation networks, GIS, network configuration, open data

Using space syntax to model pedestrian movement in urban transportation planning

Yoav Lerman[1], Yodan Rofè[2] and Itzhak Omer[1]
[1] Department of Geography and Human Environment, Tel-Aviv University
[2] Desert Architecture and Urban Planning, Institute for Drylands Environment and Energy Research,
Ben-Gurion University of the Negev

Abstract
Transportation planning is changing. What used to be a concern with motorized vehicles only is evolving into a discipline dealing with multi-modal systems where priority is given to transit and non-motorized means of transport, chief among them is walking. This study presents a novel use of pedestrian movement modeling used in urban transportation planning in conjunction with more traditional means. The city of Bat Yam has chosen to pioneer in Israel planning for pedestrians as an integral component of its transportation master plan. The basis for such planning is a model for pedestrian movement in the city. This study shows that pedestrian movement distribution can be explained mainly by the spatial variables that represent the street network properties. Changes to this network structure are relatively rare and therefore they will not change in a fundamental way in the future. Furthermore, by overlaying the pedestrian movement model on the model of motorized traffic it is possible to focus on those streets and places where conflicts among the various road users (pedestrians, bicycles, transit vehicles and private cars) are expected.

Keywords: Pedestrian Movement, Space Syntax, Transportation Modeling, Spatial Analysis

13:00 – 15:00   **Session 5: Evacuation, routing and accessibility** (Chair: Toshihiro Osaragi)

Estimation of Spatiotemporal Distribution of Automobile Users with Detailed Personal Attributes for Disaster Mitigation Planning

Toshihiro Osaragi and Ren Shimada
Department of Mechanical and Environmental Informatics,
Graduate School of Information Science and Engineering,

Tokyo Institute of Technology
2-12-1-W8-10 O-okayama, Meguro-ku, Tokyo 152-8552, Japan
osaragi@mei.titech.ac.jp, shimada@os.mei.titech.ac.jp

Abstract
In the field of urban disaster mitigation planning, it is important to clarify the characteristics of the spatiotemporal distribution of populations when considering provisions for human casualties by a severe earthquake. In this paper, we construct a model that simulates the route choice behavior of automobile users on geographic information systems using data from a person trip survey and a road traffic census. We estimate the spatiotemporal distribution of automobile users in Tokyo and demonstrate several applications of this data to urban disaster mitigation planning.

Keywords: spatiotemporal distribution, automobile users, person trip survey data, road network

A Comparative Study of the Street Networks of OpenStreetMap and the Official Austrian Reference Graph for Vehicle Routing

Anita Graser, Markus Straub, Melitta Dragaschnig
Dynamic Transportation Systems, Mobility Department, AIT Austrian Institute of Technology, Vienna, Austria

Abstract
Vehicle routing is one of the main areas of application for street network graphs. With the advances of OpenStreetMap (OSM), interest in using OSM in routing applications is growing but, at the same time, there are concerns about the quality of OSM and Volunteered Geographic Information (VGI) in general. In this paper, we address the lack of systematic analyses of the quality of the OSM street network for vehicle routing and the effects of switching vehicle routing applications to OSM. We propose a method to compare the quality of street networks for vehicle routing purposes which compares street network features as well as resulting route lengths and geometries using Hausdorff distance. Our comparisons of OSM and the official Austrian reference graph "Graph Integration Platform" (GIP) in the city of Vienna show close agreement of one-way street and turn restriction information. Further comparisons based on 99,000 OSM and GIP route pairs show promising results for vehicle routing applications especially for route length computation.

