A framework for the data-consistent deployment of urban microsimulations

Gunnar Flötteröd and Michel Bierlaire

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Outline

Integrated transportation land use simulation

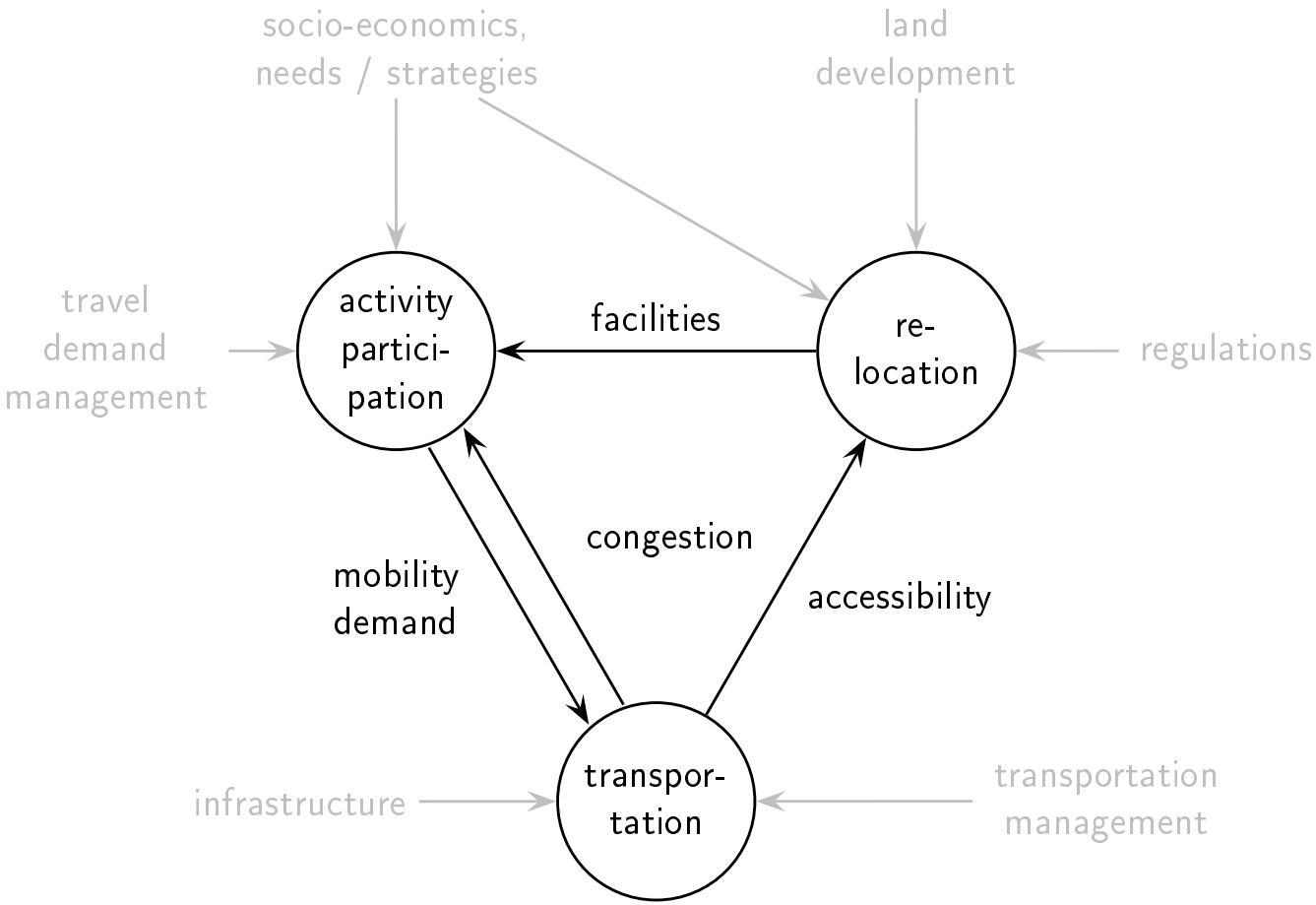
An old criticism of OD matrices

Truly microscopic urban traffic state estimation

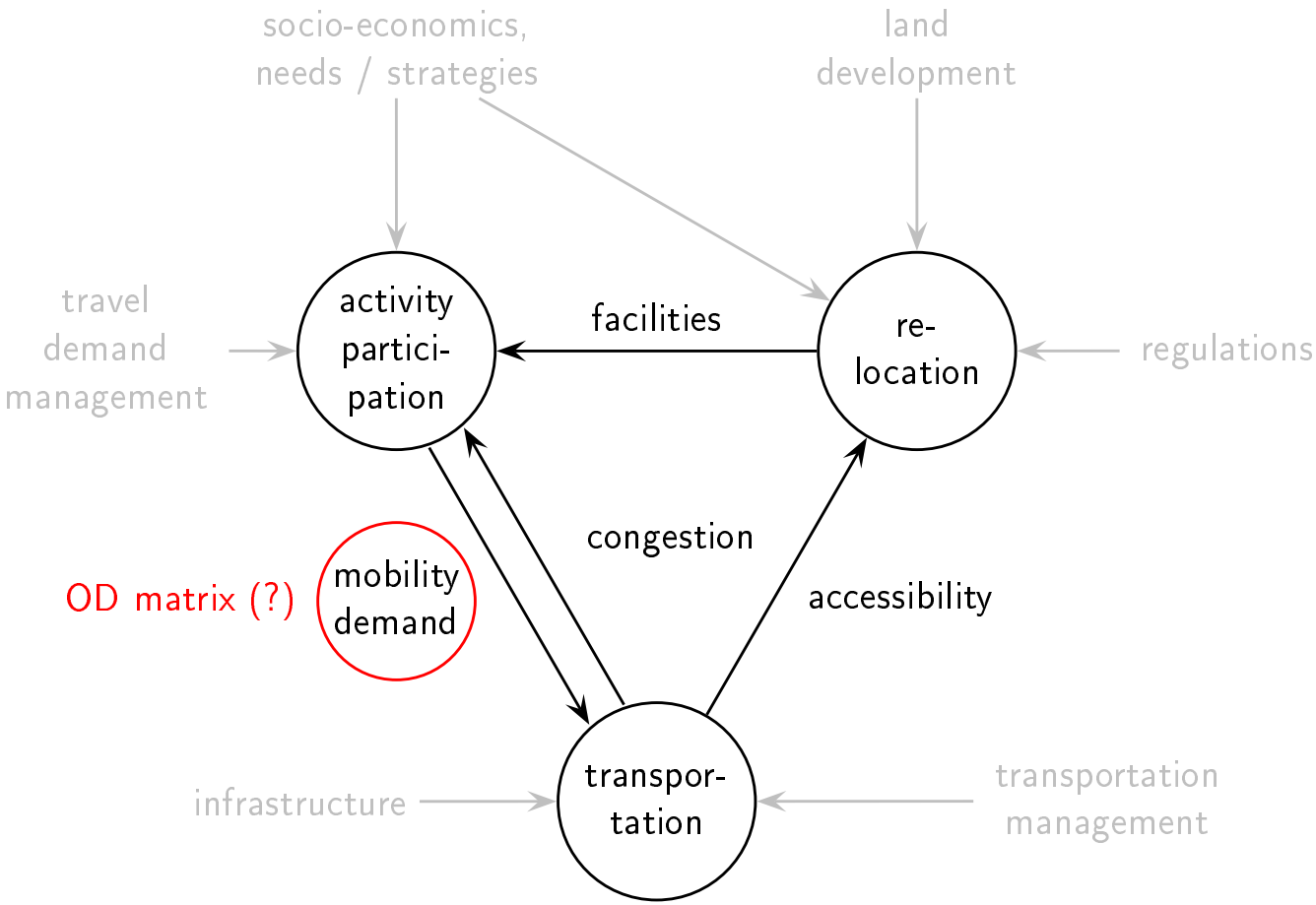
Outlook & summary

Outline

Basic processes



Basic processes



Basic processes: dynamics, data, resolution

	time scales	data sources	data resolution
transportation	short (seconds)	network sensors	aggregate or by vehicle
activity participation	medium (days)	surveys, personal sensors	by individual actor
relocation	long (years)	measurable	by individual actor

