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Agent-Based Transport Simulation: Modelling Future Mobility

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Dr. Alexander Erath
17 November 2015

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CREATE

Multi Agent Transport Simulation



MATSim Singapore

Data platform architecture

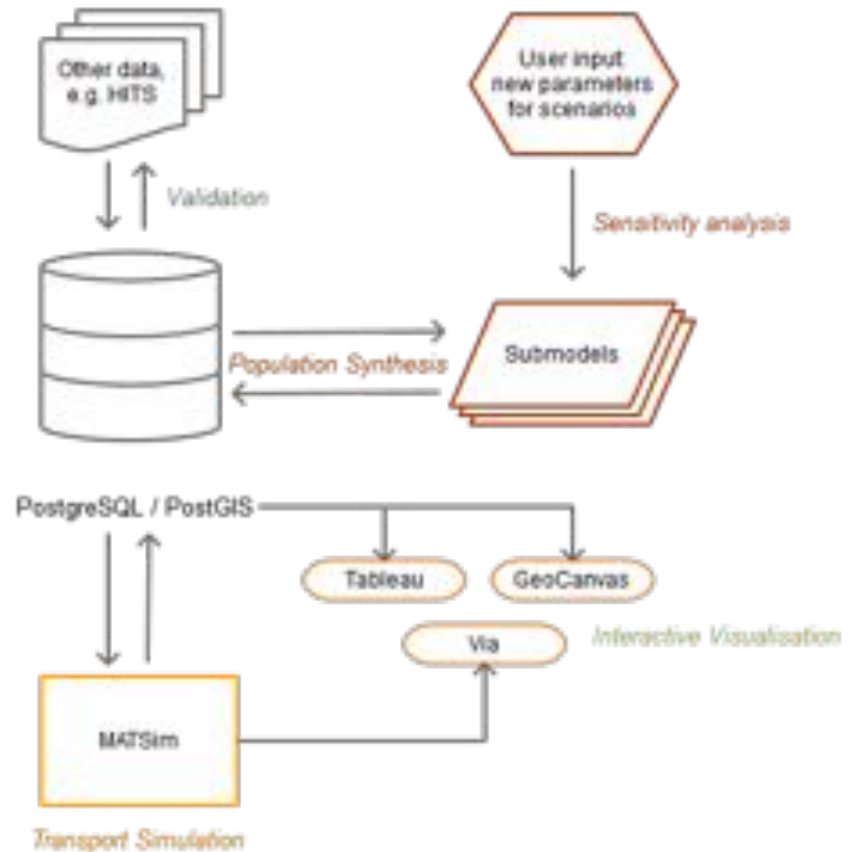
Data hosted on spatial database.

Various data sets integrated and cross-referenced.

Strict separation of data and code.

All newly created code shared among project partners under GPLv2 on GitHub.

If available and relevant, Open Source Software Tools are used.



