Reference

- Balmer, M. (2012), Stochastic user equilibrium in a fully integrated, agent-based travel demand modeling and traffic simulation environment, presentation at ITM 2012, Tampa, Florida, April 2012

May 29th 2012, Tampa (FL) / ITM 2012

Stochastic user equilibrium in a fully integrated, agent-based travel demand modeling and traffic simulation environment

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Transport Planning

THE CUSTOMER POINT OF VIEW

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Questions

- Transport infrastructure providers (public and private)
  - Who uses (who has to pay for) a new motorway around a city?
  - Who and how should I charge for congestion?
  - Why does bus bunching at line X always occur after 9:30 am?
  - How to define optimal zones in a zonal pricing system for pubic transit?
  - Where can I find potential customers for public transport?
  - Where should I add new car sharing stations?

Questions

- Site assessment and location planning
  - What is the market potential of locations for specific markets?
  - How many potential customers / passers-by are in front of my shop?
  - Where should I put my next shop such that I reach others than the customers I already have?
  - Most of my employees have to have a degree in higher education. Where should I relocated my company to reach as many (potential) employees with that profile within 30 minutes commuting time with public transportation?
- And
  - “I need something to show, that my boss understands.”

To summarize (from the transport planning point of view)

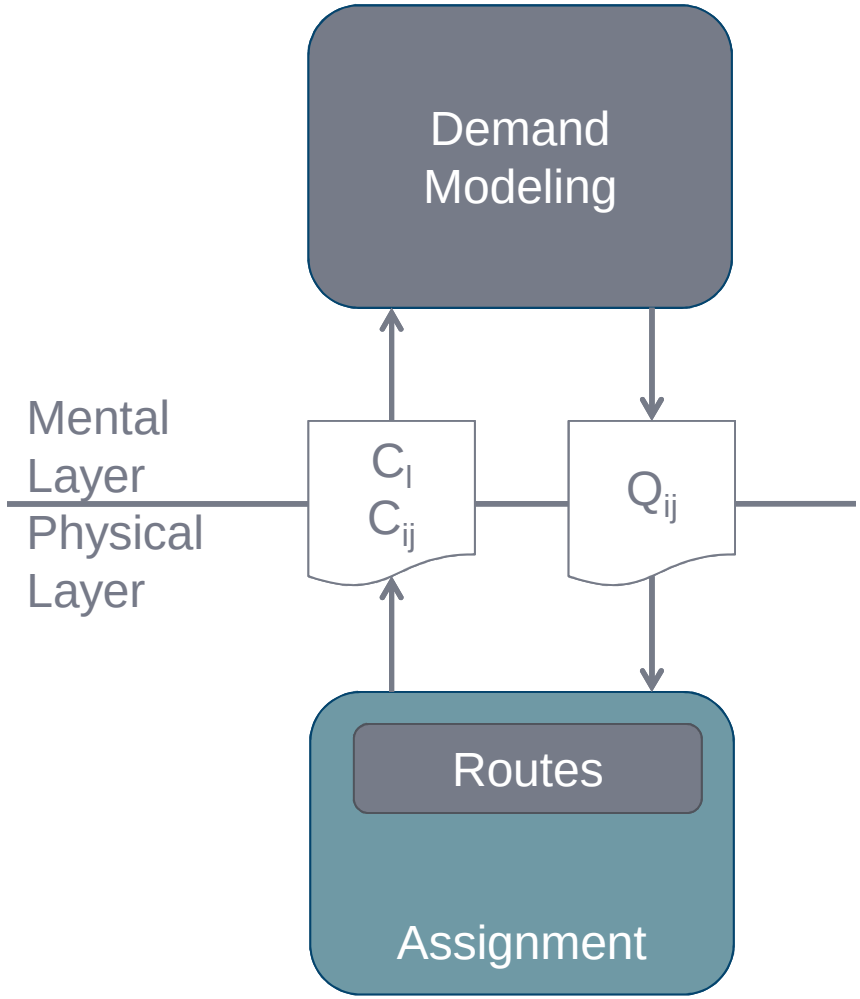
- “Person tracking” / “Moving” (socio-)demographics (customer groups) during the day
- Time dynamic demand & supply (availability)
- High level of spatial detail
- Interaction of different modes (e.g. multi-modal trips)
- “WYSIWYG”

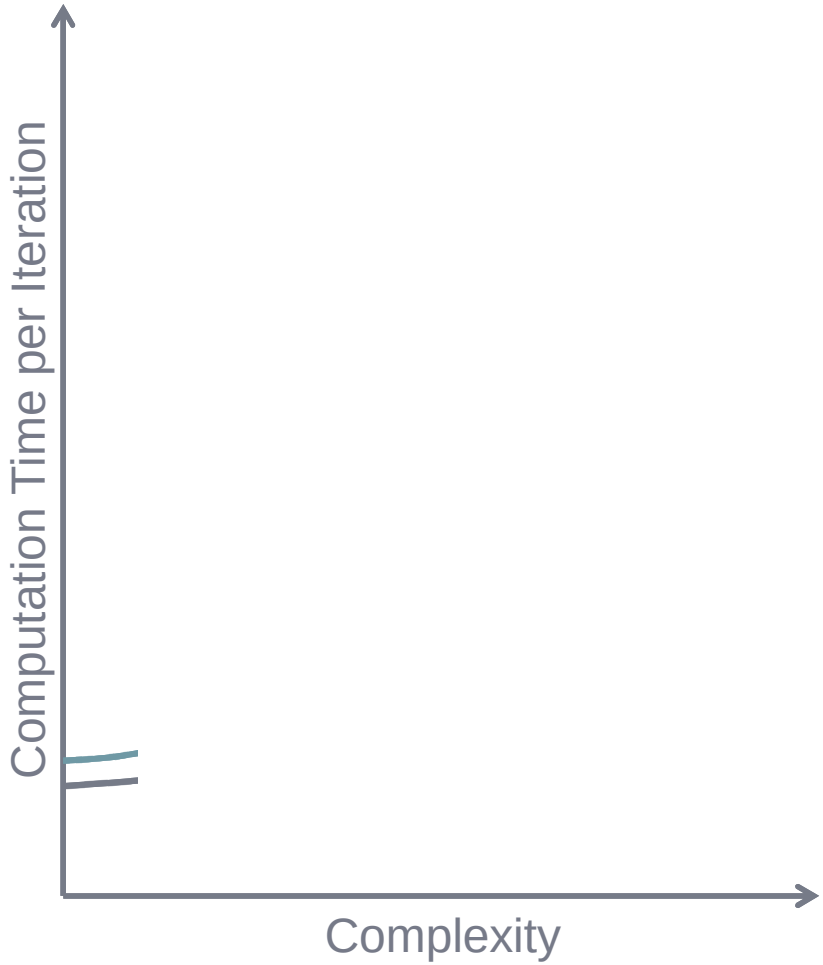
Integrated, agent-based travel demand modeling and traffic simulation can actually cope with all aspects

Computational Aspects

“PERSON TRACKING”

