An agent-based model for modal shift in public transport

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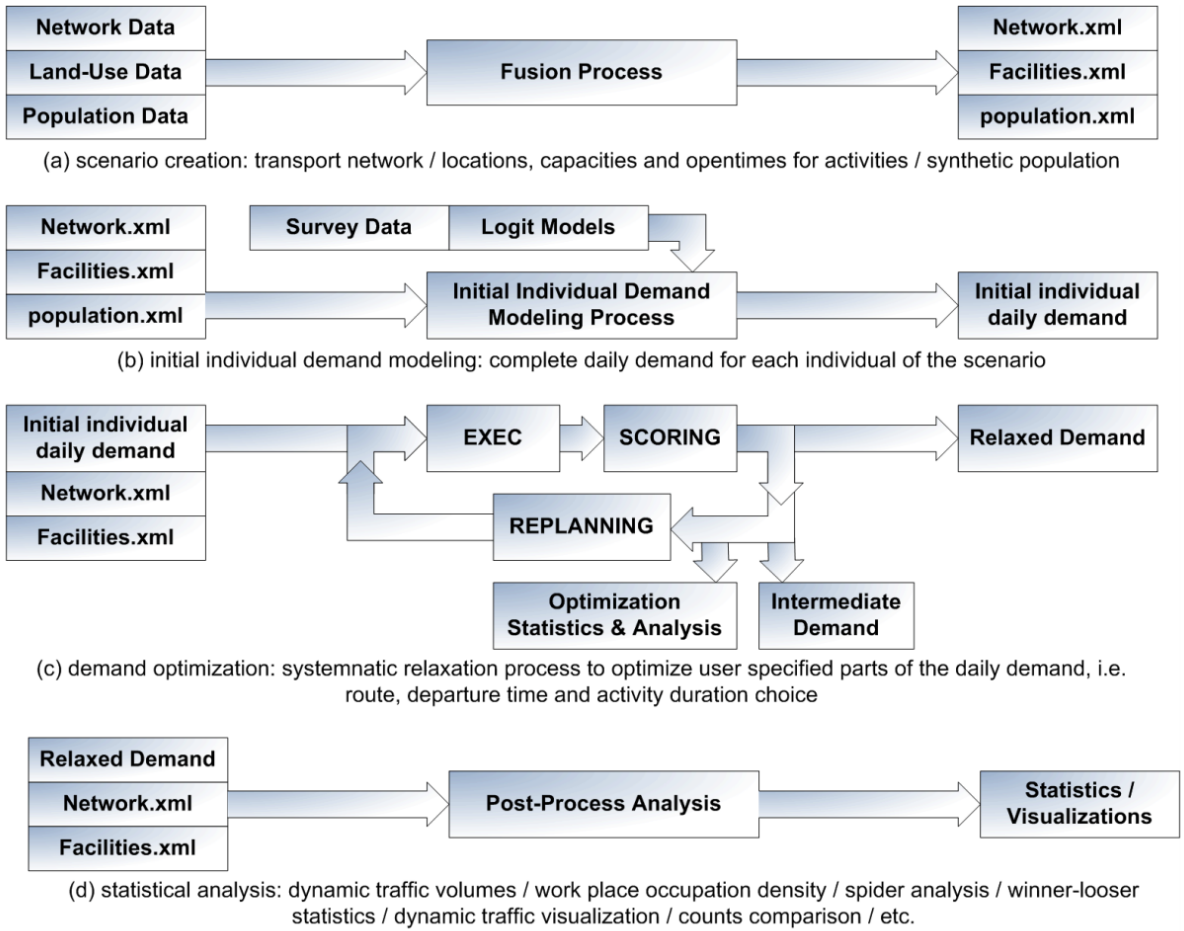
[Zhuge et al., 2019]

