Towards integrated urban models for sustainable policies

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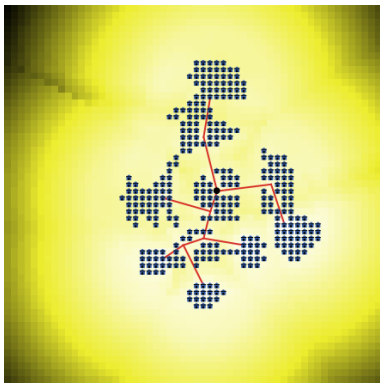
[1]CASA, UCL
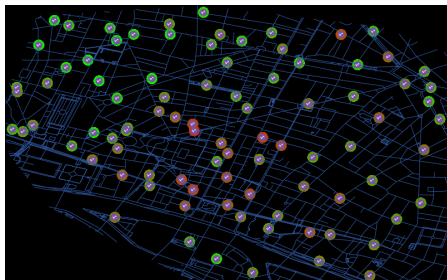[2]UPS CNRS 3611 Complex Systems Institute Paris
[3]UMR CNRS 8504 Géographie-cités

Urban Analytics Tongji Workshop
July 3rd 2019
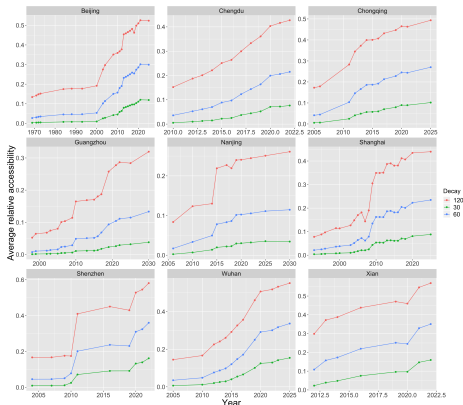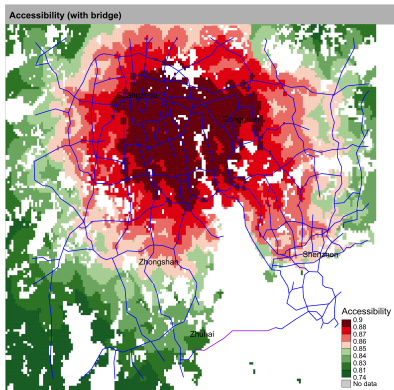
Hybrid urban morphogenesis model

Raimbault, J., Banos, A., & Doursat, R. (2014, June). A Hybrid Network/Grid Model of Urban Morphogenesis and Optimization. In 4th International Conference on Complex Systems and Applications (pp. 51-60).

Agent-based modeling of bike-sharing

Raimbault, J. (2015). User-based solutions for increasing level of service in bike-sharing transportation systems. In Complex Systems Design & Management (pp. 31-44). Springer, Cham.

Accessibility as part of complex processes of co-evolution between transportation networks and territories.

Raimbault, J. (2019). Evolving accessibility landscapes: mutations of transportation networks in China. In Aveline-Dubach, N., ed. *Pathways of sustainable urban development across China - the cases of Hangzhou, Datong and Zhuhai*, pp 89–108. Imago. ISBN:978-88-94384-71-0
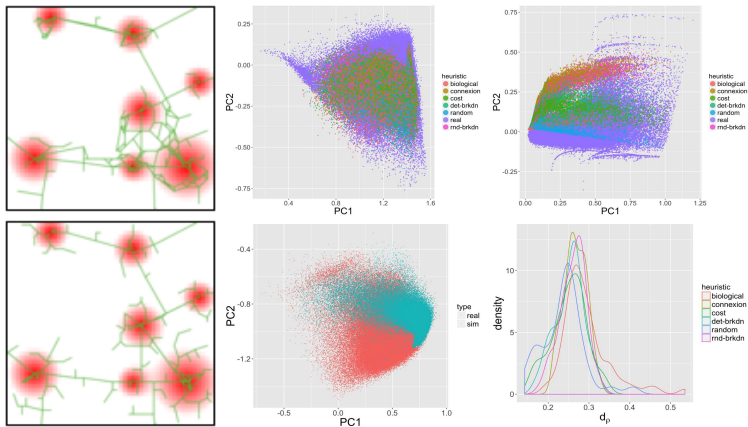
Macroscopic scale:

- Interaction models between cities including networks $\rightarrow$ *Demonstration of network effects; exploration of interaction regimes*

Mesoscopic scale:

- Urban morphogenesis model coupling urban form and network growth
  $\rightarrow$ *Complementarity of multiple processes; calibration at the first and second order*
- Exploration of a model including transportation governance