Population synthesis with Bayesian Networks

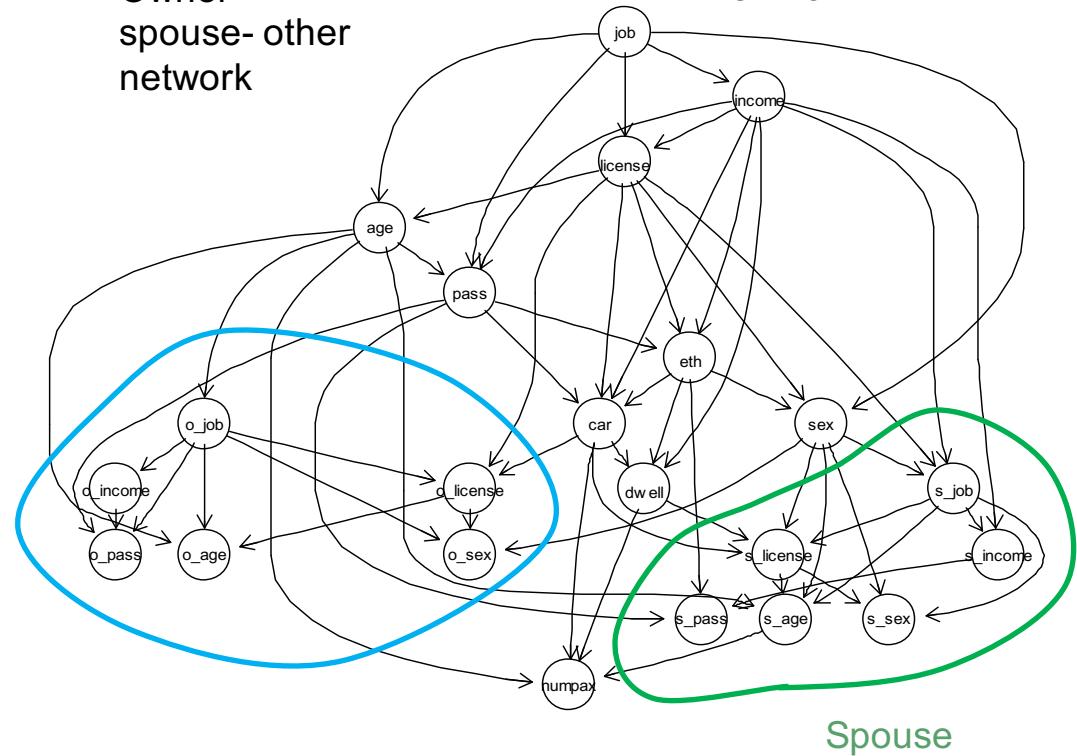
A new Bayesian Network based hierarchical population synthesis methodology.

The new procedure allows to account for hierarchy of households and persons.

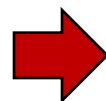
For populating a new scenario, the planner only needs to define the relevant control totals for a new zone, e.g. expected number of people by dwell type x age

