Mapping the integration between Knowledge Domains in Theoretical and Quantitative Geography

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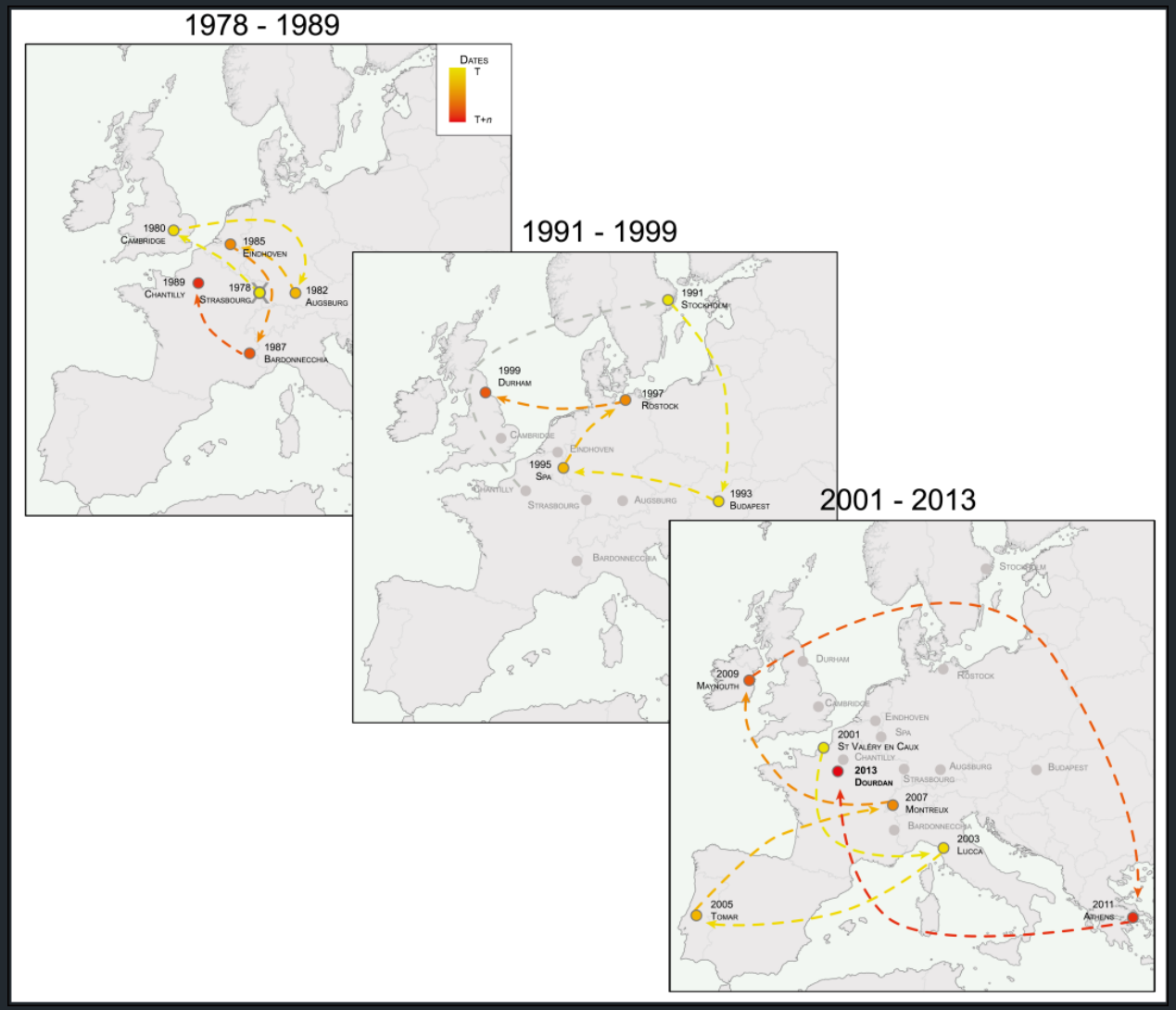
[2]CASA, UCL
[3]UPS CNRS 3611 ISC-PIF
[4]UMR CNRS 8504 Géographie-cités