- process interactions are reflected in the data
- exploit this when estimating the model system

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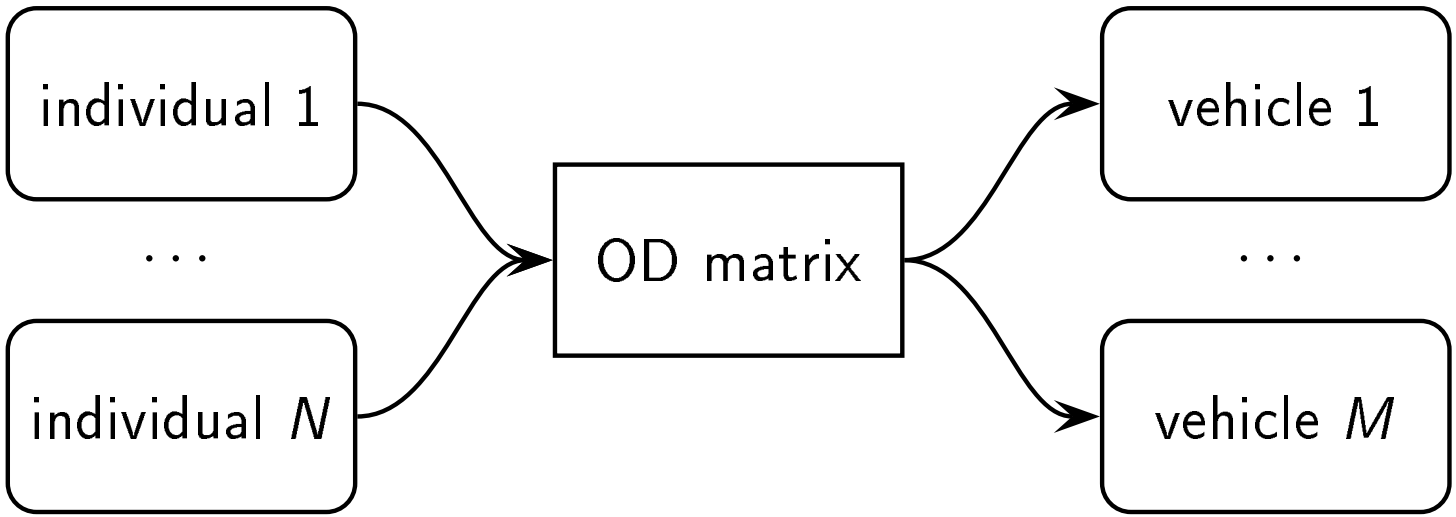
Activity participation $\longrightarrow$ transportation



1. individual-level microsimulation of activity participation
2. OD matrices represent *aggregations* of realized choices
3. transportation microsimulation samples *anonymous* vehicles

OD matrix estimation

- adjustment of trip intensities is at most a mesoscopic technique
- does not account for
  - behavioral a priori information
  - trip linkage (reduces problem dimension)
  - individual-specific behavior (heterogeneity)
- same holds for path flow estimators
- why not estimate the individual-level choices directly?