Owner-spouse-other network

Owner



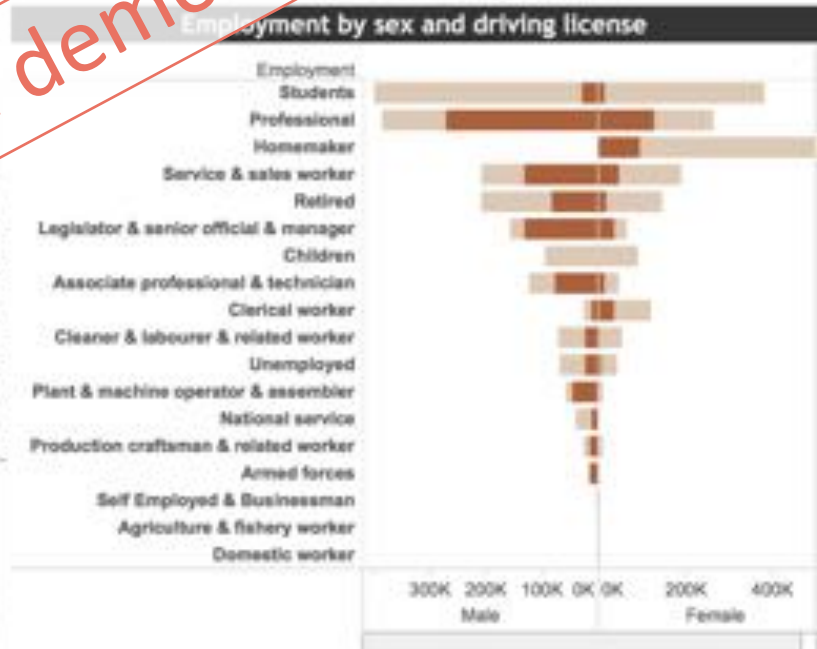
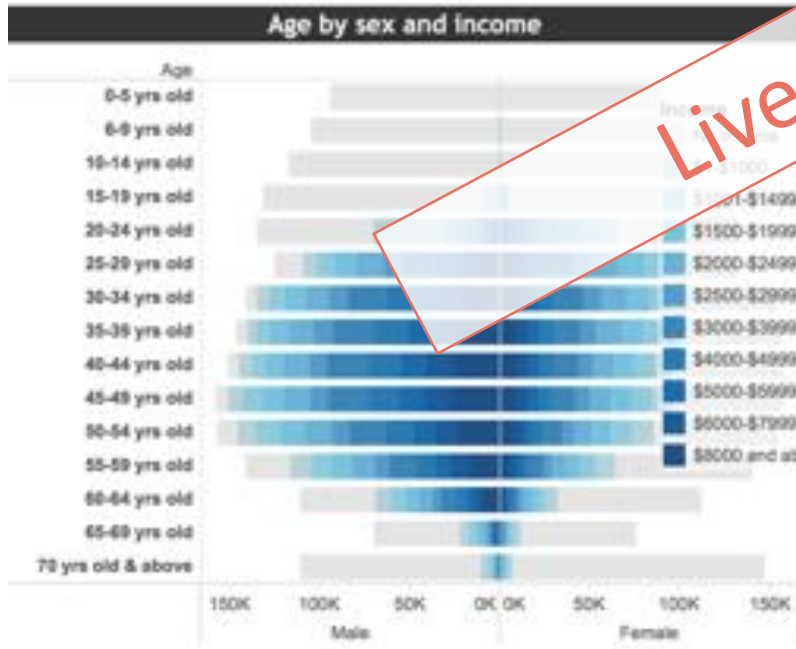
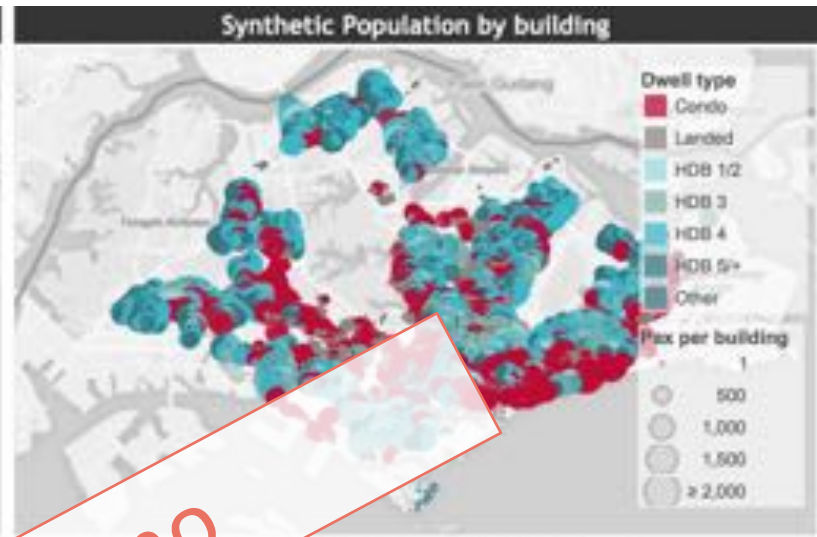
Pool of households



| Zone_n | Age_1 | Age_2 | ... | Age_n |
|----------|-------|-------|-----|-------|
| Zone_1 | Age_1 | Age_2 | ... | Age_n |
| Income_1 | 100 | 200 | | 150 |
| Income_2 | 200 | 320 | | 200 |
| ... | | | | |
| Income_n | 120 | 230 | | 330 |

Control total tables

Synthetic Population for MATSim Singapore



Live demo

Evaluating Future Mobility Solutions with MATSim



Electric vehicles (EV)

Agent-based transport simulation allows to track each vehicle's battery level and charging state. This allows to simulate electricity demand, analyse how EV can contribute to a Smart Grid and how people might react to fluctuating energy prices.

Waraich, Rashid Ahmed (2013). 'Agent-Based Simulation of Electric Vehicles: Design and Implementation of a Framework'Diss., ETH Zürich, Nr. 21633, 2013.