Demand & Assignment: One mode, one group, static





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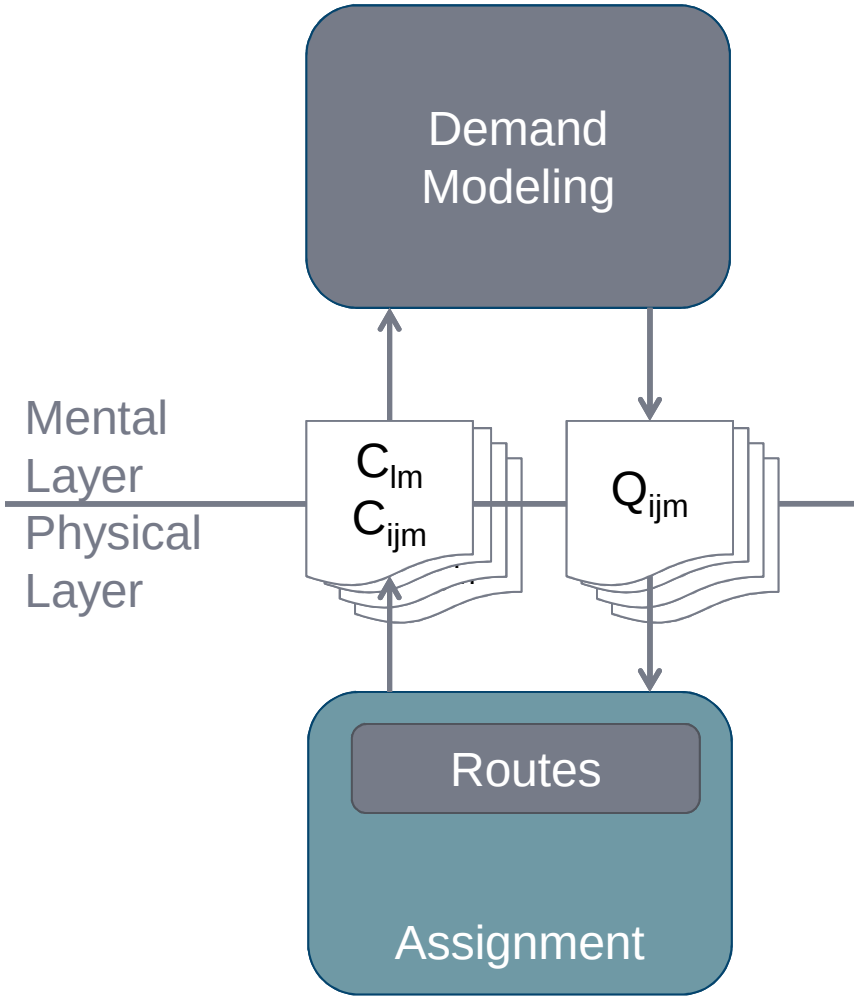
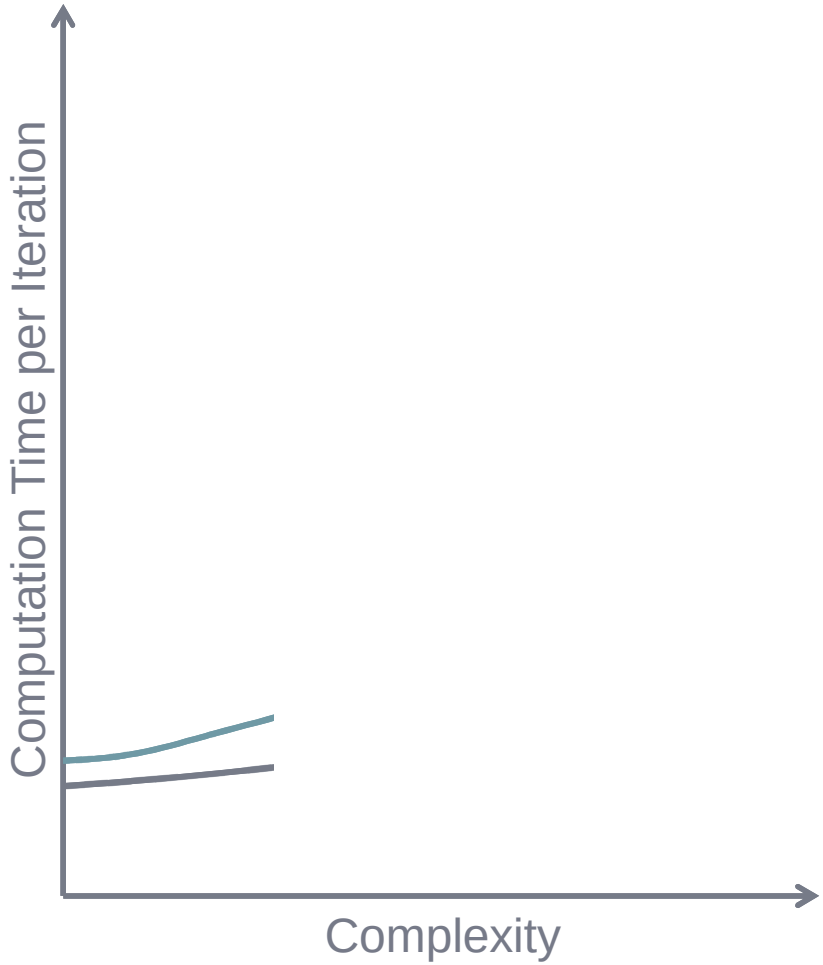
Demand & Assignment: 4 modes, one group, static





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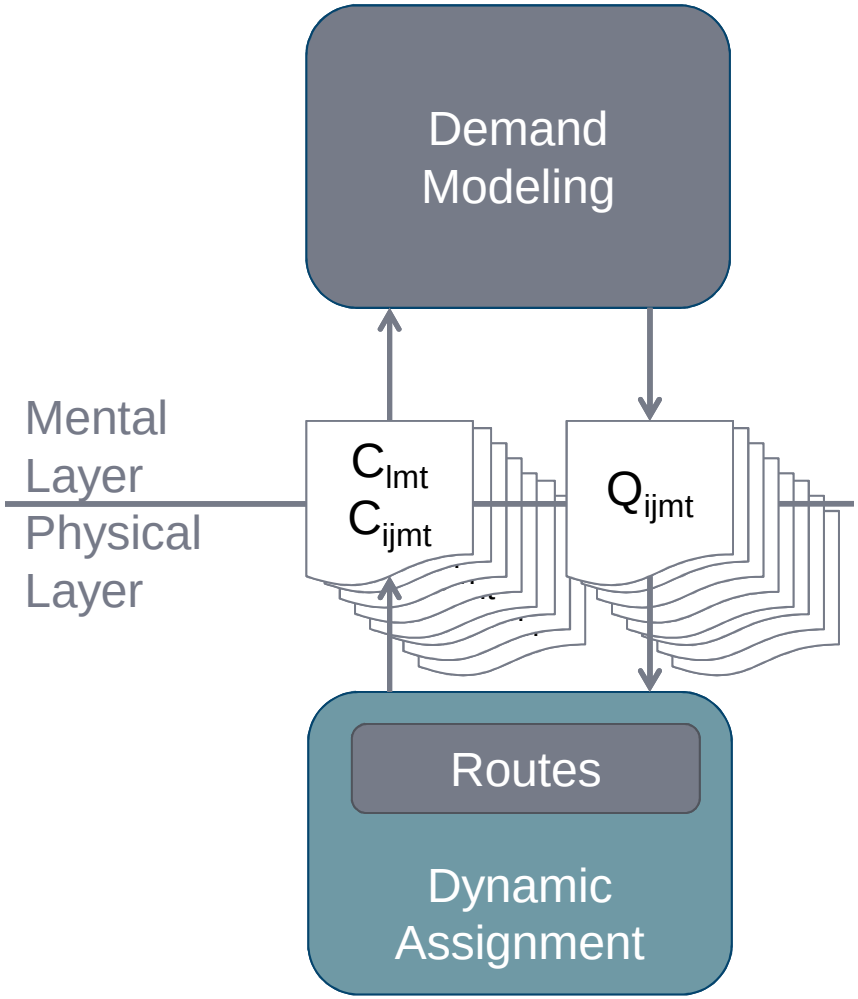
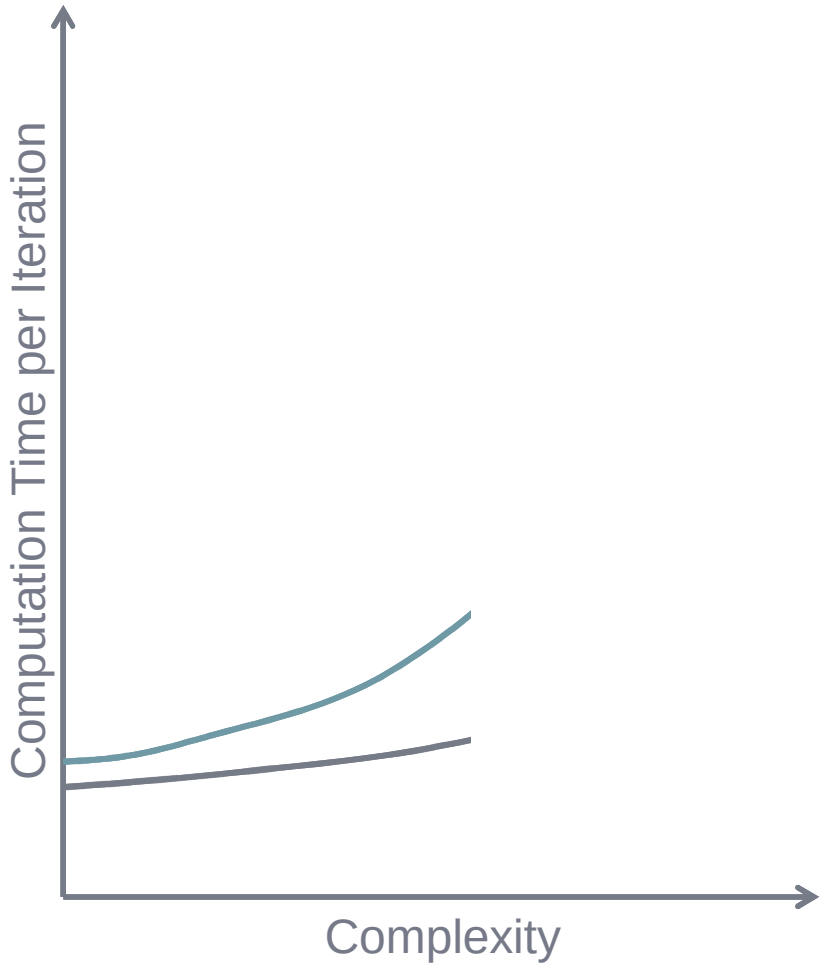
Demand & Assignment:
4 modes, one group, dynamic