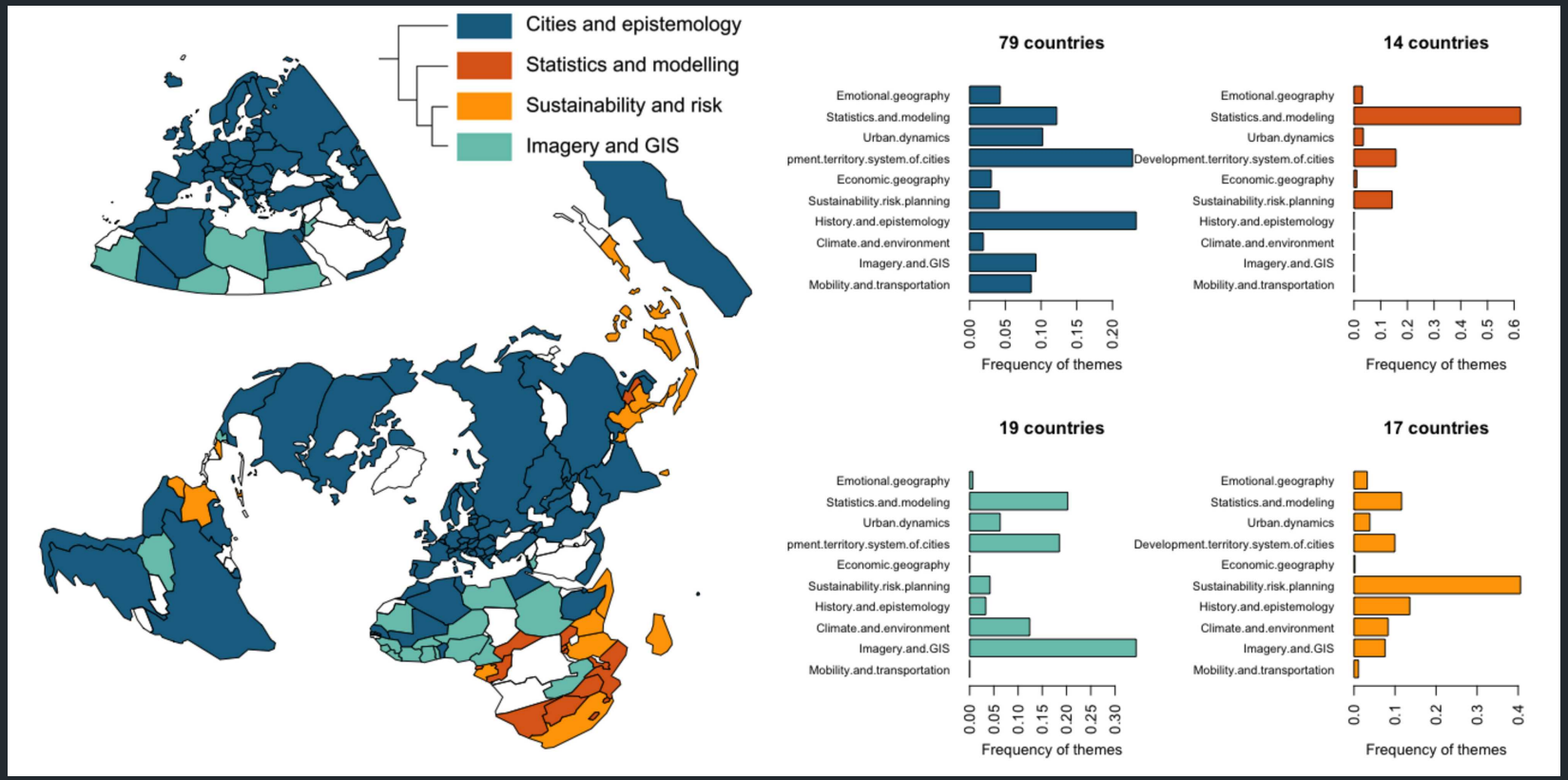
ENSG Géomatique
ÉCOLE NATIONALE DES SCIENCES GÉOGRAPHIQUES

History of ECTQG



Diversity and integration of Theoretical and Quantitative Geography [Cuyala, 2016].

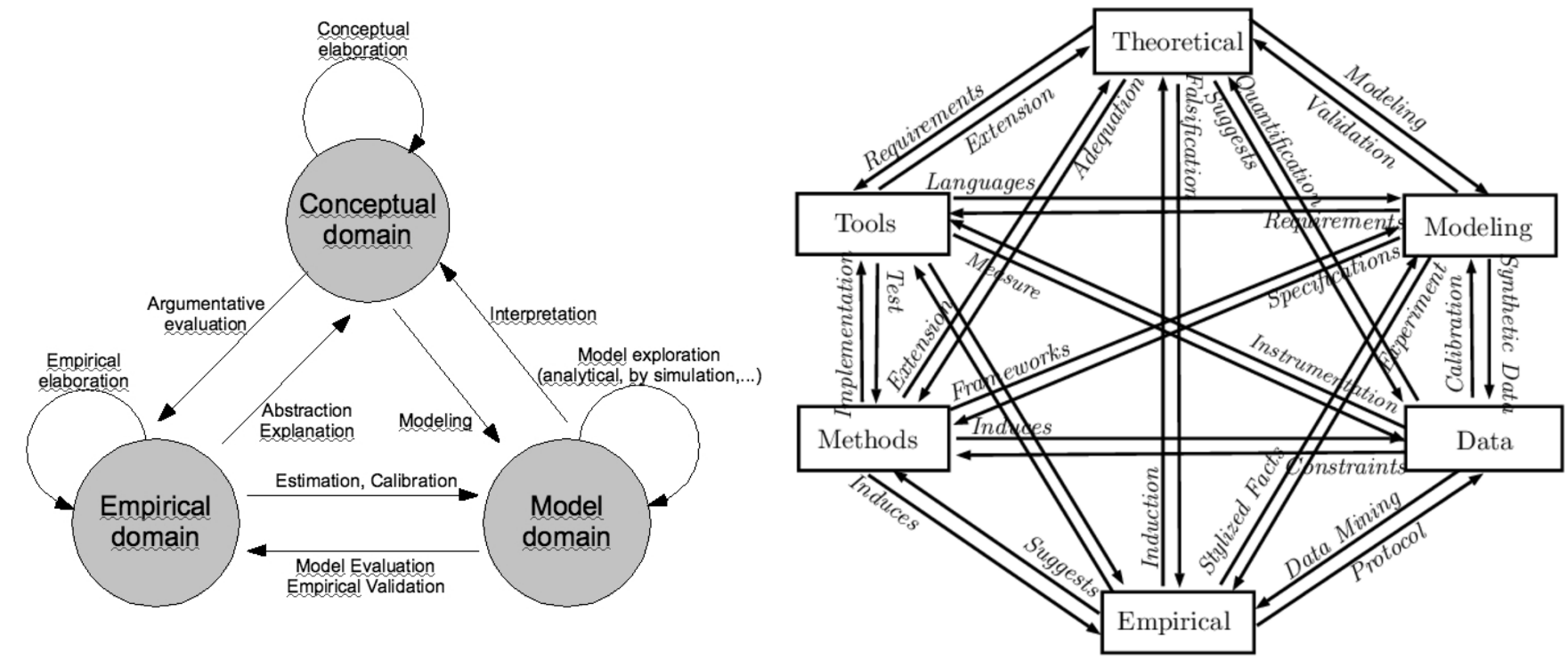
Quantitative epistemology



Spatialised bibliometrics as a tool for a more reflexive and open science: CybergeoNetworks project [Raimbault et al., 2021], continued into OpenJournalScope (currently submitted to FNSO).

