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# CREATE SYMPOSIUM 2015



## From Big Data to Smart Data

Developing a large-scale public transport simulation that runs on Smart Card Data

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8 July 2015		CENTRE	研究甲心

## **MATSim Singapore**

Simulating the mobility of 5.4 million people

## <u>Multi Agent Transport Simulation</u>



### **MATSim Singapore**



# Flashes indicate agent activities starting:

home, **work**, school, shopping, errands and leisure

(FCL) FUTURE

CITIES

LABORATORY

senozon

Multi-Agent Transport Simulation

未来

城市

## Making MATSim accessible for planning practice



#### **MATSim** applications around the world



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#### From Big Data to Smart Data

Applying MATSim for Predictive Modelling based on Smart Card Data

#### The potential of data driven transport planning



#### **Turning Big Data into Smart Data**



#### **Dwell time model**

#### Boarding and alighting process



#### Results of statistical model

Critical occupancy at 63% of total capacity.

Low floor allows short dwell processes.

Double decker alighting time per pax 0.285 seconds longer.

With higher occupancy and number of boarding and alighting passenger -> shorter activity time

Sun, Lijun, Alejandro Tirachini, Kay W. Axhausen, Alexander Erath and Der-Horng Lee (2014). 'Models of Bus Boarding and Alighting Dynamics', *Transportation Research Part A: Policy and Practice* 69: 447–460.

#### Heteroscedasticity of dwell times



Sun, Lijun, Alejandro Tirachini, Kay W. Axhausen, Alexander Erath and Der-Horng Lee (2014). 'Models of Bus Boarding and Alighting Dynamics', *Transportation Research Part A: Policy and Practice* 69: 447–460.

#### Accounting for travel time variability



Derive from Smart Card Data records travel times between stops

Each observed travel time between two subsequent stops contitutes one observation

Independent variables to be either derived from smart card data or GIS data, but do not require any other data source (e.g. traffic flow)

Static variables

- Availability of bus lane
- Number of intersections
- Number of left/right turns
- Curviness
- Deviation from crowfly distance
- Number of traffic lights
- Intersection density

Time-dependent variables

 Boarding/alighting activites in 500m radius

#### Validation



Access, egress times removed from matsim bus times

#### **Evaluation of new services and routes:**

- How can new network designs improve reliability and tackle overcrowding?
- How many passengers will be attracted by a new service?

#### Simulation and analysis:

- A full day simulated in just about 40 minutes.
- Leverage on off-the-shelf business analytic software for interactive analysis.

#### The reliability of a long bus line



### Simulating and evaluating a line split



#### The effect of splitting the line





### **Reliability: Excess waiting time along line**



#### From Big Data to Smart Data

- Use Big Data to understrand the underlying operational patterns of public transport operations
- Agent-based simulation to model the inherent dynamics of public transport operations

# A tool to evaluate alternative service provison

- How do different fare collection alternatives impact service quality?
- Which bus type for which line?
- How to adjust service provision in case on road works or congestion?
- How is the perfomance of alternative network designs?

#### **Further research**

- Inferring activity purposes and locations
- Integration of induced demand

## The team to make it happen



Prof. Dr. Kay Axhausen Pl



Dr. Alex Erath Deputy PI, project manager



Pieter Fourie PhD student Operations Research



Sergio Ordonez PhD student Computer Scientist



Artem Chakirov PhD student Electric Engineer



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### Quantifying the impact of local accessibility



## **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.





MATSim allows to account for taste heterogenity 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.



#### 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?

## **MATSim applications beyond mobility**



#### **Economic potential**

The basic unit of spatial analysis in MATSim 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.





#### **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 ona nation-wide scale.

#### Accessibility analysis

Beside personal attributes and preferences, accessibility to destinations is one of the key determinants of travel behaviour. The data framework behind MATSim allows customised accessibility on the level of individual buildings and across travel modes, including walking and cycling.

# Next: Using MATSim for bus network planning

Iterative learning approach:

- Profitable lines increase frequency by adding more buses
- Non-profitable lines lower frequency and may die out

New lines created either from scratch or by altering existing lines

The model automatically adapts supply to demand



## Validation of optimisation model: the case of Berlin

