

Invisible Bridges ? Scientific landscapes around similar objects studied from Economics and Geography perspectives

J. Raimbault^{1,2}

`juste.raimbault@polytechnique.edu`

¹UMR CNRS 8504 Géographie-cités


²UMR-T IFSTTAR 9403 LVMT

ECTQG 2017 - York

Session 4A - Bridges between Geography and Economics

September 9th 2017

An Utopia of interdisciplinarity ?



INTERDISCIPLINARITY

Nature's special issue probes how scientists and social scientists are coming together to solve the grand challenges of energy, food, water, climate and health. This special scrutinizes the data on interdisciplinary work and looks at its history, meaning and funding. A case study and a reappraisal of the Victorian explorer Richard Francis Burton explore the rewards of breaking down boundaries. Meanwhile, a sustainability institute shares its principles for researchers who work across disciplines. Thus inspired, we invite readers to test their polymathy in our lighthearted quiz.

Image credit: Dean Trippe

Perspectivism

Scientific Perspectivism [Giere, 2010] : each scientific enterprise as a perspective, which medium is called a model

Question 1 : Which compromises between transversal approaches (interdisciplinary) and vertical approaches (specialization) ?

→ Banos' vertuous circle [Banos, 2013] ; Complex Systems integrated roadmap [Bourgine et al., 2009]

Question 2 : Taking interdisciplinarity as an objective, which processes of knowledge production and interactions between disciplines occur and would be desirable ?

Geographical systems

Geographical System by essence heterogeneous and require interdisciplinarity

Example : [Fujita et al., 1999] an economic geography approach with equilibrium reproducing observable hierarchy ; incompatible with dynamical complex approaches from Evolutive Urban Theory ? [Pumain, 2012]

→ *Are incompatibilities intrinsic to epistemologies, or how to make bridges ?*

Research Question

Research Objective : In the case of Economics and Geography, how can the way they study specific objects help understand the persistent isolation between the two ?

→ Quantitative Epistemology approach : investigate “scientific landscape” around intersecting ontologies

→ Case studies : Interactions between Networks and Territories ; Urban Growth

Methodology

- Hypernetwork approach to the scientific landscape : combination of citation layer with semantic layer [Raimbault, 2016] [Bergeaud et al., 2017]
- From initial corpus, backward reconstruction of the citation network at depth 2
- Collection of abstracts and text-mining to extract relevant keywords (multi-stems)
- Intra and interlayer analysis : construction of endogenous domains by community detection ; measures of interdisciplinarity between layers

Interactions between Networks and Territories

Complex co-evolutive processes between Territories and Transportation Networks



Expanding HSR network in China and ambiguous effects (Source : fieldwork survey)

Citation Network



Citation Network Properties

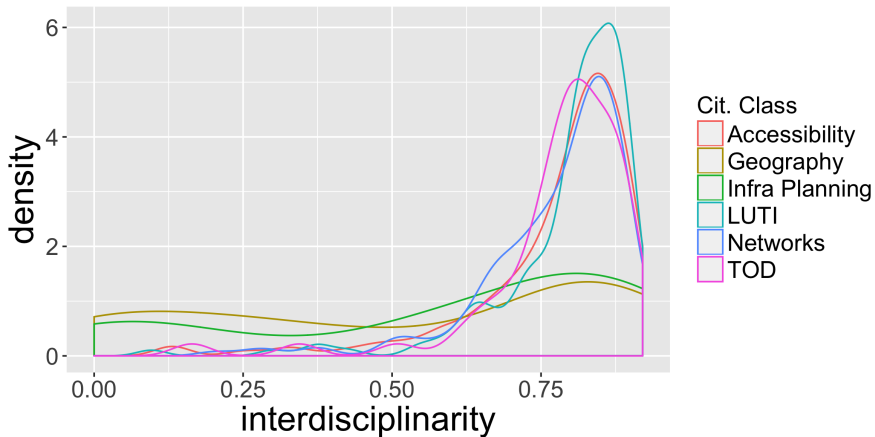
For the core (hence full) subnetwork :

- Size $V = 3510$, Mean degree $\bar{d} = 2.53$ and density $\gamma = 0.0013$, weakly connected.
- 13 communities, directed modularity [Nicosia et al., 2009] 0.66 (null model gives 0.0005 ± 0.0051 on $N = 100$ bootstraps)
- Content : LUTI (18%), Urban and Transportation Geography (16%), Infrastructure Planning (12%), TOD (6%), Spatial Networks (17%), Accessibility studies (18%)