ERP 2

MATSim allows to account for taste heterogeneity among travellers. Therefore it is ideally suited to evaluate different pricing strategies. Researchers at the FCL are currently developing tools that allow to identify optimal pricing strategies.

Chakirov, Artem (forthcoming). 'Urban Mobility Pricing with Heterogeneous Users'Diss., Singapore ETH Centre and Eidgenössische Technische Hochschule ETH Zürich,.



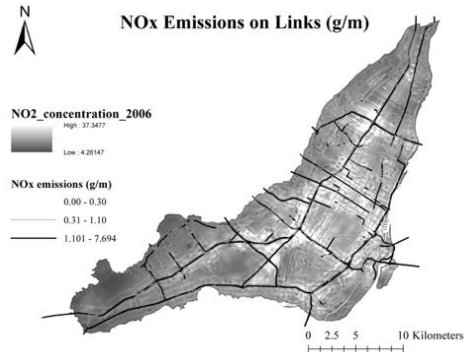
Shared AVs

The new technology has the potential to be a game changer for urban transport. Agent-based models are ideally tailored to evaluate the impact of autonomous cars for different stages of its market introduction, e.g. :

How different penetration rates increase road capacity? How can autonomous cars replace public transport?

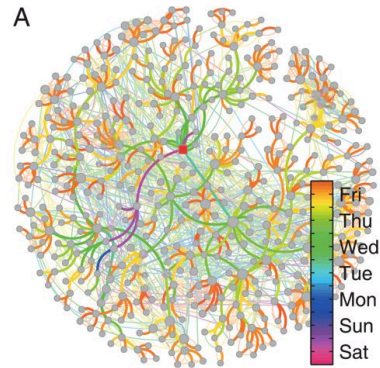
Bösch, P., F. Ciari and K.W. Axhausen (2015) Required autonomous vehicle fleet sizes to serve different levels of demand, paper to be presented at the 95th Annual Meeting of the Transportation Research Board, Washington, D.C., January 2016.

MATSim applications beyond mobility



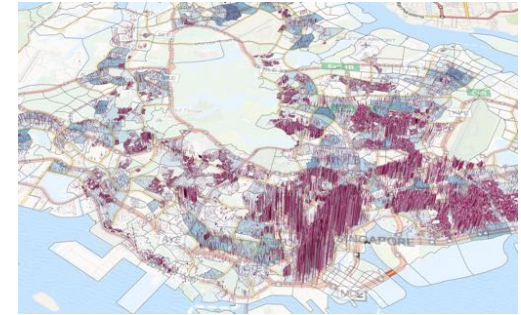
Emission modelling

Since MATSim is modelling individual vehicle Links with full temporal dynamics, it is ideally suited to generate noise and pollution emission data. At the same time MATSim also can be used for exposure analysis. Coupled with relevant dispersion modelling tools it is a very powerful solution to test noise and vehicle emission mitigation strategies.



Disease spreading

Agent-based simulation is the tool of choice to model the spreading of contagious diseases. Knowing the collocation of people while traveling, working and spending leisure time, MATSim Singapore can be applied to test prevention strategies on a nationwide scale.