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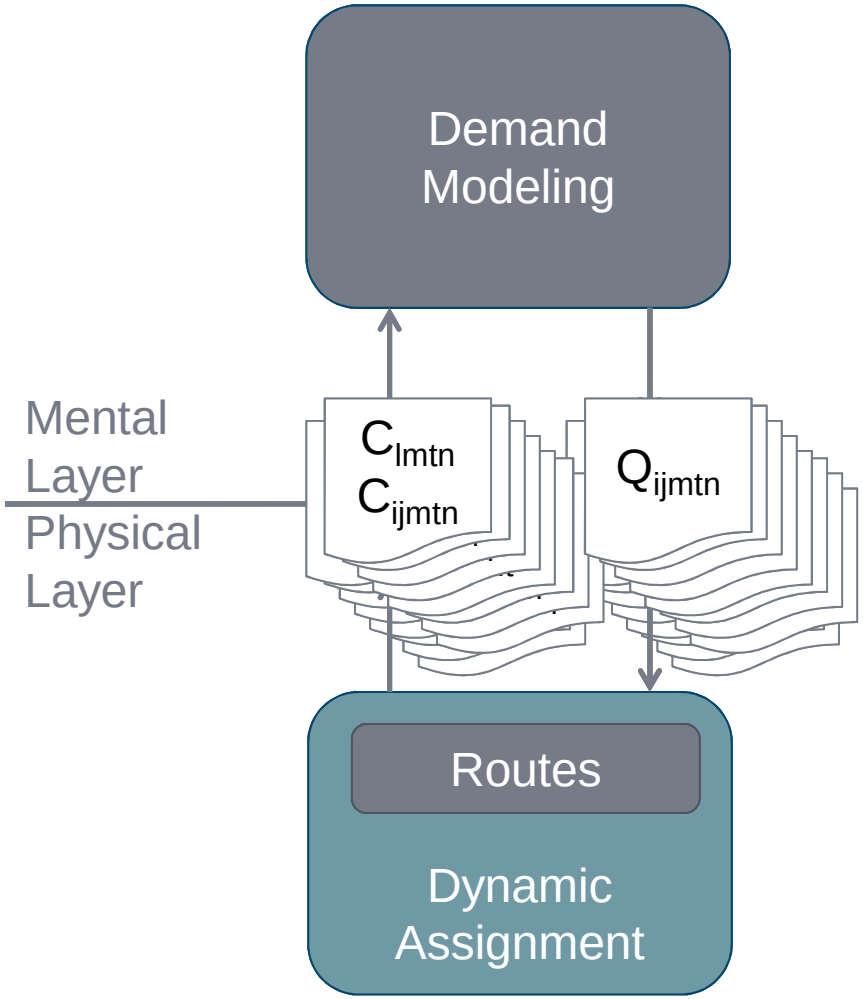
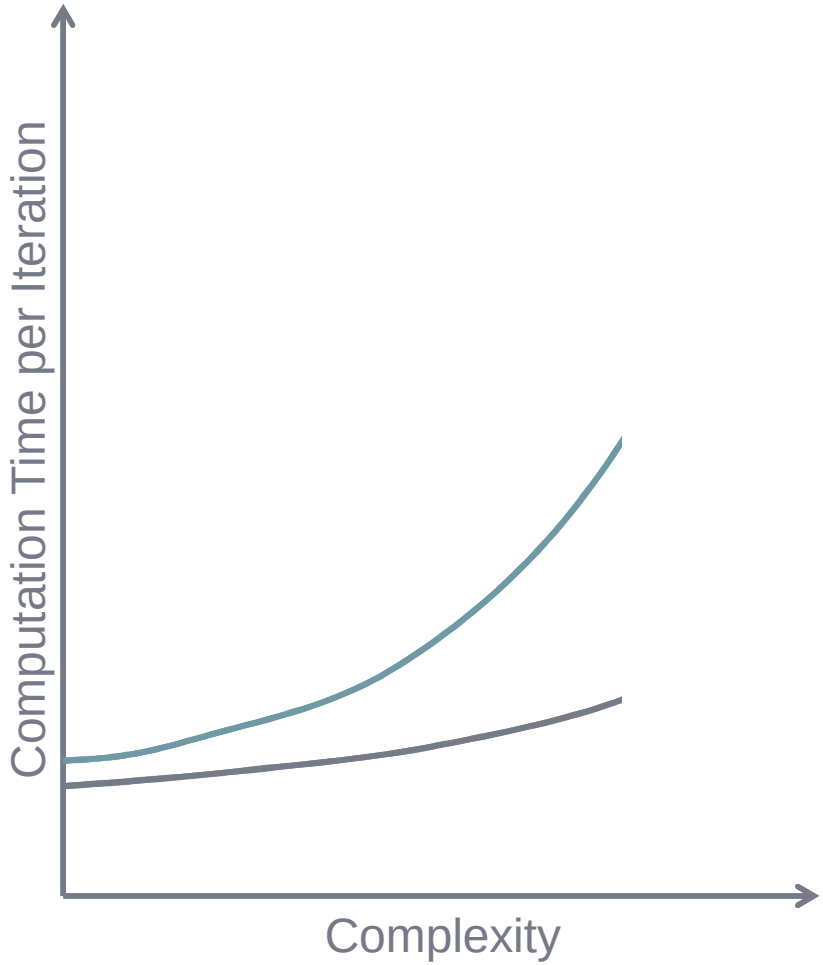
Demand & Assignment:
4 modes, *n* OD-groups, dynamic