Keywords: OpenStreetMap, Volunteered Geographic Information (VGI), quality assessment, routing, street networks

A Novel Accessibility Measure Using Travel Time and Space Syntax Indices

Seungjae Lee
The University of Seoul
sjlee@uos.ac.kr
Byoungwook Lee
Seoul Metropolitan Government
Jooyoung Kim
The University of Seoul
Shinhae Lee
Seoul Institute

Abstract
Accessibility generally means the degree of availability for accessing to active places and areas. In transportation fields it also means the degree that traffic modes access to certain areas. In other words, any area with high accessibility has many traffic modes that run to other areas from it. Seoul city has reorganized its bus systems as an hierarchical system since 1st, July, 2004. The Seoul bus reorganization is evaluated for

an improved function of corridor, accessibility, efficiency and comfort of the bus. The Metropolis of Seoul changed public transportation convenient and rapid by rearrangement of bus lines with median bus lines, which is the priority policy of public transportation. Policy planners and policy makers have subjectively evaluated public transportation so far because there was no quantitative analysis tool. The paper has therefore developed a methodology of calculating accessibility in bus network by using a space syntax technique. The purpose is an effective analysis of accessibility improvement before and after Seoul bus reorganization. Space syntax methodology has an advantage to calculate easily network connectivity and accessibility. However, it also has a weakness not to consider the distance and travel time for calculating accessibility. As a result, we have developed a hybrid of the space syntax methodology and the travel time measures. This method has been applied to evaluate the accessibility before and after the hierarchical bus systems introduced in Kangnam area of Seoul.

Keywords: public transport, space syntax, accessibility, hierarchical bus system

15:30 – 17:30 **Session 6: Cognition, design, and BIG data** (Chair: Itzhak Benenson)

Cognitive networks: towards an architectural model of the city

Lars Marcus (lars.marcus@arch.kth.se)
School of Architecture, KTH, 100 44 Stockholm
Meta Berghauser Pont (M.Y.BerghauserPont@tudelft.nl)
School of Architecture, TU Delft

Abstract
It is clear how urban modelling since its very beginning is founded on what in general terms could be identified as a geographical understanding of urban space, and, one might add, with a close relation to urban economics. In this paper we will take on the challenge to investigate the possibilities of an urban model based in what we in similar general terms identify as an architectural understanding of urban space. We find many strong arguments for such a model with repercussions on rather deep theoretical questions about both cities and space. For instance, where geography and planning, speaking in broad terms, concerns distributions of entities in space, architecture and urban design concerns the distribution of space itself. That is, the built form of cities is in urban geography and planning a distribution in space among many others, while it in architecture and urban design has a privileged position as the medium that structures urban space as an entity in itself. Since how we model the world informs us on how to act upon the world, there consequently seems to be an urgent need for an architectural model of the city in support of architectural practice, such as urban design. In this paper we outline such a model taking our point of departure in the particular features originating in the gravity model but subsequently applied in most urban modelling, mass and distance.

Keywords: urban modelling, space syntax, networks, cognitive distance

Open syntax computing: enabling geography of communities

Giuseppe ROCCASALVA Amanda PLUVIANO
Politecnito di Torino, research fellow
Architecture and Design Department
DAD
SiTI Istituto Superiore sui Sistemi
Territoriali per l'Innovazione
United College London
giuseppe.roccasalva@polito.it amanda.pluviano.09@alumni.ucl.ac.uk

Abstract
Nowadays, cities have an amount of unexploited public spaces and buildings; these could host new uses, boosting bottom up initiatives. The presence of communities with different cultures requires flexible spaces which are conflicts avoiding and open to all. Instead, spaces often lack of spontaneity and identity. Configuration analysis helps to support decision about layout efficiency of public spaces. While community initiatives are fragmented, marginal and disconnected this proposal aims at gathering the so-called "diffuse knowledge" by ubiquitus tools into a syntactic map. Segnala.To is a project developed for a Turin quarter (Barriera di Milano) which is under a major renewal. The project aims to create a web platform for advising shared urban spaces over a configuration expert analysis which include the metropolitan area of Turin. This web tool highlights the creative uses of space, it is based on an open source geo-spatial web portal. The aim of this tool is to share spontaneous initiatives, promoting new way of connecting people within and between quarter and their broader environments, using situated computing as a "shaping access" to information and human relations by means of configuration analytic work. This open and responsive platform fosters the creation of local communities which are interested in the quality of their urban public space neighborhood.