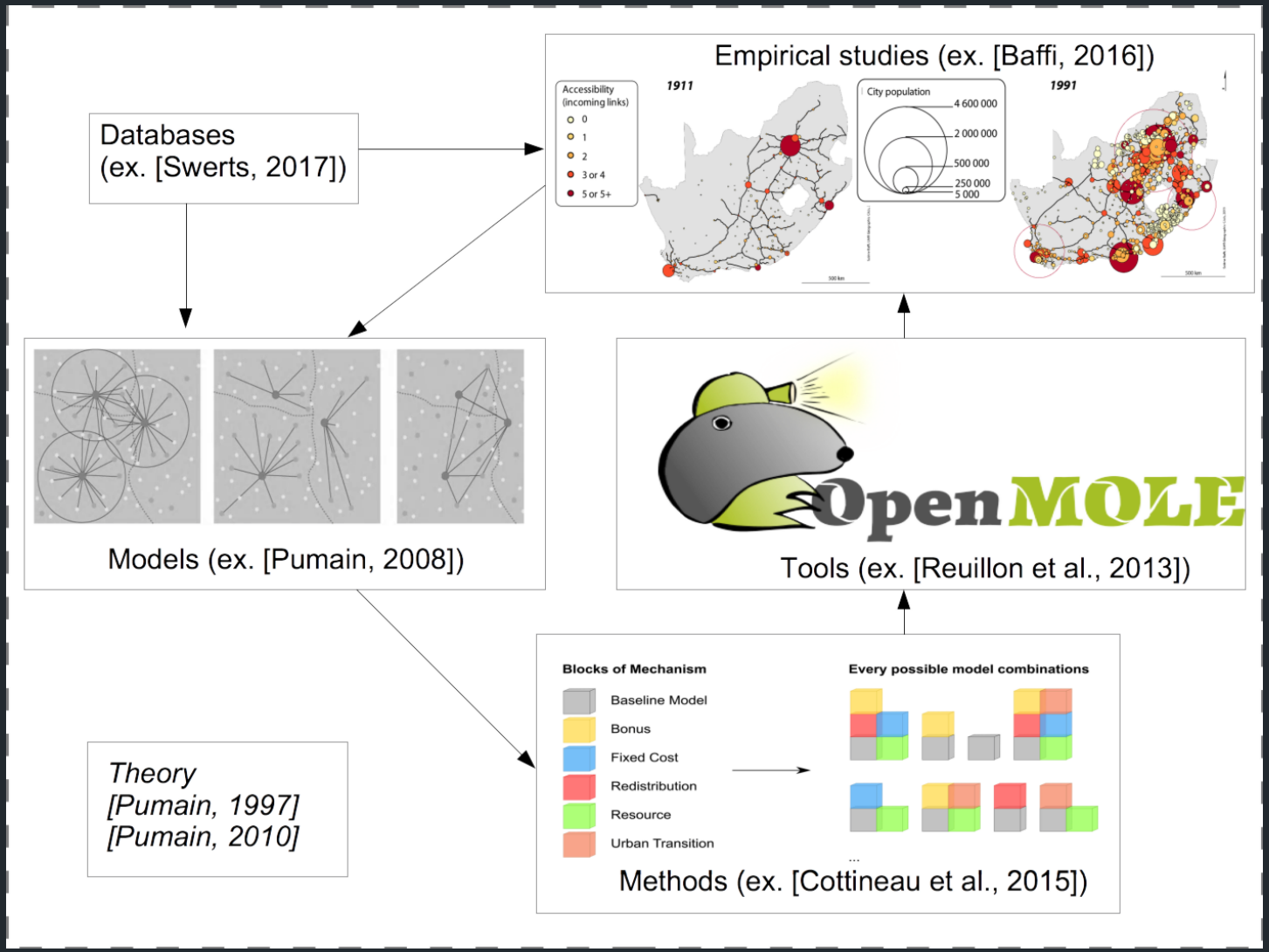
`https://analytics.huma-num.fr/geographie-cites/cybergeonetworks/`

Knowledge domains



(Left) Knowledge framework for agent-based modelling by [Livet et al., 2010]; (Right) Refinement with more Knowledge Domains (KDs) by [Raimbault, 2017a].

KDs in Pumain's Evolutionary Urban Theory



[Raimbault, 2017a]

Research objective

$\rightarrow$ previous work on Pumain's Evolutionary Urban Theory [Pumain, 2018] by [Raimbault, 2017a] suggested an integration of KDs

$\rightarrow$ more general ongoing epistemological research on TQG: [Raimbault, 2017b] (ECTQG 2017), [Raimbault, 2019a] (ECTQG 2019), [Raimbault, 2023] (ECTQG 2023)

Research objective:

Quantify some TQG corpuses in terms of knowledge domains, their use, diversity, and integration.