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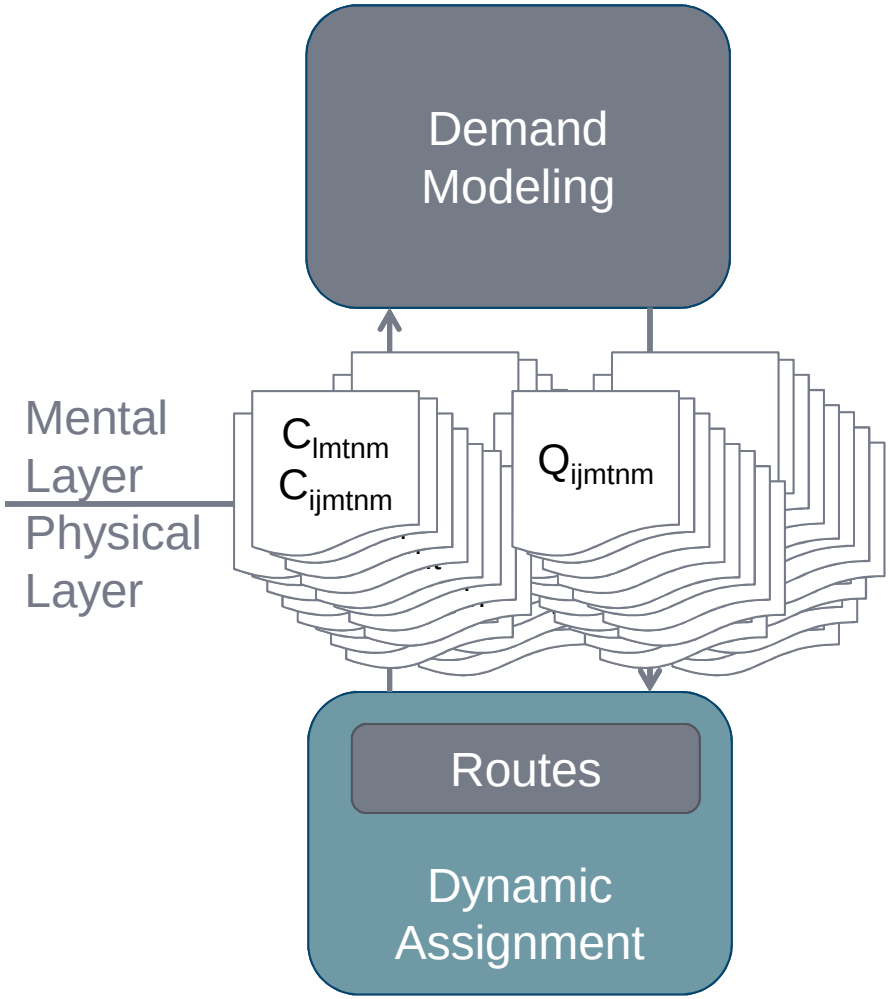
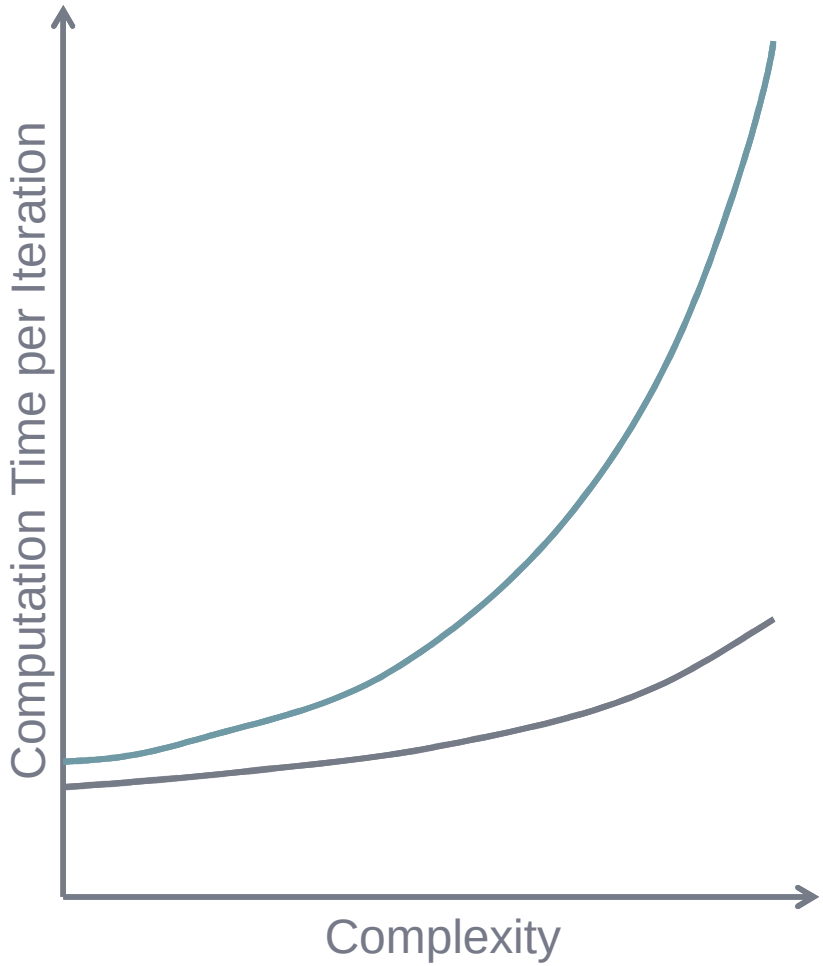
Demand & Assignment:
4 modes, *n* OD-groups, m population groups, dynamic