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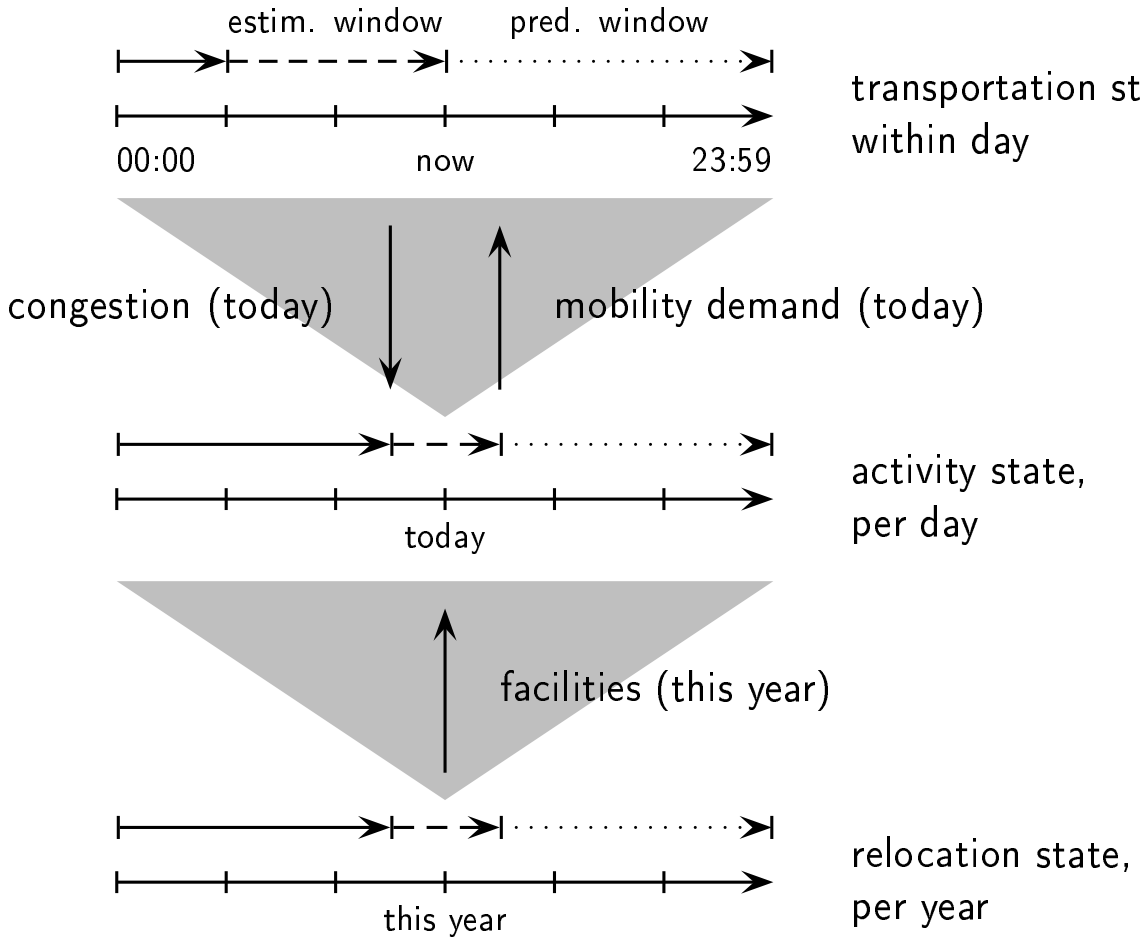