Data: case studies

Corpus 1: Pumain's evolutionary urban theory [Pumain, 2018], typical of a fruitful TQG approach (discipline: geography).

Corpus 2: studies of Zipf's law for the size of cities, important theme in TQG but studied by various disciplines (economics, regional science, geography, physics), constructed by [Cottineau, 2017].

Data collection: corpus construction

→ start from an initial corpus: [Pumain, 1997] and [Sanders et al., 1997]; 39 papers for Zipf listed by [Cottineau, 2017].

→ reconstruct backward citations networks at depth 2, using the open data collection tools developped by [Raimbault, 2019b]: (16333 nodes and 21775 edges for Ev. Urb. Th.; 99756 nodes and 150611 edges for Zipf).

→ extract core network by removing nodes of low degree (thresholds 3 and 30).

→ corpuses for analysis to be annotated for domains: (1252,4950) Ev. Urb. Th.; (858,8143) Zipf.

Data consolidation: manual annotation

→ manually annotate each paper for its **main** knowledge domain.

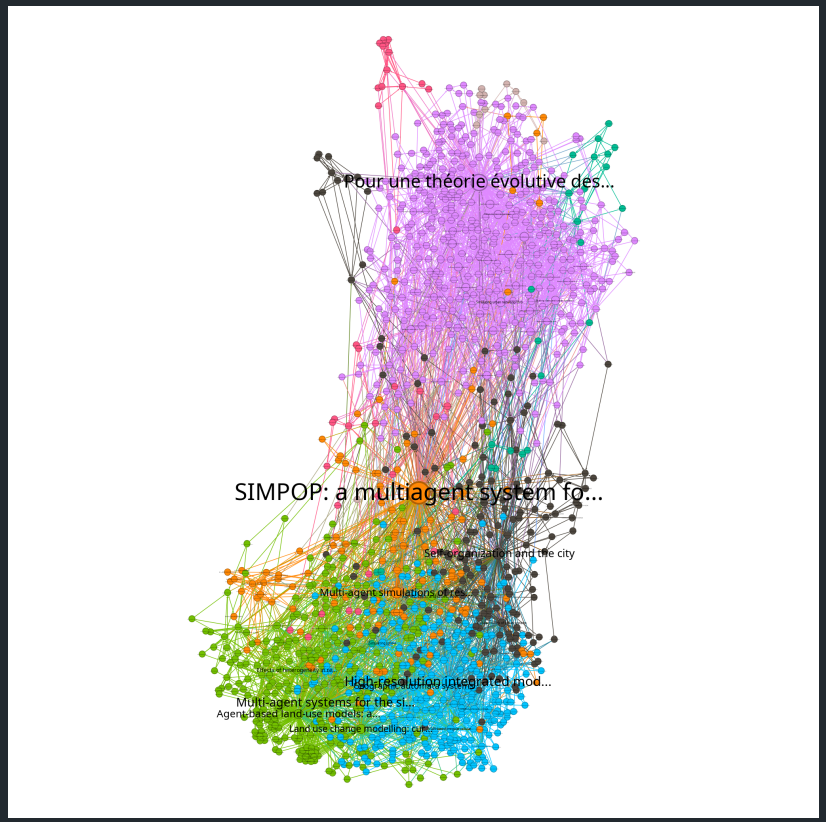
→ reviews and meta-analyses classified as "theory".

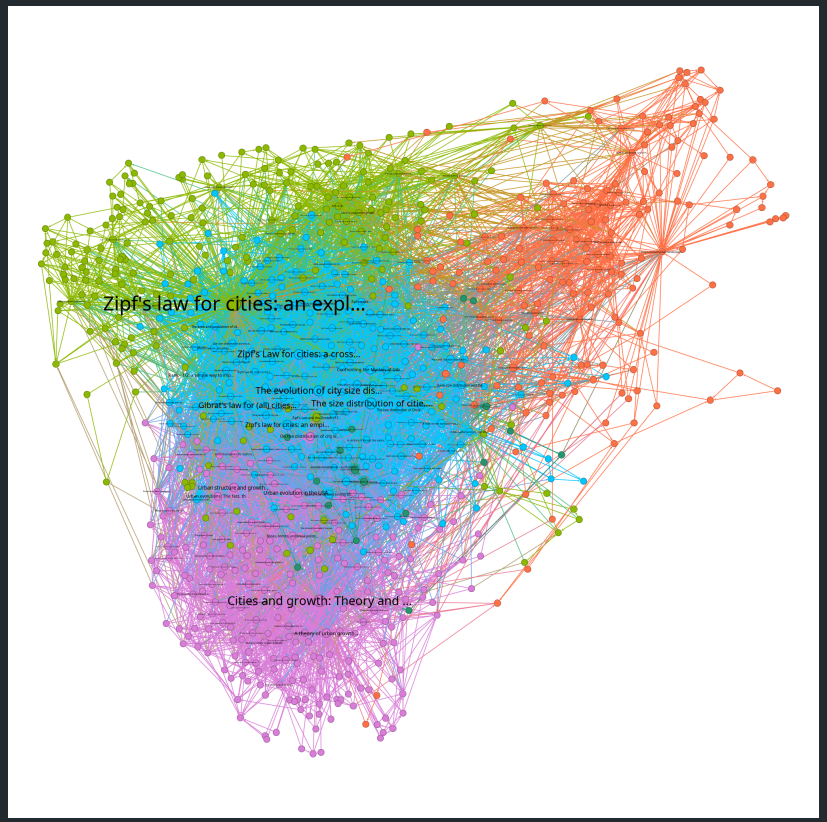
→ machine learning approach not relevant with these corpus sizes.