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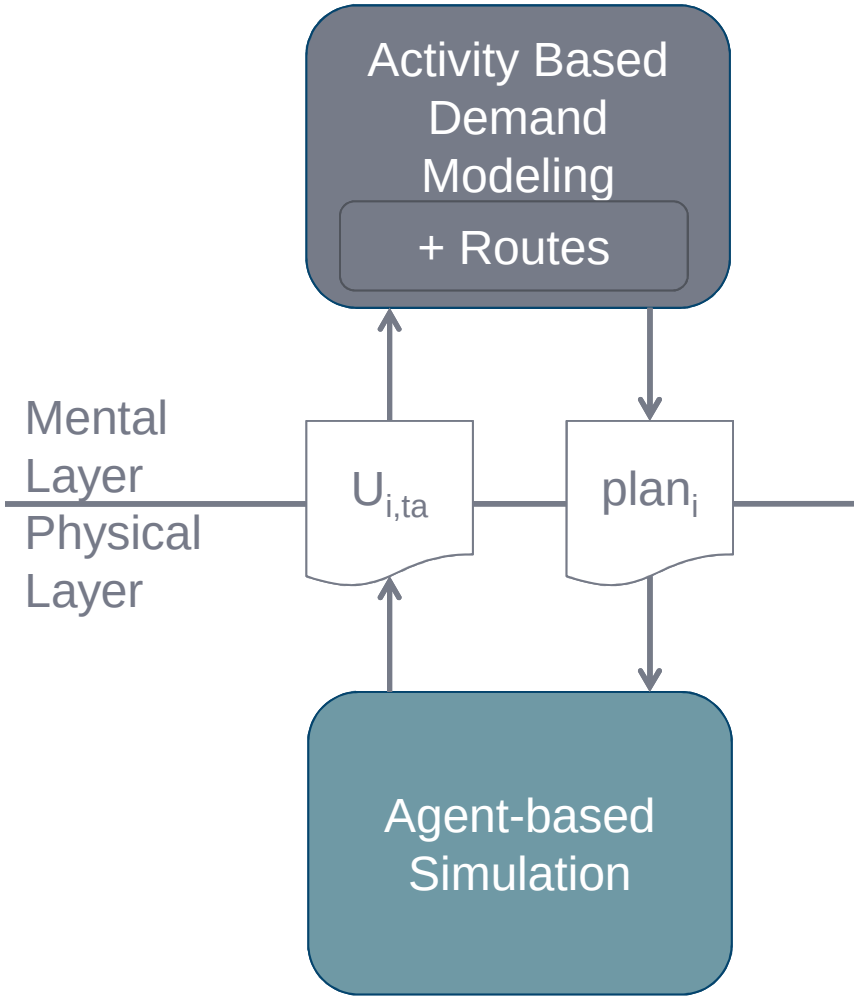
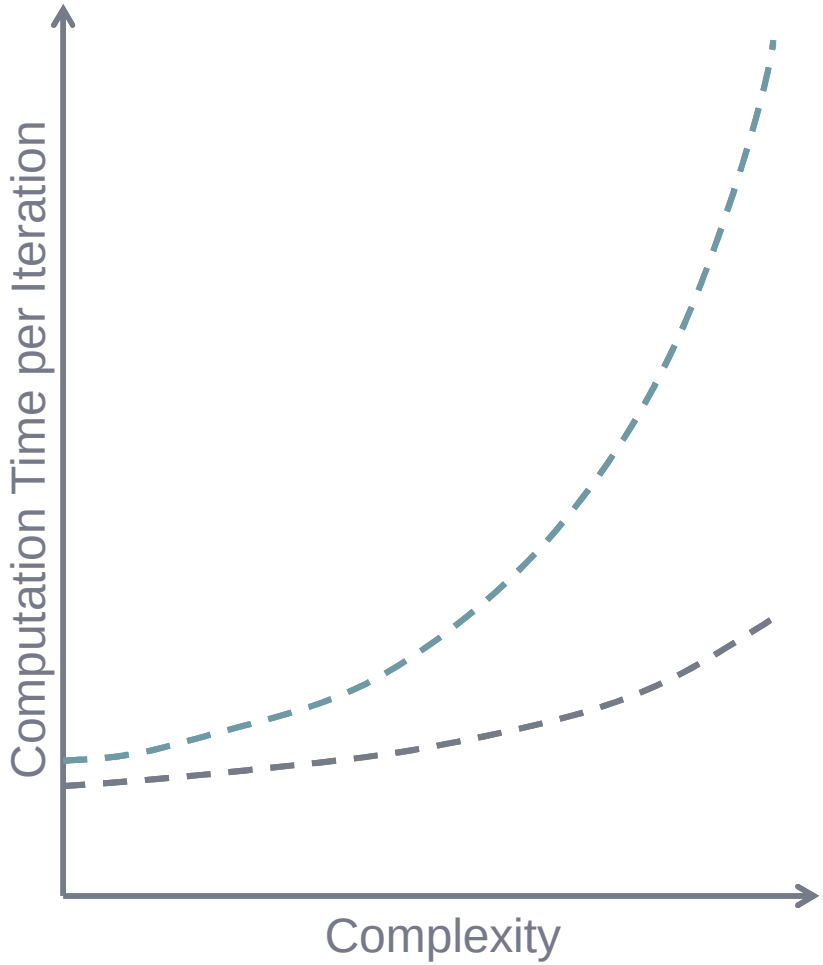
Activity Based Demand & Simulation





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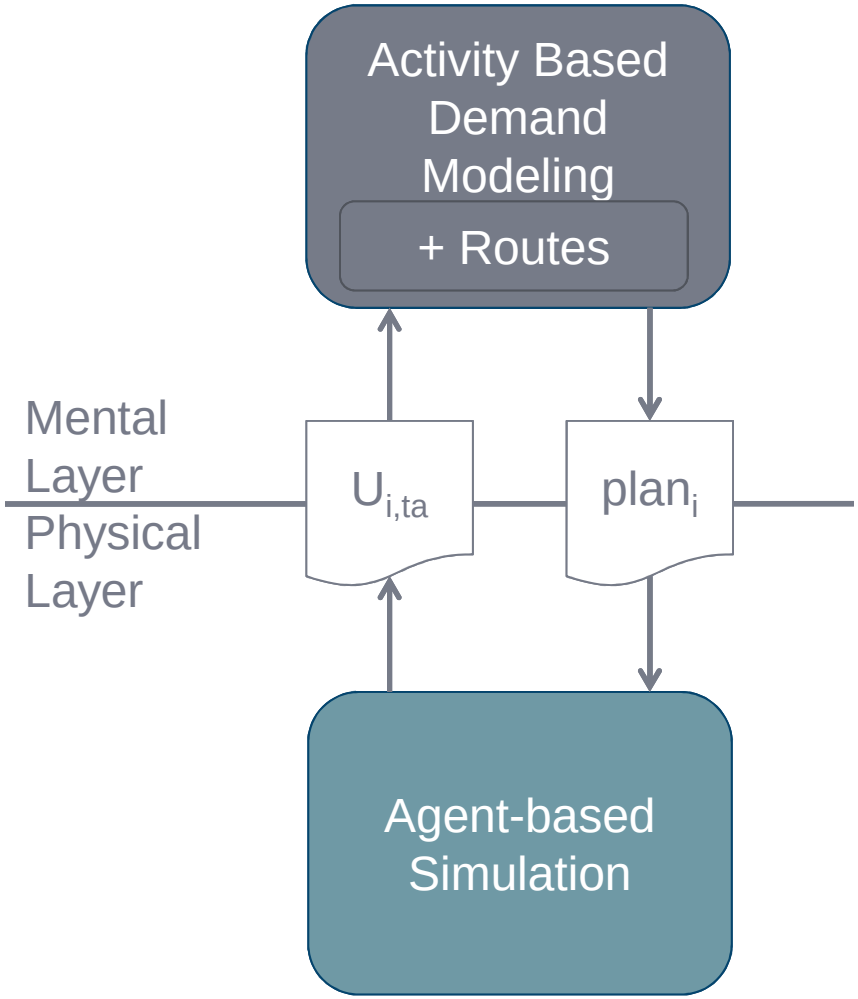
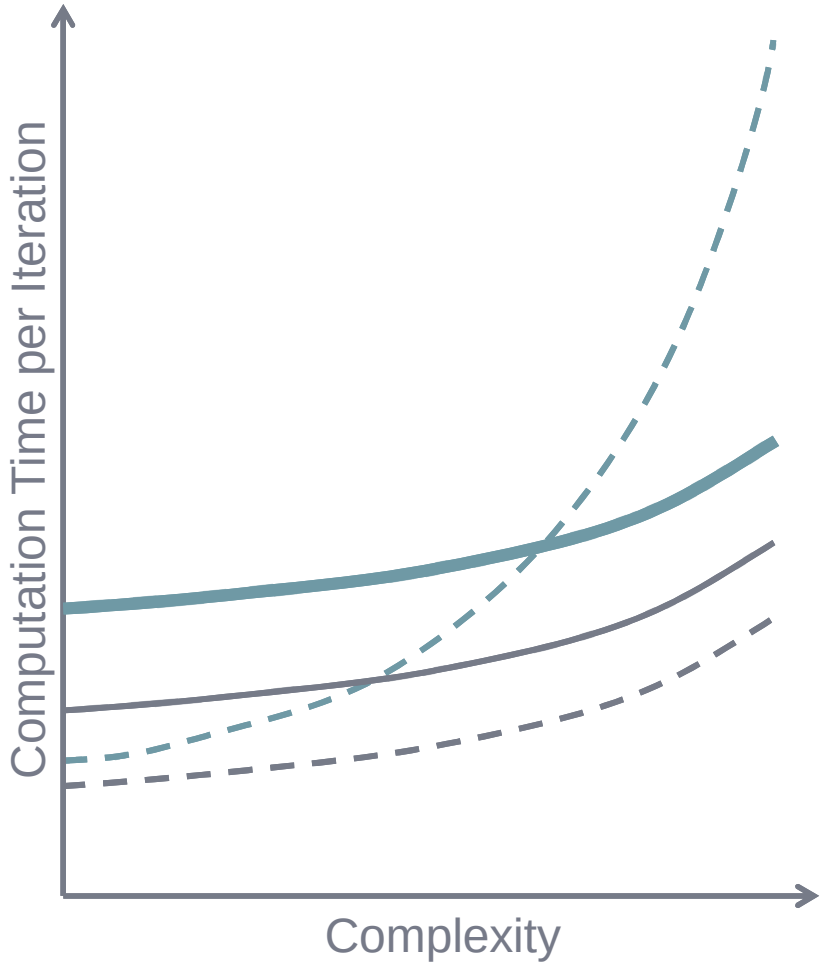
Activity Based Demand & Simulation