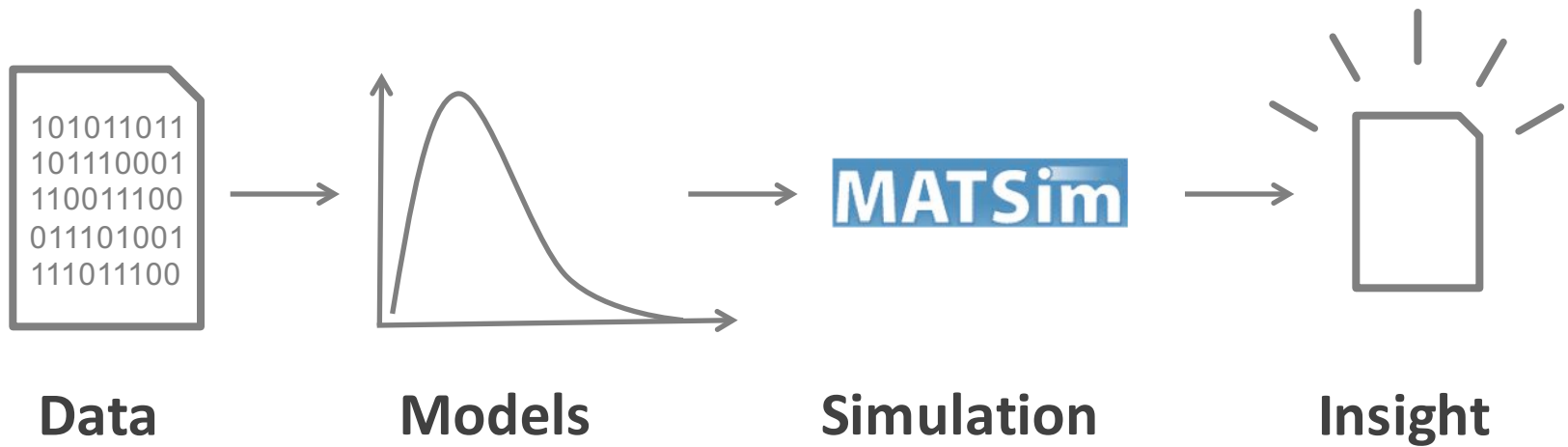
Accessibility analysis

The basic unit of spatial analysis in MATSim Singapore is the individual building. For each building, MATSim models the number and type of activities people perform. This allows to quantify the potential for commercial activities and to assess the need for public amenities nearby.