Counts:

	data	empirical	method	model	theory	tool	NA
EUT	2	208	108	387	456	17	74
Zipf	2	380	41	198	210	0	27

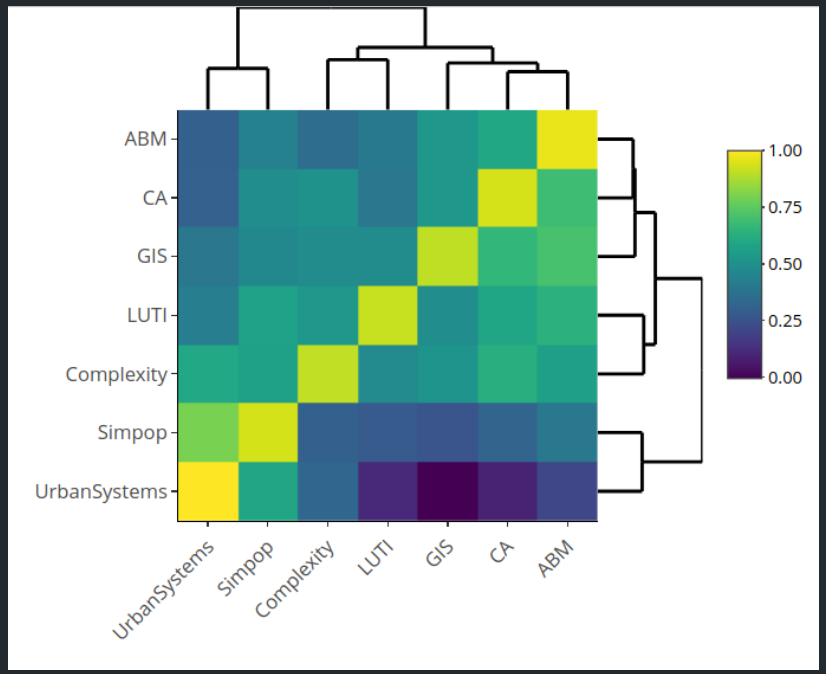
Results: citation networks

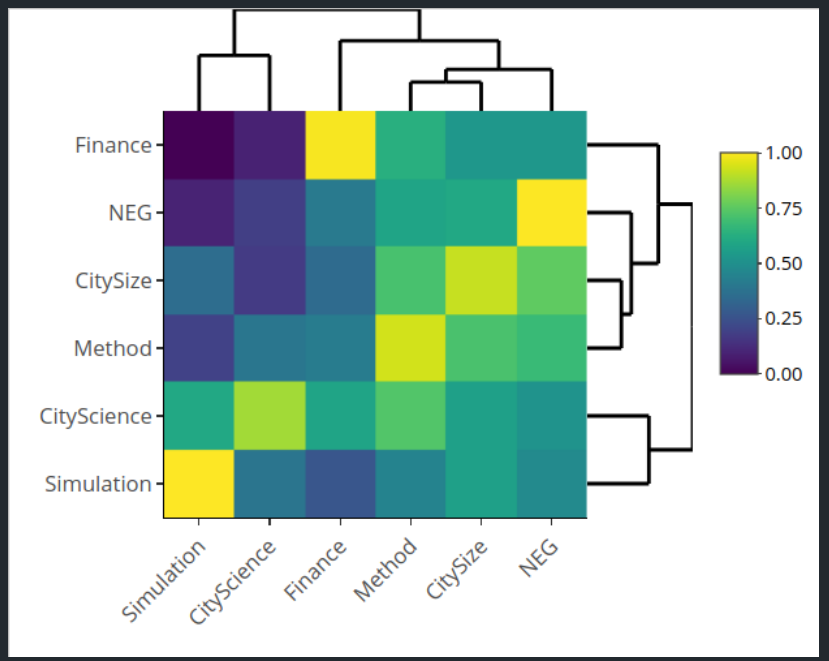




(Left) Evolutionary Urban Theory; (Right) Zipf