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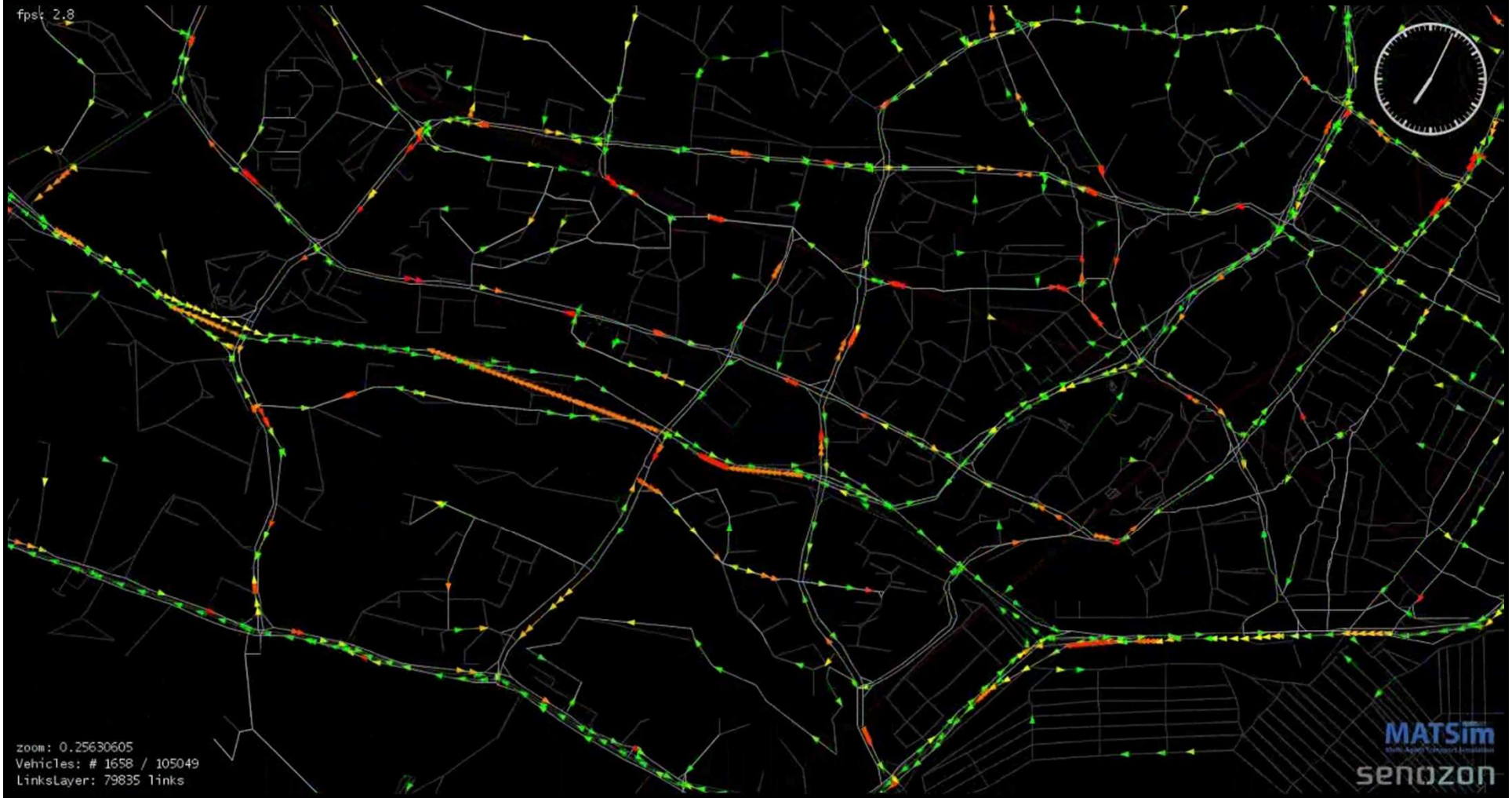
Continuous Time versus Time Bins

TIME DYNAMIC SIMULATION

Continuous time



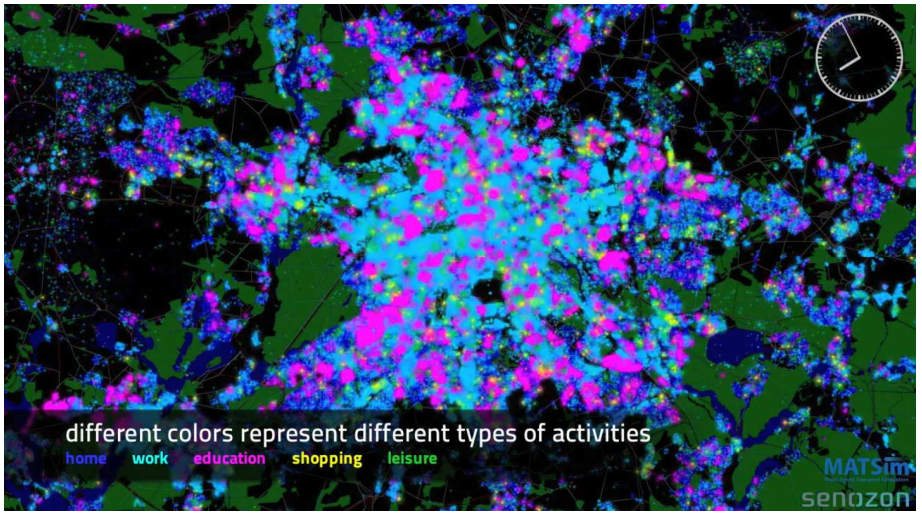
FCL, Singapore (2012) Video available at http://www.vimeo.com/24822377