Mesoscopic models: morphogenesis

A morphogenesis model with reaction-diffusion and multi-modeling of network growth: complementarity of heuristics, calibration for Europe on forms and their correlations
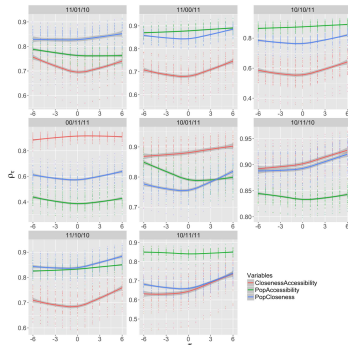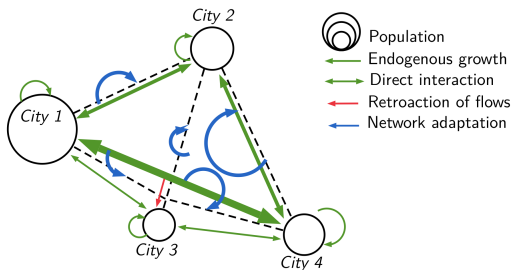
Raimbault, J. (2018). Calibration of a density-based model of urban morphogenesis. PloS one, 13(9), e0203516.

Raimbault, J. (2019). An urban morphogenesis model capturing interactions between networks and territories. In The Mathematics of Urban Morphology (pp. 383-409). Birkhäuser, Cham.

Macroscopic interaction model

System of cities interaction model including network evolution; production of multiple co-evolution regimes and calibration for France.

Raimbault, J. (2018). Indirect evidence of network effects in a system of cities. Environment and Planning B: Urban Analytics and City Science, 2399808318774335.
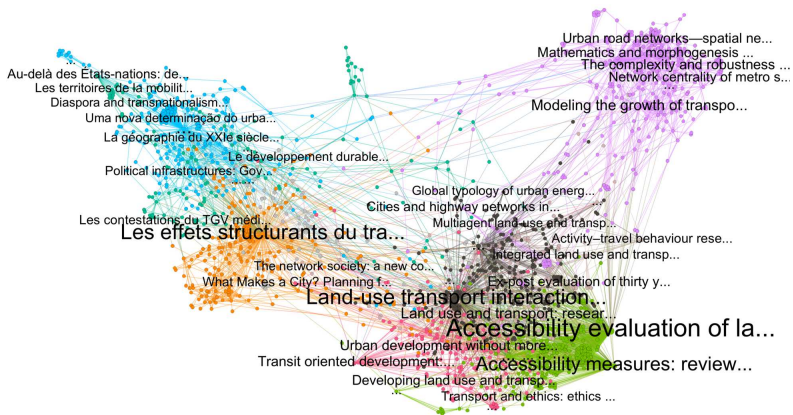
Raimbault, J. (2019). Modeling the co-evolution of cities and networks. In Niel, Z., Rozenblat, C., eds. *Handbook of Cities and Networks*, Edwar Elgar Publishing, *in press*.

Types of integrations for urban models:

- Horizontal integration (interdisciplinarity)
- Vertical integration (multi-scale)
- Knowledge domain integration

Complementary modeling approaches

Au-delà des Etats-nations: de...
Les territoires de la mobilit...
Diaspora and transnationalism...
Uma nova determinação do urba...
La géographie du XXIe siècle...
Le développement durable...
Political infrastructures: Gov...

Urban road networks—spatial ne...
Mathematics and morphogenesis ...
The complexity and robustness ...
Network centrality of metro s...
Modeling the growth of transpo...

Les contestations du TGV médi...
Les effets structurants du tra...

Global typology of urban energ...
Cities and highway networks in...
Multiagent land-use and transp...
Activity–travel behaviour rese...
Integrated land use and transp...

The network society: a new co...
What Makes a City? Planning f...
Land-use transport interaction...
Land use and transport: resear...
Ex-post evaluation of thirty y...
Accessibility evaluation of la...

Urban development without more...
Transit oriented development...
Developing land use and transp...
Transport and ethics: ethics ...
Accessibility measures: review...

Raimbault, J. (2019). Exploration of an interdisciplinary scientific landscape. Scientometrics, 1-25.