Semantic communities

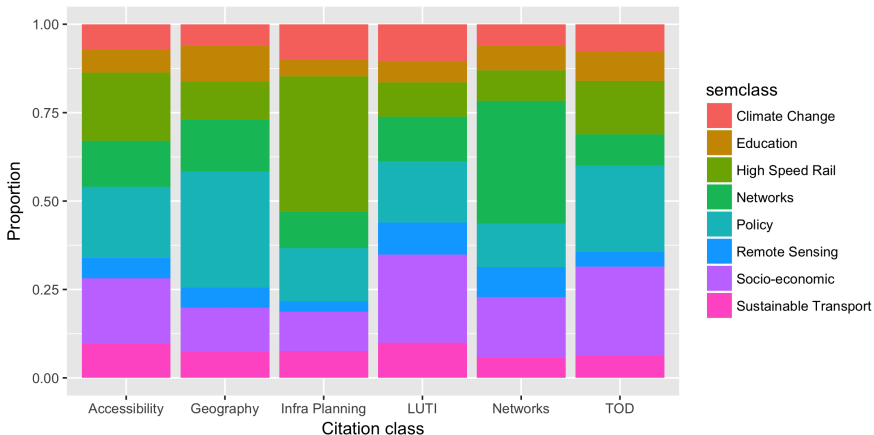
Name	Size	Weight	Keywords
Networks	820	13.57%	social network, spatial network, res
Policy	700	11.8%	actor, decision-mak, societi
Socio-economic	793	11.6%	neighborhood, incom, live
High Speed Rail	476	7.14%	high-spe, corridor, hsr
French Geography	210	6.08%	système, développement, territoire
Education	374	5.43%	school, student, collabor
Climate Change	411	5.42%	mitig, carbon, consumpt
Remote Sensing	405	4.65%	classif, detect, cover
Sustainable Transport	370	4.38%	sustain urban, travel demand, activi
Traffic	368	4.23%	traffic congest, cbd, capit
Maritime Networks	402	4.2%	govern model, seaport, port author
Environment	289	3.79%	ecosystem servic, regul, settlement
Accessibility	260	3.23%	access measur, transport access, urb
Agent-based Modeling	192	3.18%	agent-bas, spread, heterogen
Transportation planning	192	3.18%	transport project, option, cba
Mobility Data Mining	168	2.49%	human mobil, movement, mobil phone
Health Geography	196	2.49%	healthcar, inequ, exclus
Freight and Logistics	239	2.06%	freight transport, citi logist, moda
Measuring	166	1.0%	score, sampl, metric

Interdisciplinarity patterns



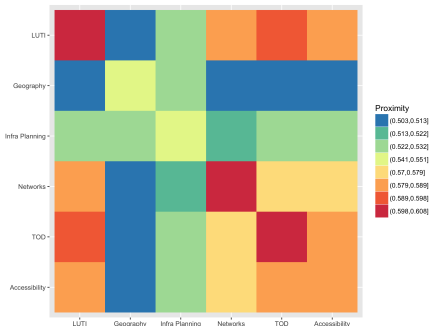
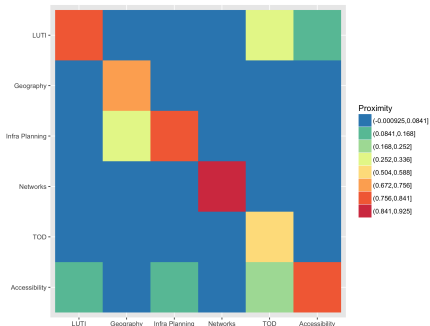
Distribution of interdisciplinarity

Interdisciplinarity patterns



Semantic composition of citation communities

Community Proximities



Proximities between citation communities (Left) and semantic communities (Right)

Urban growth

Very broad final corpus, from technical GIS studies to entrepreneurship and “creative clusters” studies

Citation Network :

- ($V = 52560$, $E = 168813$), modularity 0.70 (null model $2.20 \cdot 10^{-5} \pm 0.00078$)
- Main communities : Urban Ecology, Urban Sociology, Housing Market, Spatial Statistics, Economic Geography, Criminology, Cellular Automata, Urban Simulation, Development, Ecology, Mobility, LUTI, Networks, Economy of Information and innovation.

Summary

- Highly clustered citation practices, but presence of bridges (connected network)
- Correspondence between citation and semantic communities, but not fully correlated
- Importance of intermediate fields or sub-disciplines, such as recent disciplines to connect disciplines : Physicists as a way forward ? ([Barthelemy, 2016] [West, 2017])

Discussion

Implications

- Each discipline has its own objects, epistemologies and ontologies : open question on how to identify intersecting ontologies and achieve “Applied Perspectivism”
- Crucial role of intermediate fields to shape research subjects and convergences ? In particular performative branches, that can bring common objects and perspectives

Developments

- Towards a scaled and more systematic overview
- Trade-offs between horizontal and vertical research : towards an agent-based investigation [Chavalarias, 2017]

Conclusion

→ Hypothesis : bridging must require a high level of reflexivity, as the construction of integrative disciplines and approaches to Complex Systems (question : related to the nature of Complexity ?)