Coordinates versus Zones

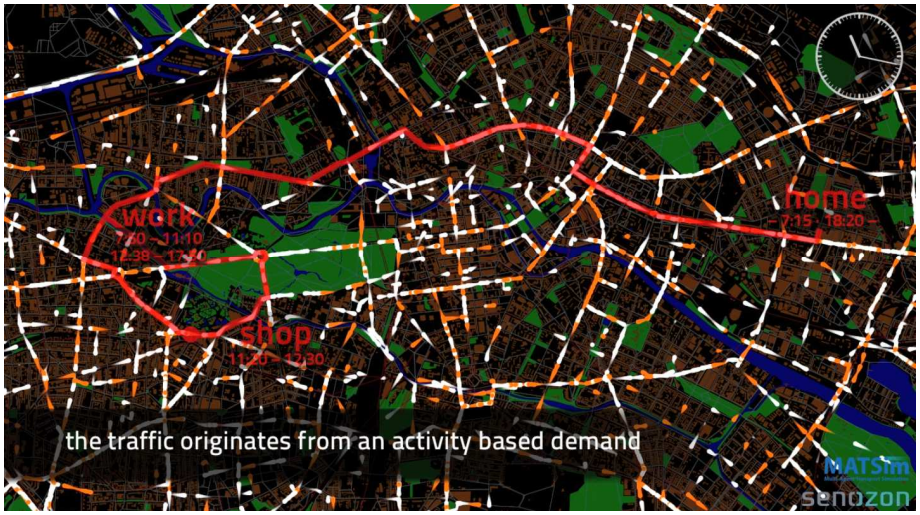
HIGH LEVEL OF SPATIAL DETAIL

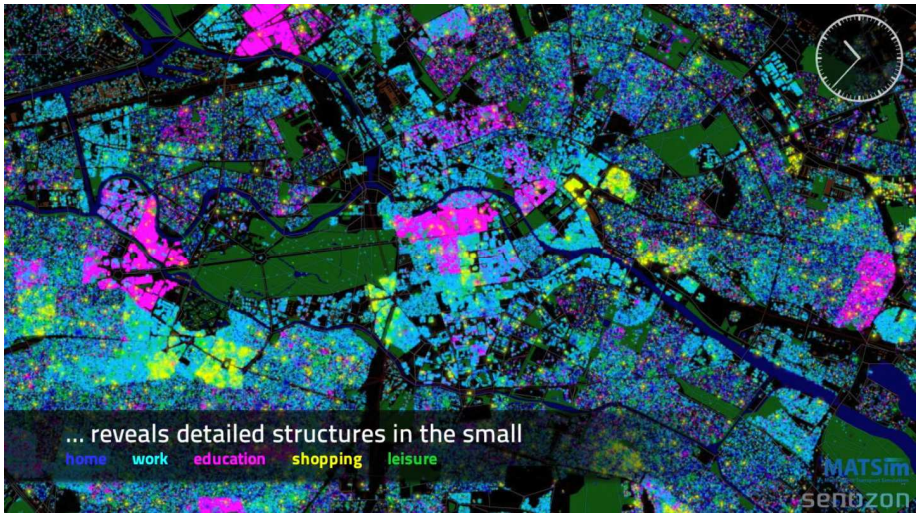
Coordinates versus Zones

- Level of detail defined by
  - Network links
  - public transit stops (coordinate)
  - Facilities / activity opportunity (coordinate)



Berlin Model 2011, Video available at http://senozon.com/blog/20120312/matsim-model-berlin-level-detail





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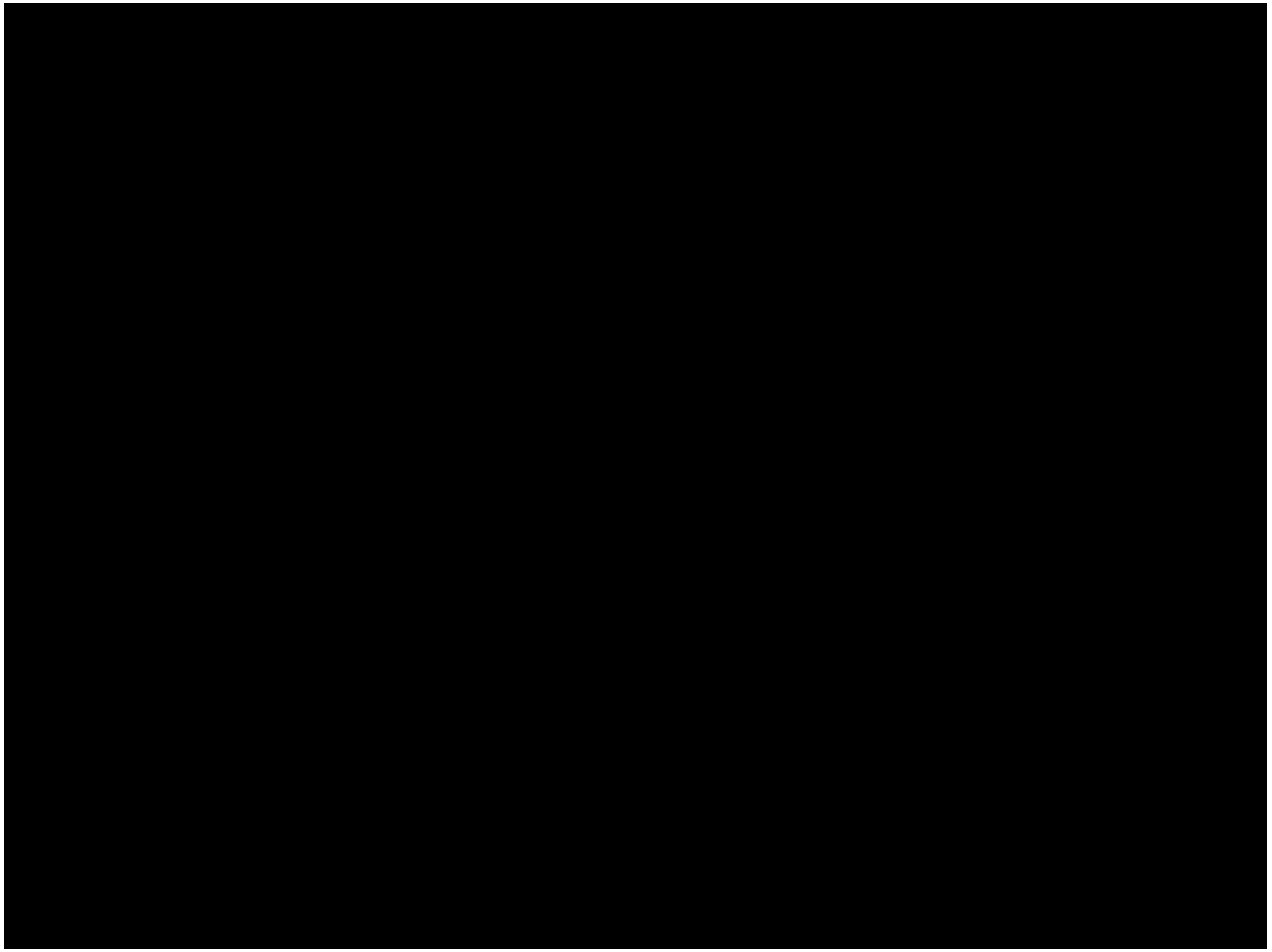
Multi-Modal Network Representation

INTERACTION OF MODES

A Bus in Congestion



Berlin Model, version Dec. 2010, 10 % sample, not calibrated

Visualization

WYSIWYG

Agent-based approach

STOCHASTIC USER EQUILIBRIUM

SUE for Aggregated Flows

Definition

- “In a SUE network, no user believes he can improve his travel time by unilaterally changing routes.” (Daganzo and Sheffi, 1977)

Operational

- The traffic flows from each OD-pair is derived from a choice distribution over a given (feasible) choice set
- The choice set itself is derived from a definition of the generalized costs of all routes from O to D