Urban transportation models

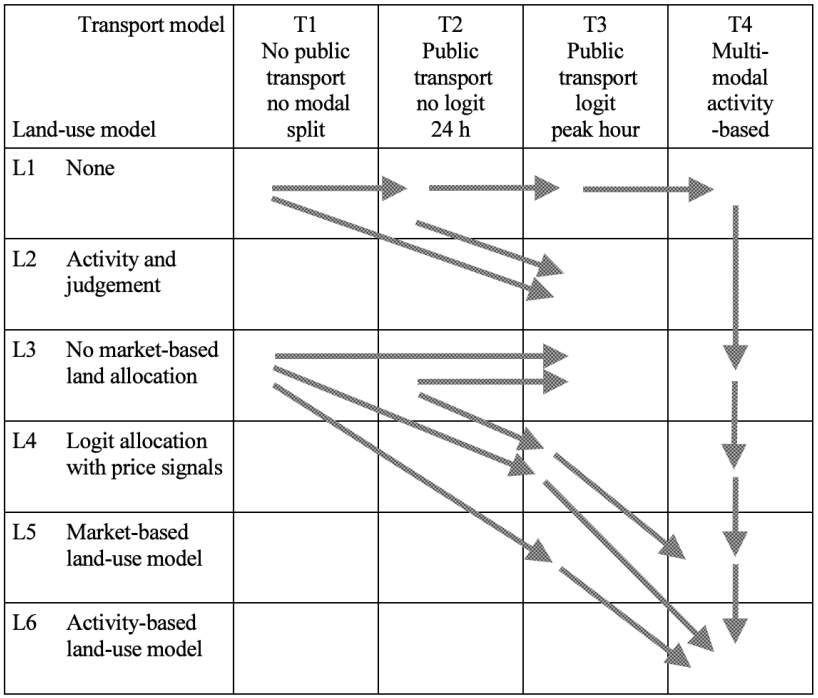
MATSim model: heterogenous data and integration of many sub-models



Source: [Balmer et al., 2009]

Land-use transport models

Land-use transport models as a progressive complexification through coupling of detailed sub-models



Models	Speed of change							
	Very slow		Slow		Fast		Immediate	
	Networks	Land use	Work-places	Housing	Employ-ment	Popula-tion	Goods transport	Travel
BOYCE	+				+	+		+
CUFM		+	+	+	+	+		
DELTA/START	+	+	+	+	+	+	+	+
HUDS				+	+	+		
IMREL	+	+	+	+	+	+		+
IRPUD	+	+	+	+	+	+		+
ITLUP	+	+			+	+		+
KIM	+				+	+	+	+
LILT	+	+	+	+	+	+		+
MEPLAN	+	+	+	+	+	+	+	+
METROSIM	+	+	+	+	+	+		+
MUSSA	+	+			+	+		+
POLIS		+			+	+		+
RURBAN		+			+	+		+
STASA	+	+	+	+	+	+	+	+
TRANUS	+	+	+	+	+	+	+	+
URBANSIM		+	+	+	+	+		+

Source: [**?**]

MATSim model integration

Case study: *Construct a modular four-step multimodal transportation model using open source projects and data*

Integrated models:

- MATSim model (MATSim Community) for the transportation system `https://www.matsim.org/` [W Axhausen et al., 2016]
- SPENSER model (University of Leeds) for the synthetic population `https://github.com/nismod/microsimulation`
- QUANT model (CASA, University College London) for spatial interactions to generate home-work plans `http://quant.casa.ucl.ac.uk/` [Batty and Milton, 2021]
- spatialdata library (OpenMOLE community) for data processing `https://github.com/openmole/spatialdata` [Raimbault et al., 2020]

Data and implementation

Data:

Generic for any Functional Urban Area (GHSL [**?**]) or any arbitrary area in the UK: NOMIS census, OrdnanceSurvey roads, Traveline National Dataset for public transport

Workflow systems:

- DAFNI facility funded by UKCRIC `https://dafni.ac.uk`
- OpenMOLE software `https://openmole.org/` [**?**]