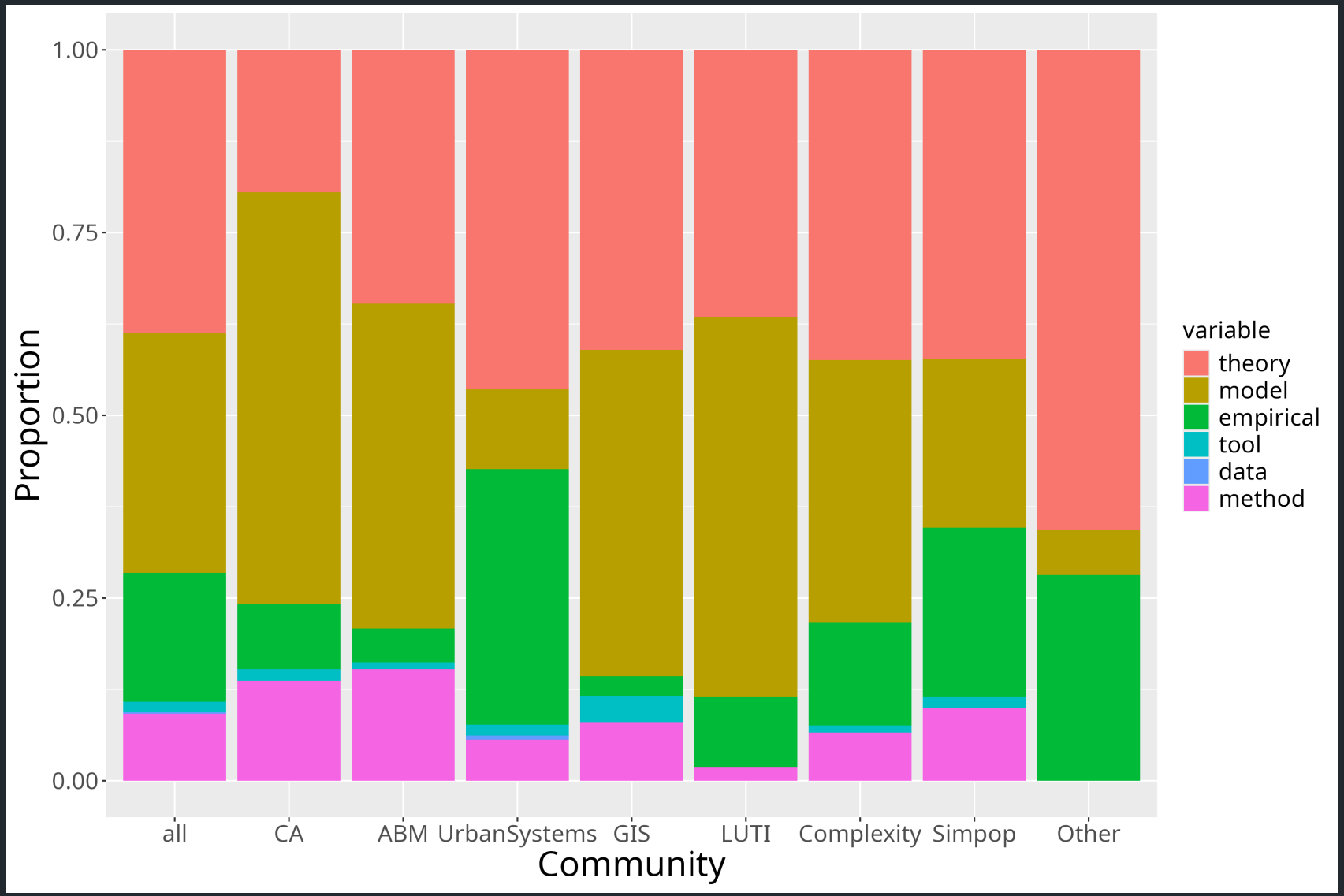
Results:community detection





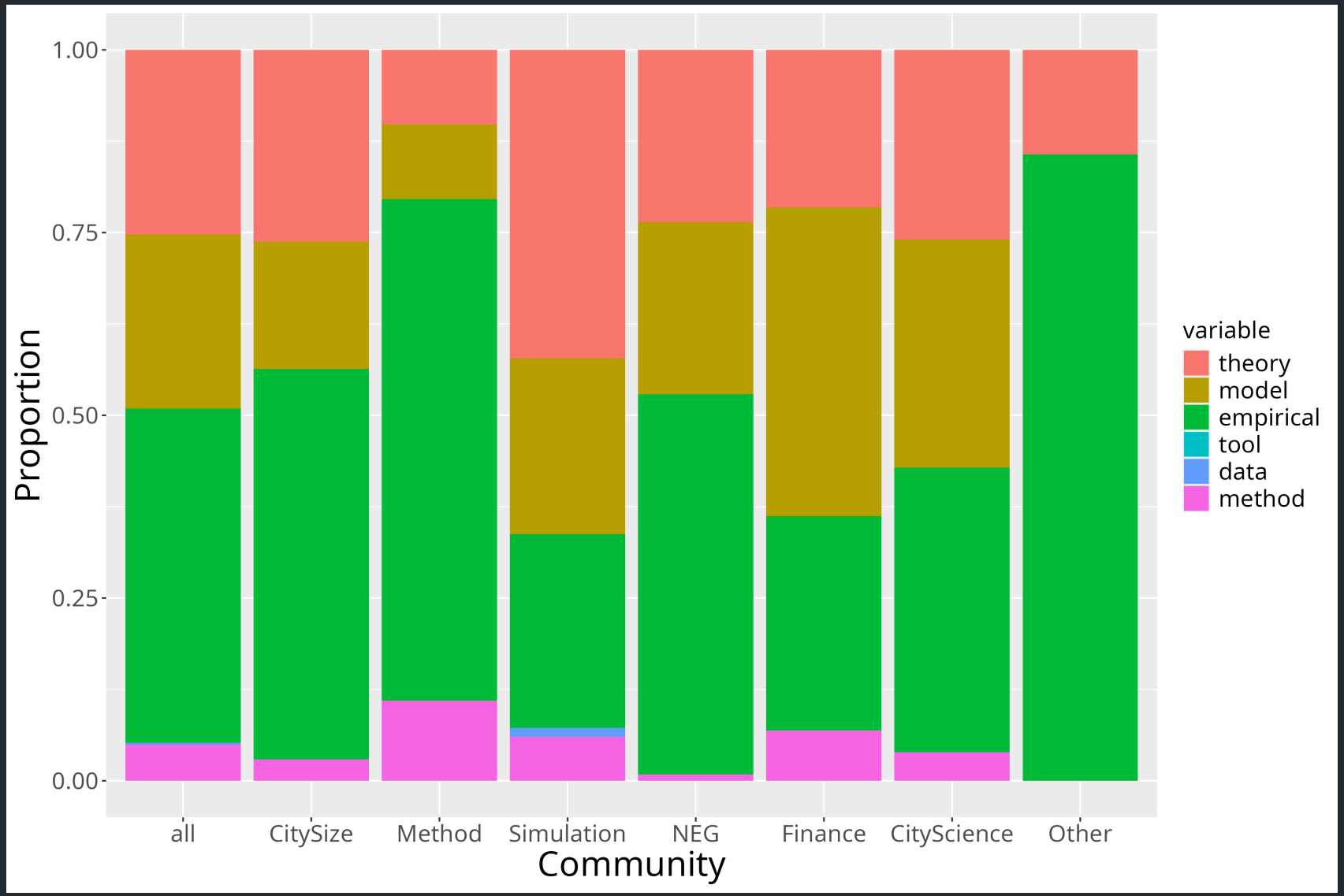
(Left) Evolutionary Urban Theory; (Right) Zipf

Results: KDs composition



Composition of communities by Knowledge Domains for the EUT.