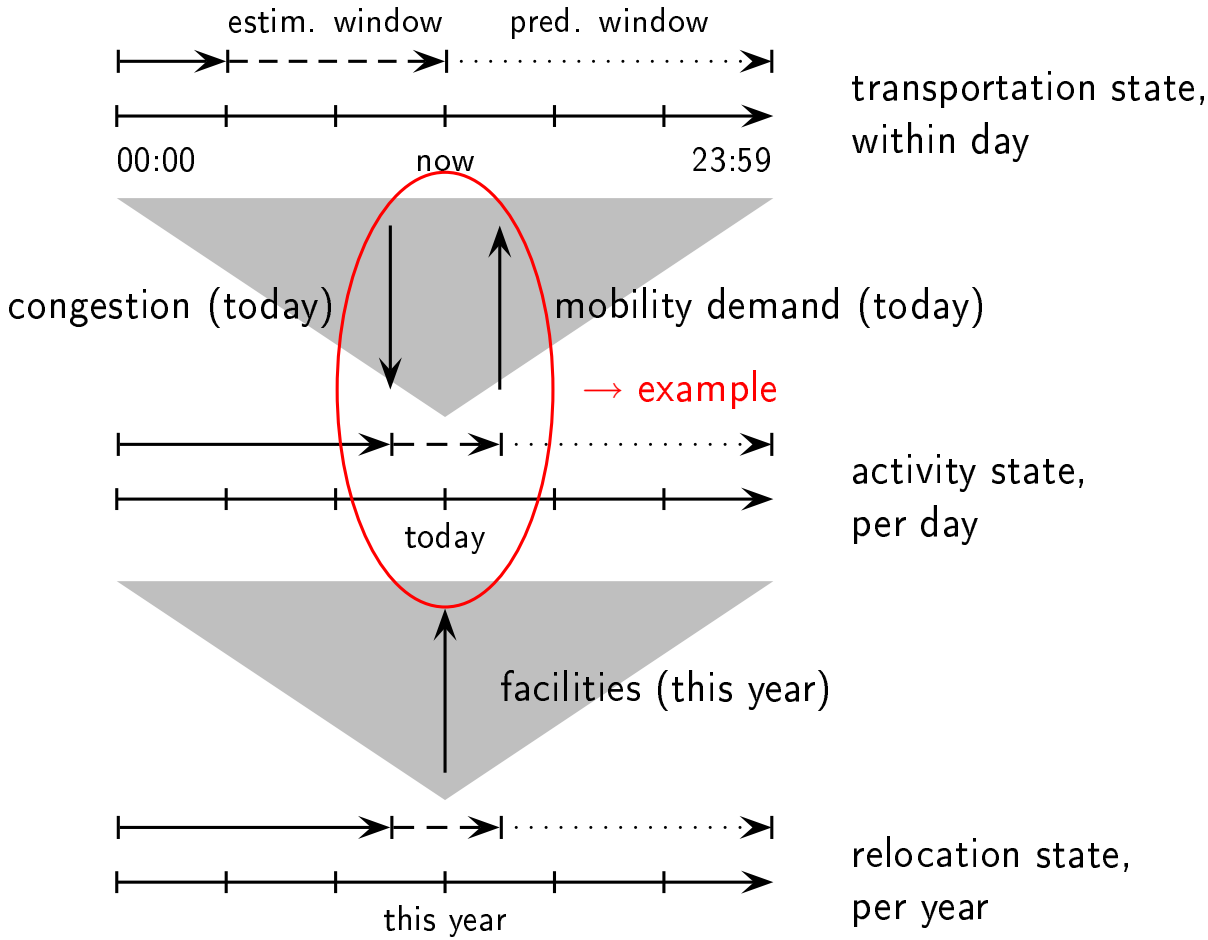
Multiple rolling horizons