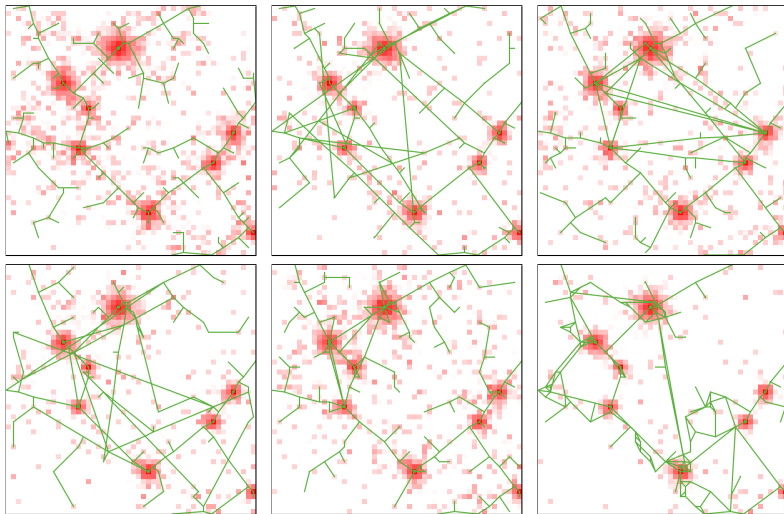|	QUANT	SPENSER
Time scale	10 years	40 years
Spatial scale	UK	UK
Spatial resolution	MSOA	MSOA
Agent granularity	Aggregated counts	individual level
Static/Dynamic	Equilibrium (static)	Dynamic
Randomness	Deterministic	Monte-Carlo
Transportation	3 modes	NA
Economics	Accessibility-based relocations	NA
Demographics	NA	Data-driven
Migration flows	Accessibility-based relocations	Data-driven

- Weak coupling Luti → microsimulation
- Weak coupling Microsimulation → Luti
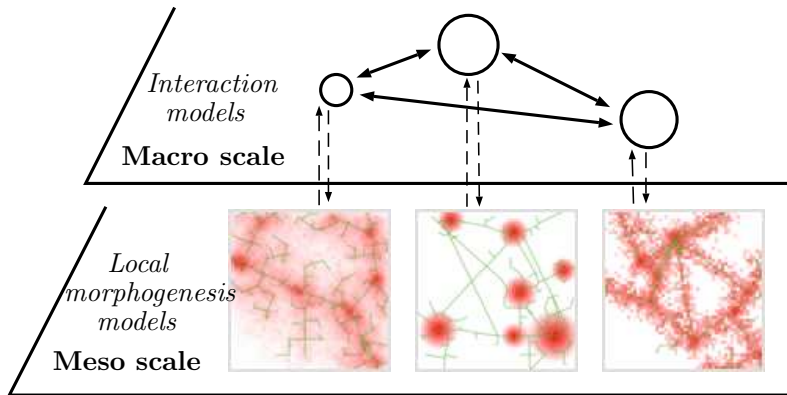- Strong coupling: as much choices as potential "coupling processes"
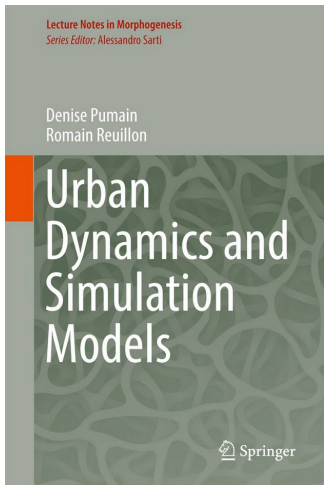
Horizontal integration: multi-modeling

Raimbault, J. (2018). Multi-modeling the morphogenesis of transportation networks. In Artificial Life Conference Proceedings (pp. 382-383). MIT Press, Cambridge.

Processes specific to scales, coupling implies dedicated ontologies

Lecture Notes in Morphogenesis
Series Editor: Alessandro Sarti

Denise Pumain
Romain Reuillon

Urban
Dynamics and
Simulation
Models

Springer

Development of evolutive urban theory

$\rightarrow$ Recurrent stylized facts on main systems of cities

$\rightarrow$ Construction of simulation models (with an explicative purpose)

$\rightarrow$ Tools and methods to explore simulation models

Pumain, D. (2018). An evolutionary theory of urban systems. In International and Transnational Perspectives on Urban Systems (pp. 3-18). Springer, Singapore.

Raimbault, J. (2017). An Applied Knowledge Framework to Study Complex Systems. In Complex Systems Design & Management (pp. 31-45).

Model exploration methods to foster knowledge integration

(i) Innovative exploration methods; (ii) Scaling of methods on high performance computing environments; (iii) No interference with the model.
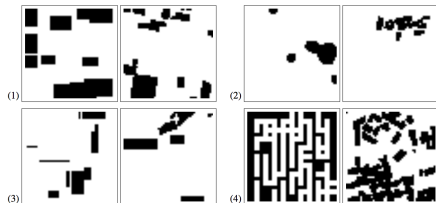
Variance-based method to assess the sensitivity of agent-based models to spatial configuration