Results: KDs composition



Composition of communities by Knowledge Domains for the Zipf corpus.

Results: diversity

Erfindahl diversity index, computed within each community:

$$d = 1 - \sum_i p_i^2$$

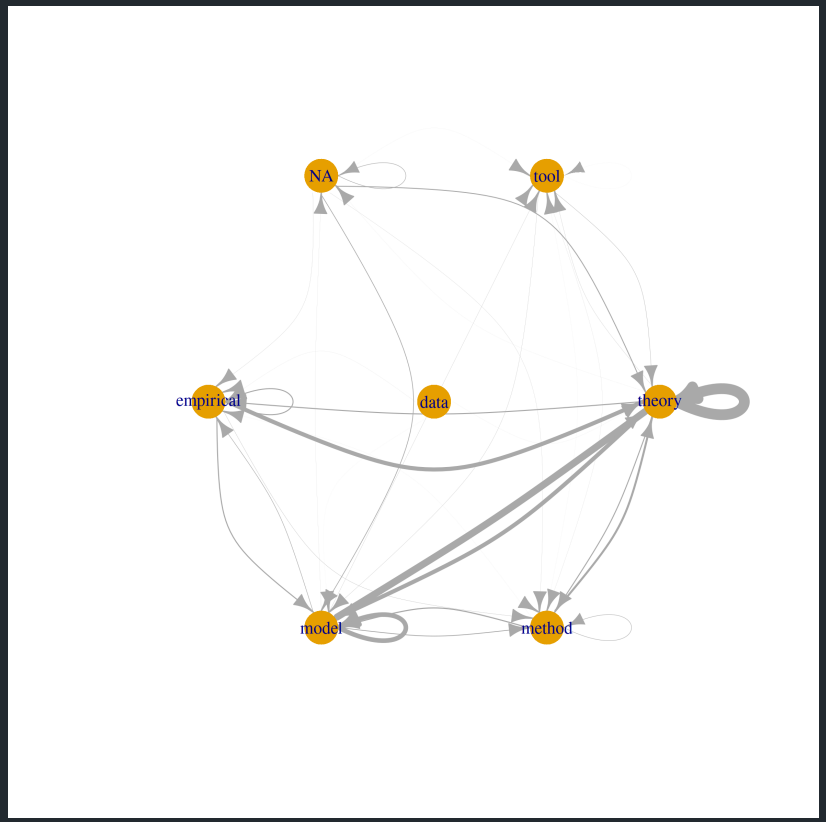
EUT:

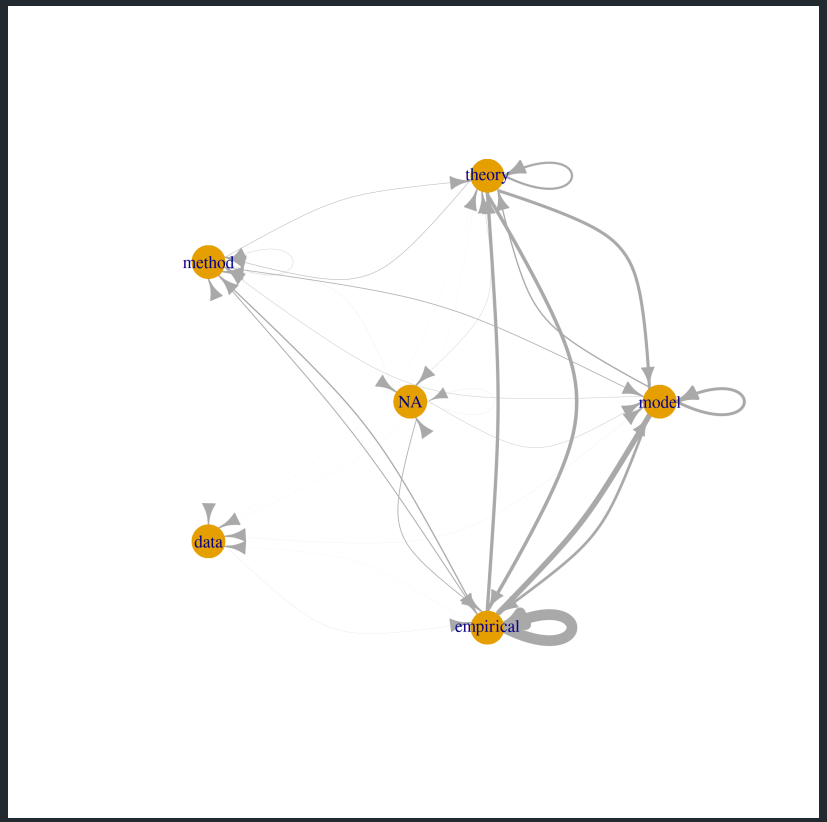
ABM	CA	Complexity	GIS	LUTI	Other	Simpop	UrbSys	all
0.65	0.61	0.66	0.62	0.58	0.48	0.70	0.64	0.70