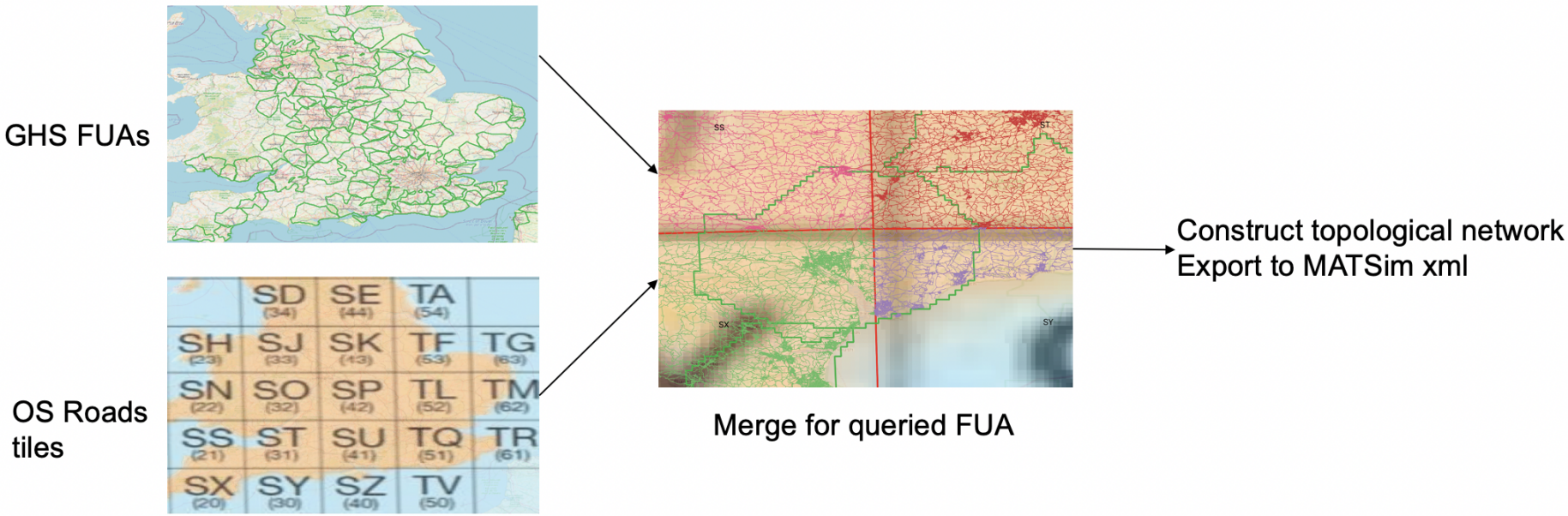
Implementation

Currently integrated into the DAFNI platform:

- synthetic SPENSER population with uniform job locations
- QUANT model to generate home-work commuting flows
- network and plans prepared into MATSim xml files and fed into a one-mode MATSim (multimodal version still tested locally)
- models integrated as Docker containers

Data preparation

→ Road network preprocessing: implemented into the `spatialdata` scala library [Raimbault et al., 2020]



→ Public transport data: from TransXchange (TNDS) to GTFS using UK2GTFS R package [**?**]; GTFS to MATSim xml schedule using `pt2matsim` library

OpenMOLE workflow engine

OpenMOLE model exploration open source software [**?**]