Multiple rolling horizons



Example: Zurich scenario

- configuration
  - network with 60 492 links and 24 180 nodes
  - 187 484 travelers
  - hourly vehicle counts from 161 sensors
- estimate
  - route choice
  - departure time choice
  - mode choice

for every single agent

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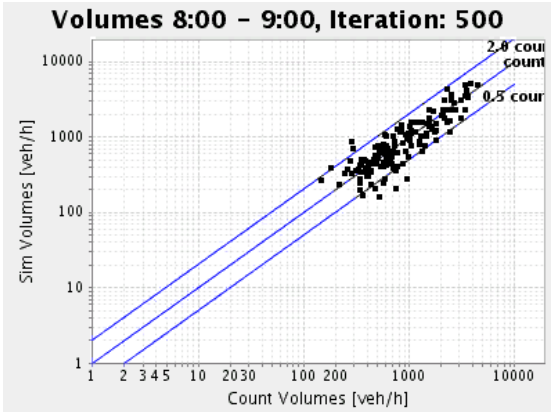
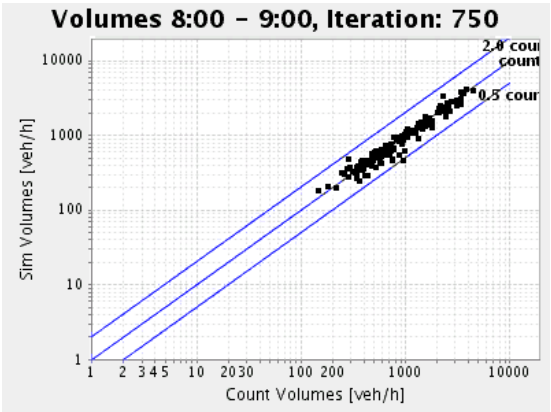
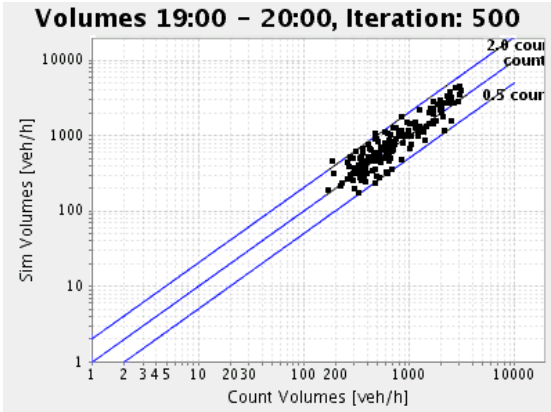
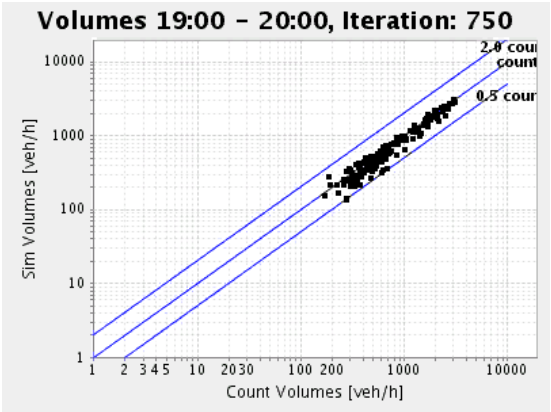
Example: estimate activities from network data

- discrete choice model of travel behavior
  - $V_n(i)$ is utility of travel plan i as perceived by individual n
  - $P_n(i) \sim \exp(V_n(i))$ is respective plan choice probability
- network data: traffic counts
  - y_{ak} is traffic count on link a in time step k
  - σ^2_{ak} is variance of counting error
- inference yields

$$P_n(i|\{y_{ak}\}_{ak}) \sim \exp\left(V_n(i) + \sum_{ak \in i} \frac{y_{ak} - q_{ak}}{\sigma^2_{ak}}\right)$$

  - q_{ak} is simulated flow on link a in time step k
  - increases utility of more plausible plans

Example: results, qualitatively

	plain simulation	with calibration
morning		
evening		

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Example: results, quantitatively

	reproduction $(\cdot)^2$ error	validation $(\cdot)^2$ error	computing time for 24 h traffic
plain simulation	103.6	103.6	133 sec
calibrated simulation	20.9	75.1	146 sec
relative difference	- 80 %	- 28 %	+ 9 %

- 10-fold cross-validation
- computationally feasible

Outline

Outlook: some challenges

- disaggregate models need disaggregate data
  - vehicle re-identification
  - smart phones
  - anonymous yet disaggregate (online) estimation
- estimation of choice models needs choice context
  - non chosen alternatives, attributes of alternatives
  - integrated calibration: *impute* choice context
  - tractability issues
- ...

Summary

- urban microsimulations comprise many processes
  - different time scales
  - different data sources
- exploitation of disaggregate models and data sources needs
  - microscopic process interfaces
  - microscopic estimation techniques
- the OD matrix estimation paradigm
  - does not reflect information generated by microsimulations
  - can be replaced by disaggregate techniques