Agent-based SUE

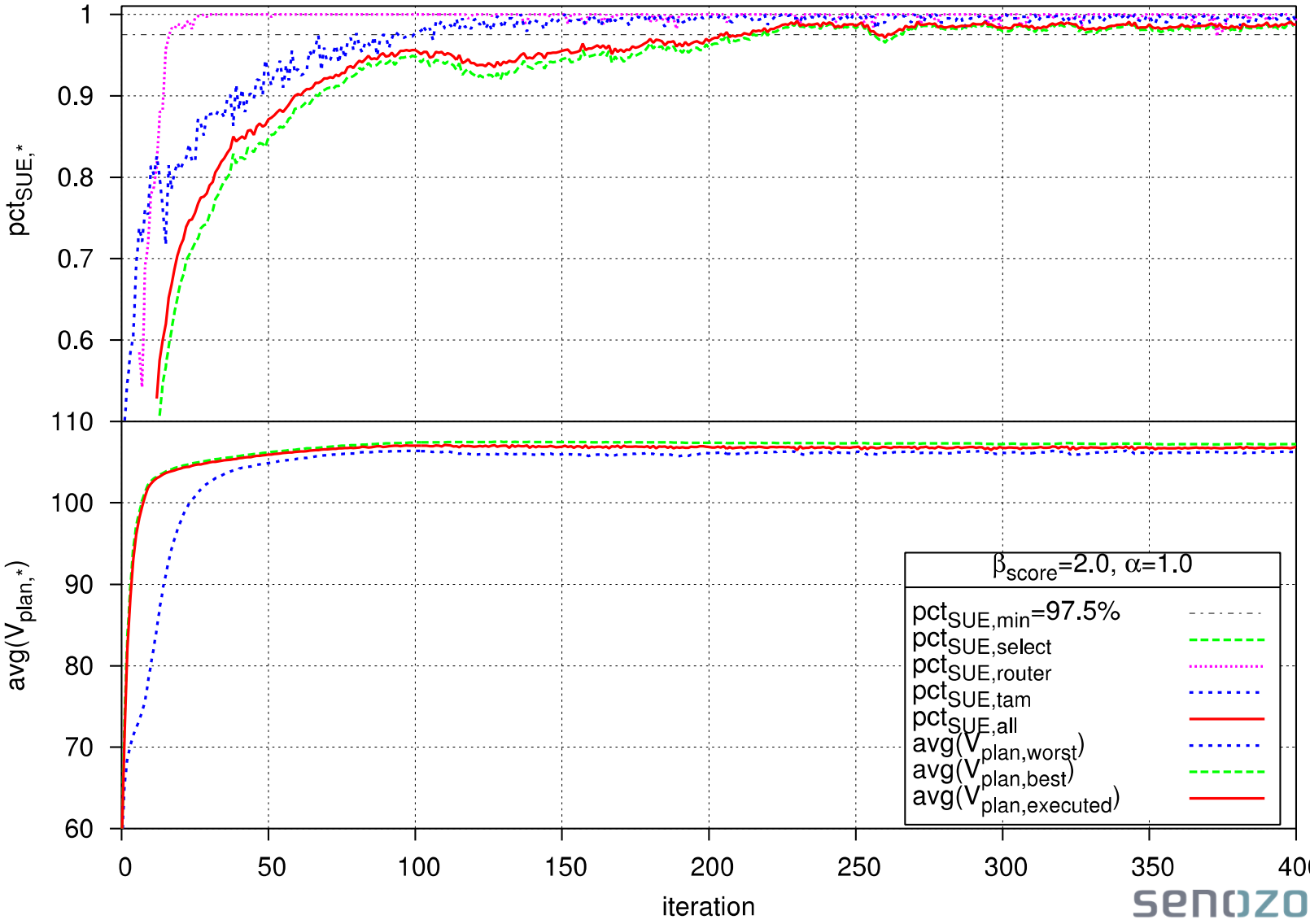
Definition

- “An agent-based SUE [. . .] is defined as a system state where agents draw from a stationary choice distribution such that the resulting distribution of traffic conditions re-generates that choice distribution. [. . .] It implies that every agent considers a whole choice of (possibly suboptimal) plans and selects one of these plans probabilistically.” (Flötteröd and Nagel, 2009)

Operational

- “An agent-based SUE is defined as a system state where the number of agents which perceive that they can improve their state is minimized, given a dynamic environment where a constant share of all agents change their plans.” (Meister, 2011, Chapter 2)

SUE Example in MATSim (route and time replanning)



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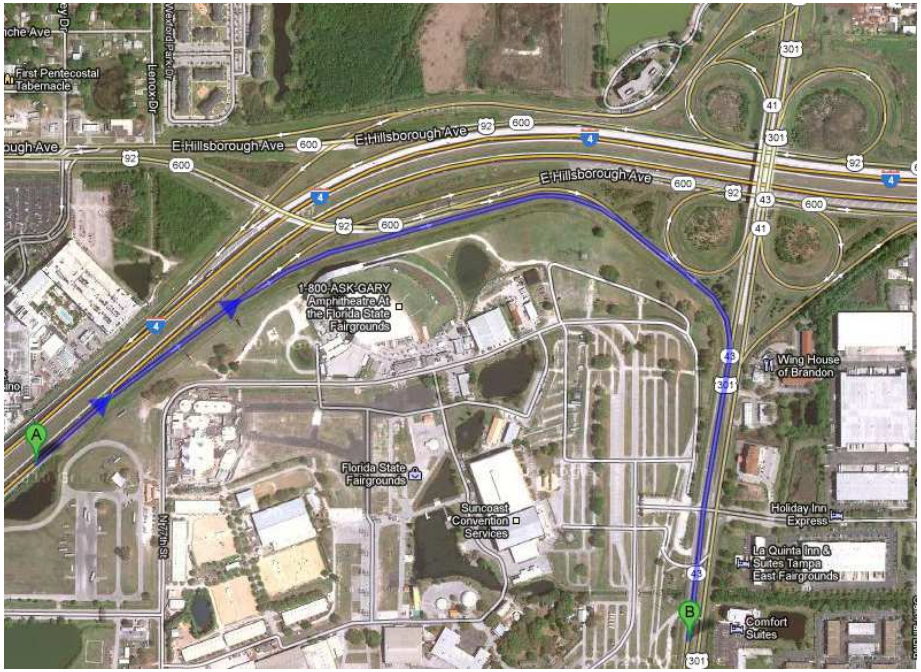
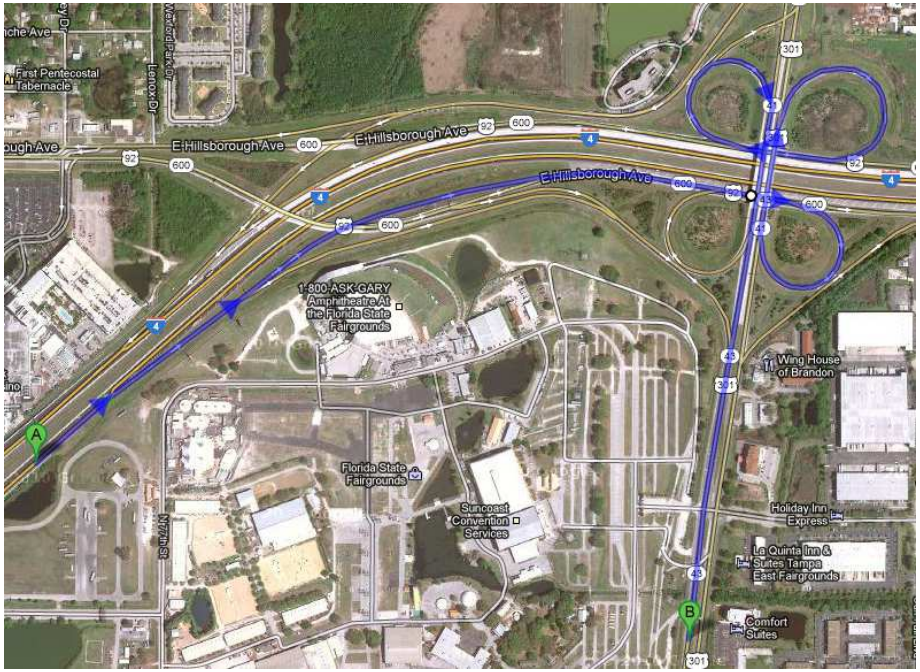
Thoughts About the (Route) Choice Sets





Source: Google Maps (2012)

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Open Questions

- What is a suitable share of agents for a SUE?
- Does the relaxation always reaches an SUE (considering any choice dimensions)?
- Does the relaxation process produce a suitable choice set?
- …

Thank you

- http://senozon.com
  http://matsim.org
  http://ivt.ethz.ch
  http://vimeo.com/search?q=matsim
- Meister, K. (2011) Contribution to agent-based demand optimization in a multi-agent transport simulation, dissertation, ETH Zurich, Zurich.
- Nagel, K. and G. Flötteröd (2009), Agent-based traffic assignment: going from trips to behavioral travelers, paper presented at IATBR, Jaipur.

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