The potential of data driven transport planning

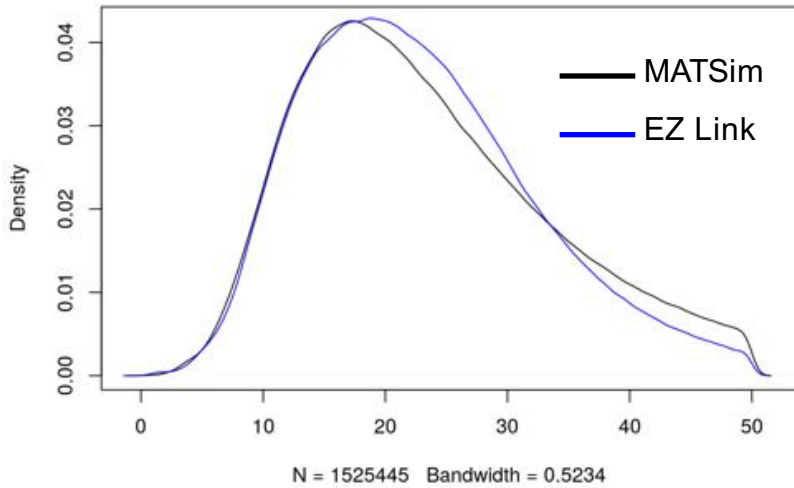


Turning Big Data into Smart Data

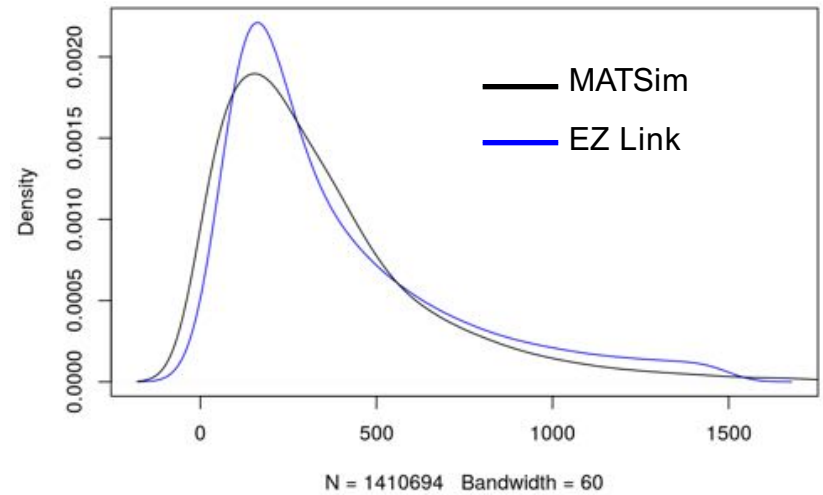


Validation

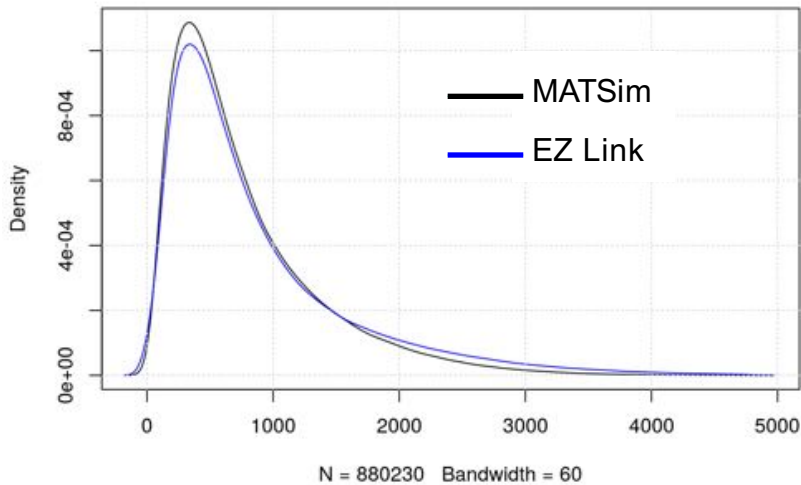
Bus speed



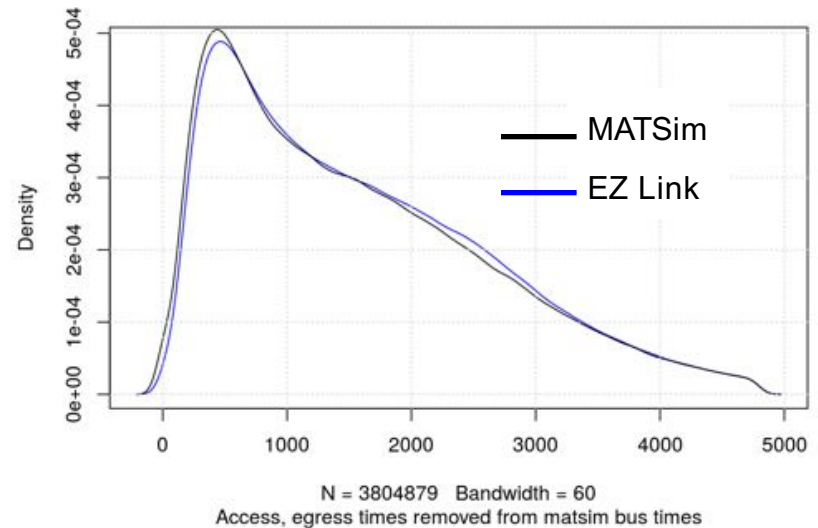
Transfer times



Trip duration (Bus)