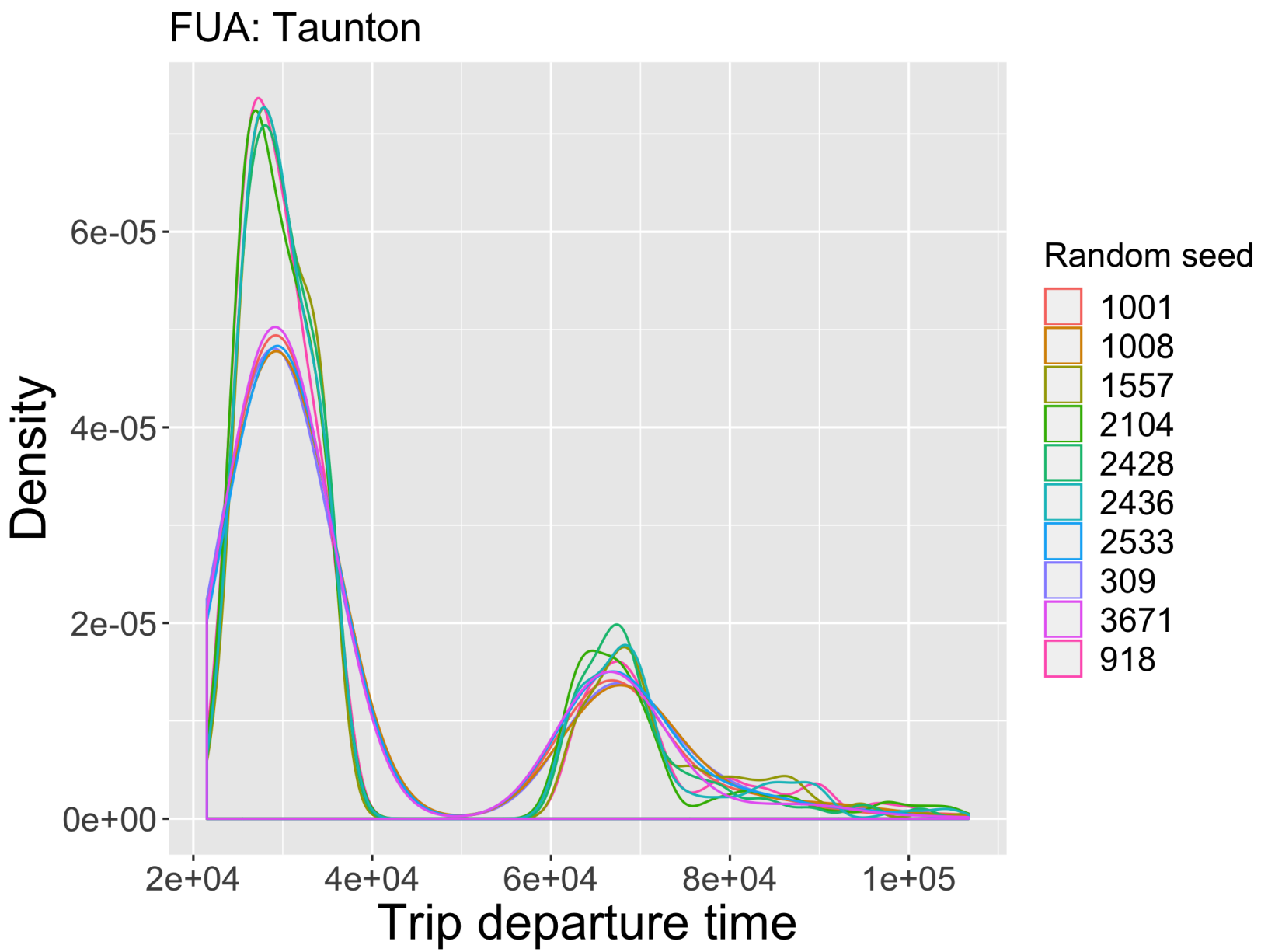
Enables seamlessly (i) model embedding; (ii) access to HPC resources; (iii) exploration and optimization algorithms

`https://openmole.org/`

Explored parameters

- Functional Urban Area (spatial context [Raimbault et al., 2019])
- Random seed (influence of stochasticity [Bienzeisler et al., 2021])
- Synthetic population sampling share
- Modal choice parameters [Hörl, 2021]

Role of stochasticity



Global Sensitivity Analysis

GSA results

Conclusion

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Open repositories

`https://github.com/JusteRaimbault/UrbanDynamics/Models/Matsim` for containers and workflows

`https://github.com/openmole/spatialdata` for data processing

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References I

Balmer, M., Rieser, M., Meister, K., Charypar, D., Lefebvre, N., and Nagel, K. (2009).
Matsim-t: Architecture and simulation times.
In *Multi-agent systems for traffic and transportation engineering*, pages 57–78. IGI Global.

Batty, M. and Milton, R. (2021).
A new framework for very large-scale urban modelling.
Urban Studies, page 0042098020982252.

Bienzeisler, L., T., L., Wage, O., Huck, L., and Friedrich, B. (2021).
Uncertainty and variability analysis of agent-based transport models.
EWGT2021 Proceedings.

References II

Hörl, S. (2021).
Integrating discrete choice models with matsim scoring.
Procedia Computer Science, 184:704–711.

Raimbault, J., Cottineau, C., Le Texier, M., Le Néchet, F., and Reuillon, R. (2019).
Space matters: Extending sensitivity analysis to initial spatial conditions in geosimulation models.
Journal of Artificial Societies and Social Simulation, 22(4).

Raimbault, J., Perret, J., and Reuillon, R. (2020).
A scala library for spatial sensitivity analysis.
GISRUK.

W Axhausen, K., Horni, A., and Nagel, K. (2016).
The multi-agent transport simulation MATSim.
Ubiquity Press.

References III

Zhuge, C., Shao, C., Wang, S., and Hu, Y. (2019).
Sensitivity analysis of integrated activity-based model: Using matsim as an example.
Transportation Letters, 11(2):93–103.