Keywords: geo platform, collective intelligent, gps surveying, real time cartography

Shortest Paths from a Group Perspective - a Note on Selfish Routing Games with Cognitive Agents

Johannes Scholz
Research Studios Austria, Studio iSPACE, Salzburg, Austria

Abstract
This paper elaborates on the effect of cognitive agents on selfish routing in traffic networks with linear latency functions. Selfish routing occurs when each agent traveling in a network acts purely selfish, and thus the Braess Paradoxon is likely to occur. The Braess Paradoxon describes a situation where an additional low-latency edge is added to a given network, which leads to higher total latency in the system. By applying the concept of cognitive agents, each agent is able to make non-selfish decisions. In addition, each agent has to cope with uncertainty in terms of travel time information in the traffic system - which is also true for real-world traffic networks. This paper evaluates on the influence of travel time uncertainty and non-selfish behavior of the agents and the effect on the overall latency. The results indicate that the both, non-selfishness and uncertainty have an influence on the latency. In addition, understanding the influence of cognitive agents on latency can help to better plan and influence traffic flows resulting in "more optimal" flows with lower latency.

Keywords: shortest paths, Braess paradoxon, selfish routing, cognitive agents

Big Data Analysis for the High-Resolution View of Urban Public Transportation Accessibility

Itzhak Benenson1, Dimitry Geyzerskiy2, Karel Martens3, Yodan Rofe4
1Department of Geography and Human Environment, Tel Aviv University, Israel
2PerformIt LTD, Haifa, Israel
3Institute for Management Research, Radboud University Nijmegen, Holland
4Blaustein Institutes for Desert Research, Ben Gurion University of the Negev, Israel
bennya@post.tau.ac.il, dima@performit.co.il, k.martens@fm.ru.nl, yrofe@bgu.ac.il

Accessibility is a key indicator to assess transport investments, urban policy and urban form. From both the environmental and the equity component of sustainability, a comparison of accessibility by car versus public transport is of the utmost importance. We propose a set of accessibility measures that directly relate transit-based and car-based accessibility to each other and present Urban.Access software that enables a detailed representation of travel times by transit and car and makes it possible to compare accessibility levels by transport mode. Depending on data availability, Urban.Access can be employed at various spatial resolutions – from urban traffic zones to separate buildings.

The application of Urban.Access to the real data demonstrates that an adequate view of urban accessibility demands analysis at resolution of the separate building, street segment, bus line and bus stop. This raises heavy computational problems: the typical metropolitan of several millions population demands processing of hundreds of thousands origins and destinations, tens of thousands street segments and thousands public transportation lines of different kinds.

High-resolution estimation of accessibility demands effective processing of the huge data sets and the latest version of the Urban.Access is implemented using open-source, high performance graph database Neo4J, http://www.neo4j.org/ employing the recent achievement of the computational graph theory that are blazing fast. Graph nature of the road and transit networks enables direct implementation of the software algorithms for estimating accessibility. Based on Neo4J, Urban.Access is being developed for the cloud deployment and is thus extremely scalable.

As an example, we present application of the Urban.Access to the current and future public transportation system in Tel Aviv and Utrecht metropolitan areas. The analysis reveals large gaps between car-based and transit-based accessibility. The accessibility maps constructed for different hours of a day reveal essential spatial and temporal heterogeneity of accessibility over the metropolitan area and the lack of fit between current public transportation network and distribution of the carless population. These gaps point to a greater need for adequate policy responses, both for reducing car-dependence and for creating a more equitable transport system.

We consider these results as a basic step towards the wide use of the Urban.Access as an intuitive and internet-based trial-and-error tool for transportation planning in the city.