Zipf:

CityScience	CitySize	Finance	Method	NEG	Other	Simulation	all
0.68	0.61	0.68	0.49	0.61	0.24	0.69	0.66

Results: citation flows between domains





(Left) Evolutionary Urban Theory; (Right) Zipf

Results: modularities

Integration measured by modularity of knowledge domains:

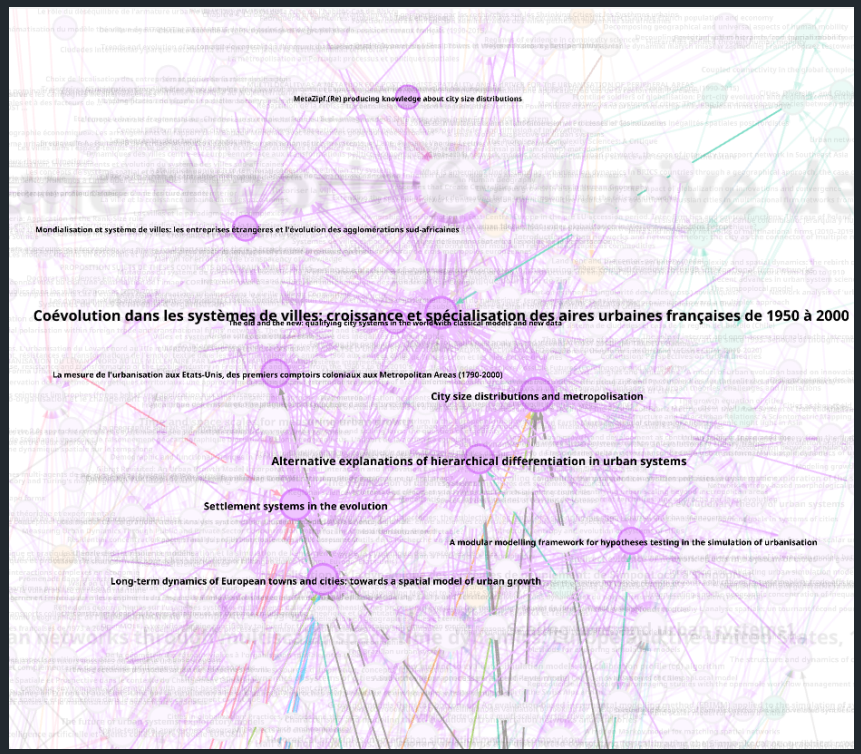
EUT:

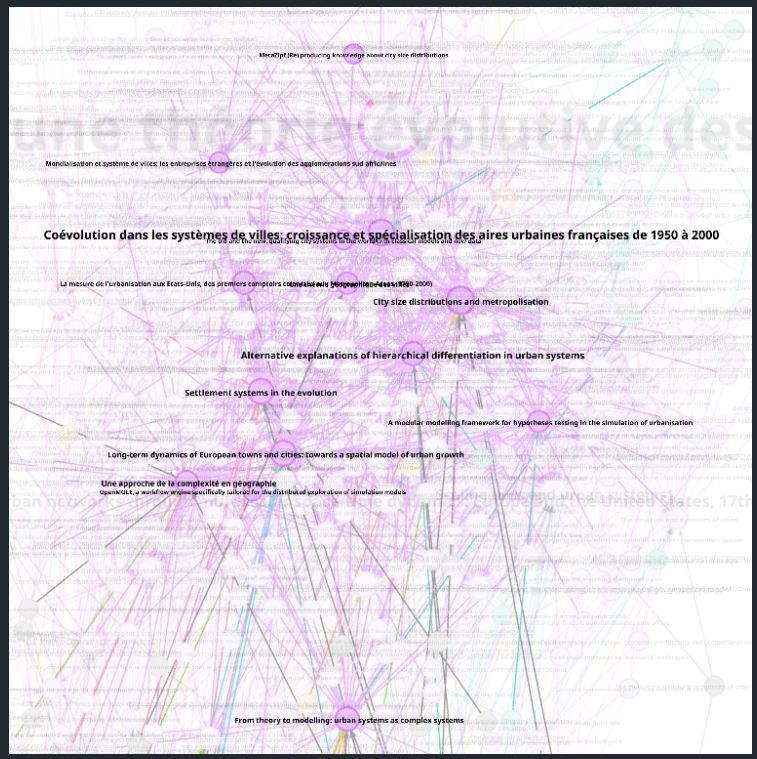
- Optimal communities: 0.496
- Knowledge domains: 0.0723
- Null model (100 bootstrap shuffling): -0.0008 ± 0.0049

Zipf:

- Optimal communities: 0.365
- Knowledge domains: 0.0664
- Null model: -0.0011 ± 0.0041

Results: key papers in the EUT





Papers with a "central" role: tool paper [Reuillon et al., 2013], and "data" paper [Cura et al., 2017].

Perspectives

Contributions:

- First quantitative approach to how knowledge domains interact
- Strong integration (low modularity) but still some structure (vs null model)
- Different interactions for EUT and Zipf

Perspectives:

- Machine learning models trained with the annotated data, for a systematic study of TQG (or more broadly urban science)
- Sensitivity analysis to initial corpuses and annotation noise
- Towards an endogenous construction of Knowledge Domains through functions of literature contributions?
- Similar work in progress on systematic model decomposition and mapping across a corpus

Code and data:

`https://github.com/JusteRaimbault/GeoTheoQuantIntegration`

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