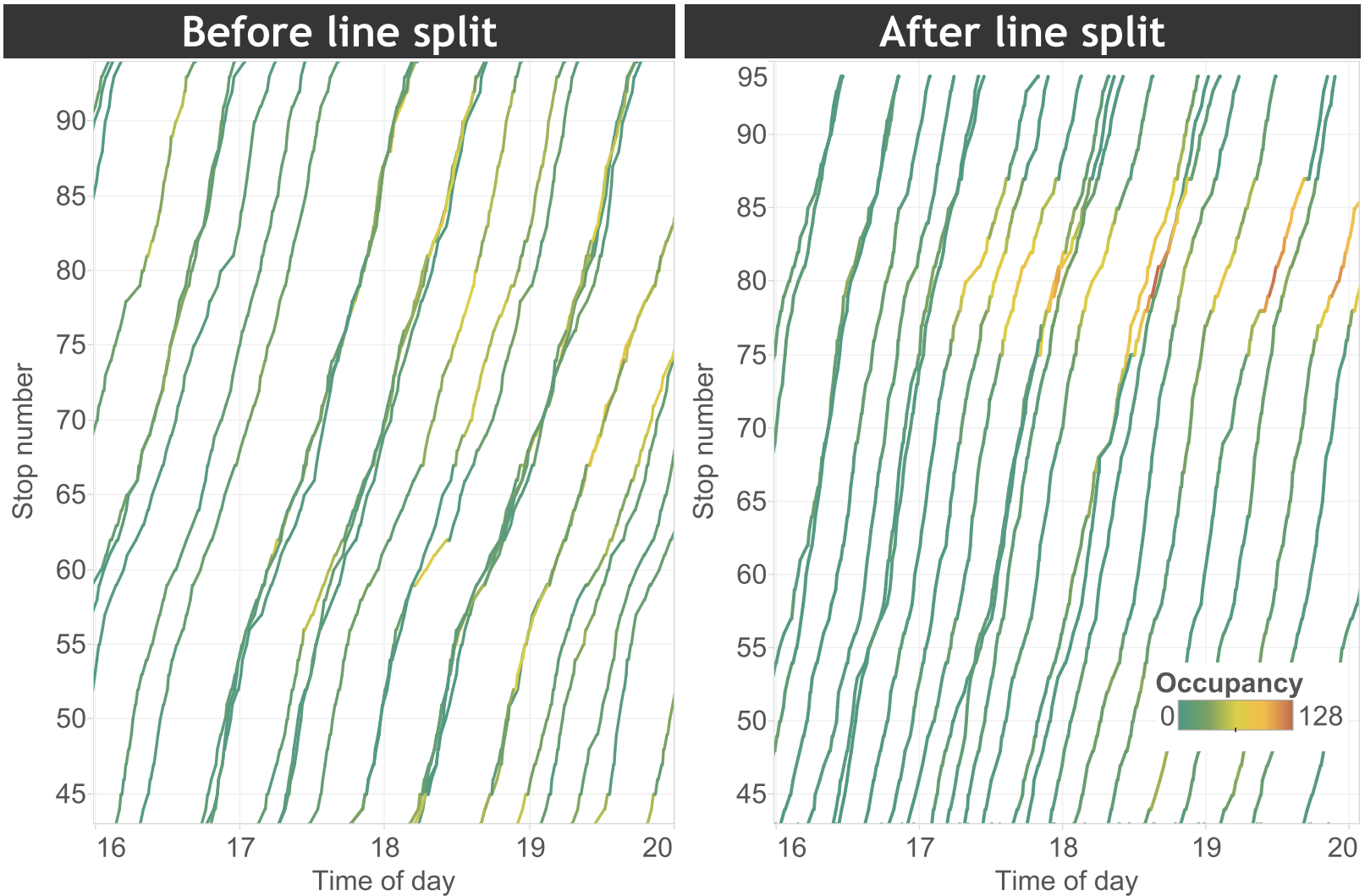


Journey duration all modes

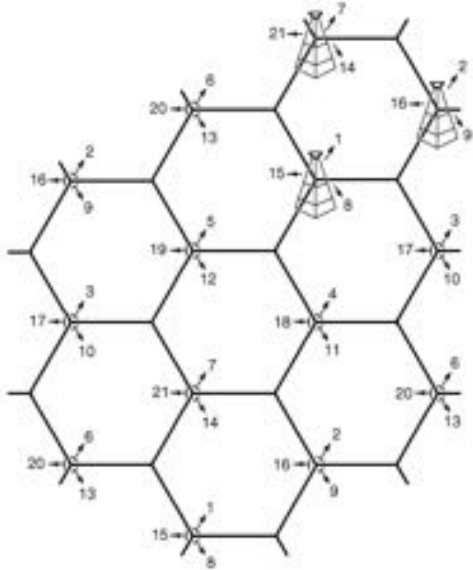


Simulating and evaluating a line split

Reliability before and after line split

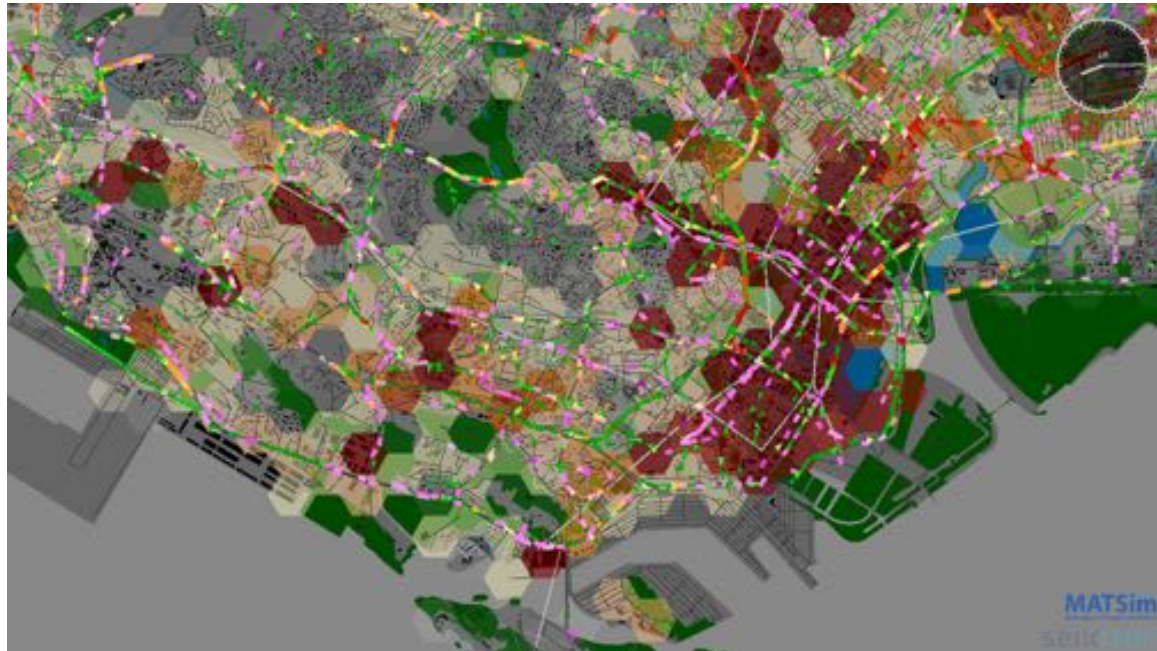


The next step: engaging mobile phone data



Cell tower transaction data is a very rich data source to understand human mobility behavior, in particular in cities.

We will explore how we can use such data to make agent-transport models more scalable, responsive and accurate.



MATSim is a collaborative effort

MATSim is an open source software under active development in various universities and spin-off with model implementation around the world.

Detail documentation available at www.matsim.org

Code repository at <https://github.com/matsim-org>



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Prof. Dr. Kay Axhausen
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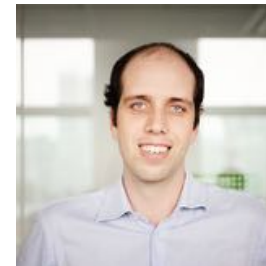
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Computer Scientist



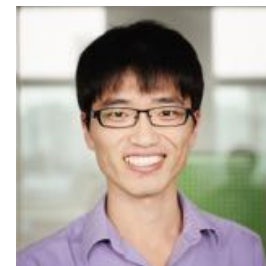
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Pricing



Dr. Lijun Sun
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Thank you.

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