→ Systematic reviews and Quantitative epistemology soon as a necessary step in research ? Empowering open initiatives such as *CybergeoNetworks*
<http://shiny.parisgeo.cnrs.fr/CybergeoNetworks>

- Code et data available at

<https://github.com/JusteRaimbault/CityNetwork/tree/master/Models/QuantEpistemo/HyperNetwork>

Reserve Slides

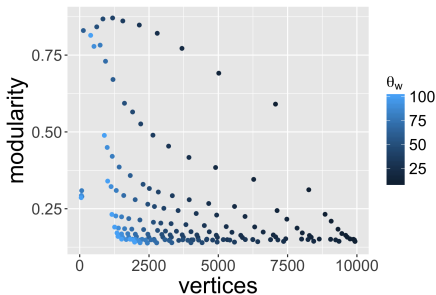
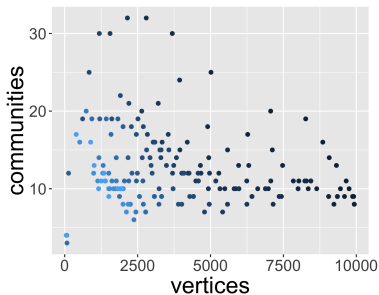
Initial Corporuses

Network and Territories : Corpus from state of the art and modelography of Modeling the relations between Networks and Territories [Raimbault, 2017]

Urban Growth : 20 first results of query “Urban Growth” in scholar, filtered and balanced subjectively

Semantic Network Construction





Multi-objective optimization between modularity and network size,
 $\theta_w = 10$, $k_{max} = 500$, compromise point yields ($V = 7063$, $E = 48952$)






Measuring Interdisciplinarity

- References as probability matrix for themes
 $\mathbf{P} = (p_{ij})$ [Bergeaud et al., 2017]
- First order interdisciplinarity $I_i = 1 - \sum_j p_{ij}^2$
- Let \mathbf{A} citation network adjacency matrix, \mathbf{I}_k row selection matrix for class k ($I_d \cdot \mathbb{1}_{c(i)=k}$) such that $\mathbf{I}_k \cdot \mathbf{A} \cdot \mathbf{I}_{k'}$ gives exactly citations from k to k'
- Citation proximity given by $c_{kk'} = \sum \mathbf{I}_k \cdot \mathbf{A} \cdot \mathbf{I}_{k'} / \sum \mathbf{I}_k \cdot \mathbf{A}$
- Semantic distance $\mathbf{D} = d_{ij} = \sqrt{\frac{1}{2} \sum (p_{ij} - p_{i'j})^2}$ and Semantic proximity given by $s_{kk'} = \mathbf{I}_k \cdot \mathbf{D} \cdot \mathbf{I}_{k'} / \sum \mathbf{I}_k \sum \mathbf{I}_{k'}$




References I

-  Banos, A. (2013).
Pour des pratiques de modélisation et de simulation libérées en géographies et shs.
HDR. Université Paris, 1.
-  Barthelemy, M. (2016).
The structure and dynamics of cities.
-  Bergeaud, A., Potiron, Y., and Raimbault, J. (2017).
Classifying patents based on their semantic content.
PloS one, 12(4):e0176310.
-  Bourgine, P., Chavalarias, D., and al. (2009).
French Roadmap for complex Systems 2008-2009.
ArXiv e-prints.

References II

-  Chavalarias, D. (2017).
What's wrong with science?
Scientometrics, 110(1):481–503.
-  Fujita, M., Krugman, P., and Mori, T. (1999).
On the evolution of hierarchical urban systems.
European Economic Review, 43(2):209–251.
-  Giere, R. N. (2010).
Scientific perspectivism.
University of Chicago Press, Chicago, ISBN: 9780226292137.

References III

-  Nicosia, V., Mangioni, G., Carchiolo, V., and Malgeri, M. (2009).
Extending the definition of modularity to directed graphs with
overlapping communities.
Journal of Statistical Mechanics: Theory and Experiment,
2009(03):P03024.
-  Pumain, D. (2012).
Multi-agent system modelling for urban systems: The series of
simpop models.
In Agent-based models of geographical systems, pages 721–738.
Springer.
-  Raimbault, J. (2016).
Indirect bibliometrics by complex network analysis.
In 20e Anniversaire de Cybergeog.

References IV



Raimbault, J. (2017).

Justeraimbault/thesismemoire: Version 3.2.



West, G. (2017).

Scale: The Universal Laws of Growth, Innovation, Sustainability, and the Pace of Life in Organisms, Cities, Economies, and Companies.

Penguin.