Raimbault, J., Cottineau, C., Texier, M. L., Néchet, F. L., & Reuillon, R. (2018). Space Matters: extending sensitivity analysis to initial spatial conditions in geosimulation models. arXiv preprint arXiv:1812.06008.
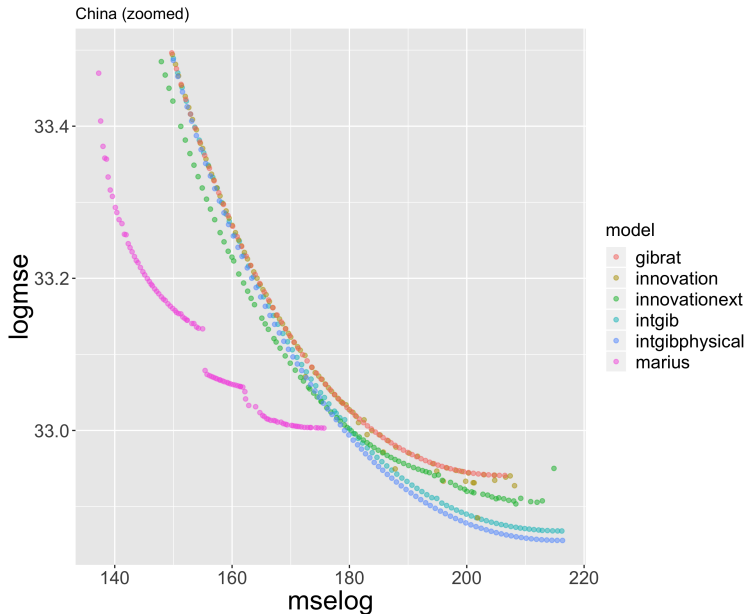
Generators of synthetic spatial configurations

Raimbault, J. and Perret, J., 2019. Generating urban morphologies at large scales. *Forthcoming in proceedings of Artificial Life 2019.* arXiv:1903.06807
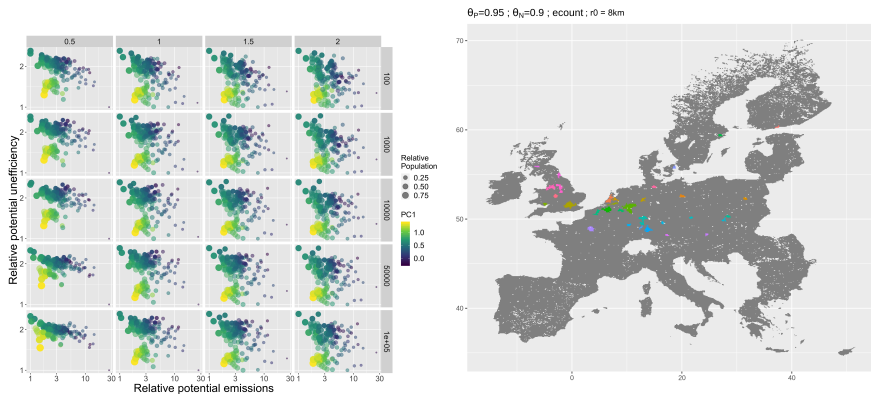
Benchmark of growth models for systems of cities

Identifying endogenous sustainable mega-city regions in Europe

Raimbault, J. (2019). Multi-dimensional Urban Network Percolation. arXiv preprint arXiv:1903.07141.

$\rightarrow$ Multiple ways to model urban systems: **towards more interdisciplinary coupling and comparison of models.**

$\rightarrow$ At which scale? **Towards multi-scale models.**

$\rightarrow$ With complementary aspects of knowledge? **Need for knowledge domain integration.**

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next.openmole.org

Some references

Raimbault, J. (2017). An Applied Knowledge Framework to Study Complex Systems. In Complex Systems Design & Management (pp. 31-45). arXiv:1706.09244.

Raimbault, J. (2018). Indirect evidence of network effects in a system of cities. Environment and Planning B: Urban Analytics and City Science, 2399808318774335.

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Satellite session on methods and epistemology in modeling and simulation, at Conference on Complex Systems, 2nd October 2019

Submit your abstract before July 7th!

`https://iscpif.fr/ccs-satelllite-session-2019-new-methods/`

Submission link:

`https://easychair.org/conferences/?conf=simexplo2019`

📄 Baffi, S. (2016).
Railways and city in territorialization processes in South Africa : from separation to integration ?
PhD thesis, Université Paris 1 - Panthéon Sorbonne.

📄 Cottineau, C., Reuillon, R., Chapron, P., Rey-Coyrehourcq, S., and Pumain, D. (2015).
A modular modelling framework for hypotheses testing in the simulation of urbanisation.
Systems, 3(4):348–377.

📄 Pumain, D. (1997).
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The Dynamics of Complex Urban Systems, pages 373–389.

📄 Pumain, D. (2010).
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Bulletin de la Société géographie de Liège, (55):5–15.

📄 Pumain, D. (2018).
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In *Conference on Complex Systems 2018*.

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📄 Reuillon, R., Leclaire, M., and Rey-Coyrehourcq, S. (2013).
Openmole, a workflow engine specifically tailored for the distributed exploration of simulation models.
Future Generation Computer Systems, 29(8):1981–1990.

📄 Swerts, E. (2017).
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Cybergeo: European Journal of Geography.