# Indirect Bibliometrics by Complex Network Analysis

J. Raimbault[1,2]

[1]Géographie-cités (UMR 8504 CNRS)
[2]LVMT (UMR-T 9403 IFSTTAR)

Cybergeo : 20 ans déjà !
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# Context

*"You are what you cite"* : **Which disciplines populate the scientific neighborhood of cybergeo ? Are they different from the ones obtained through article content (POC) and declared contents (HC) analysis ?**

→ Important for editorial policy : interdisciplinarity and Open Science

→ Semi-qualitative approach, against purely quantitative bibliometrics harmful to humanities

# Objective

**Research question :** *How does the combination of a citation network approach with a semantic analysis unveil disciplinary context of the journal ?*

→ Hypernetwork methodology : superposition of a citation network with a semantic network, in the spirit of a transversal approach

→ Data difficult to access : database to construct

# Data collection

**Cybergeo data** : journal production base

→ Structuration and Consolidation

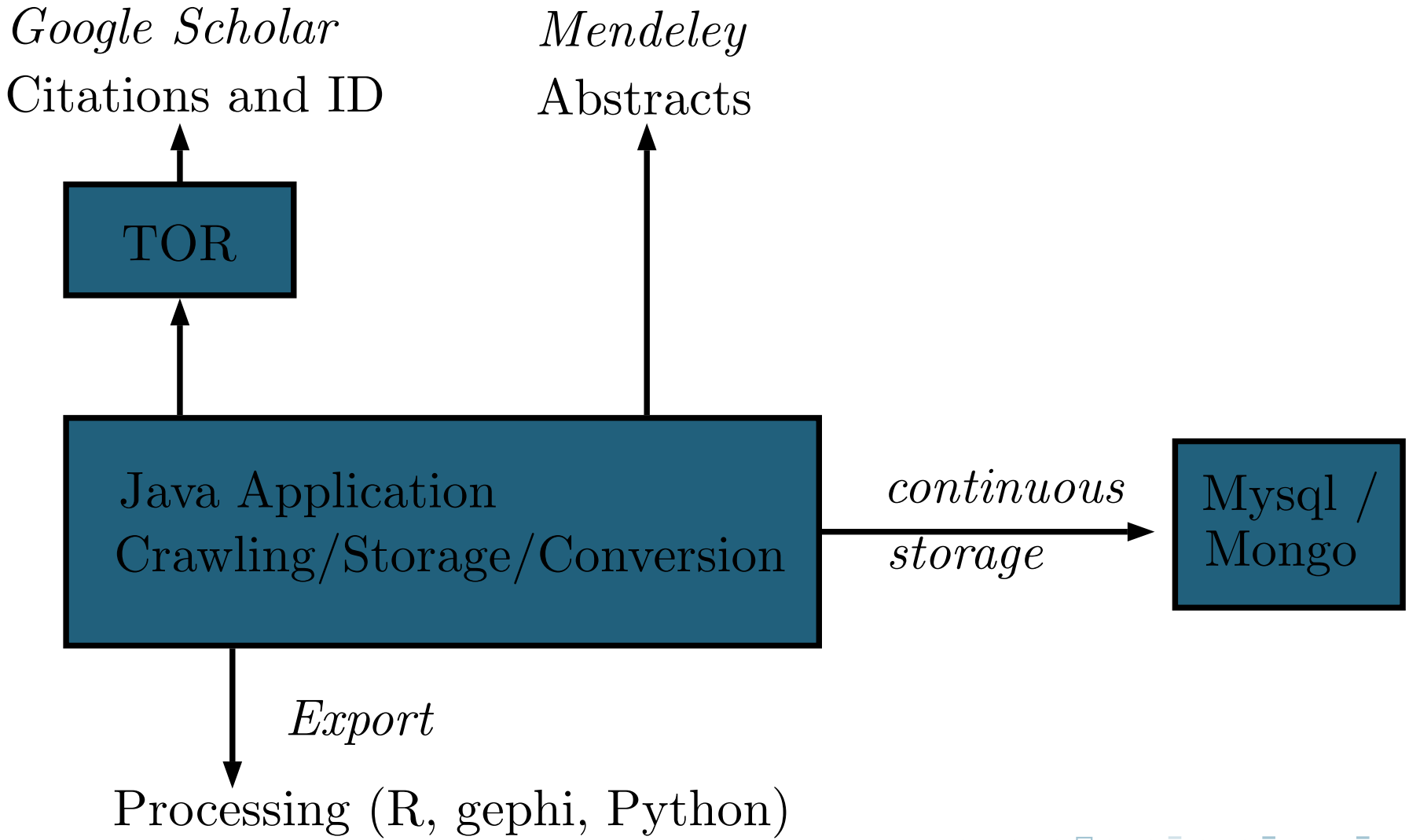
**Citation data** : cybergeo not indexed by "classical" bases (such as Web of Science©, which are furthermore not open)

→ `google scholar` crawling by using "*cited by*" option [Noruzi, 2005]

**Text data** : need abstracts for all linked articles

→ use of Mendeley API [Mendeley, 2015] (free but not open)

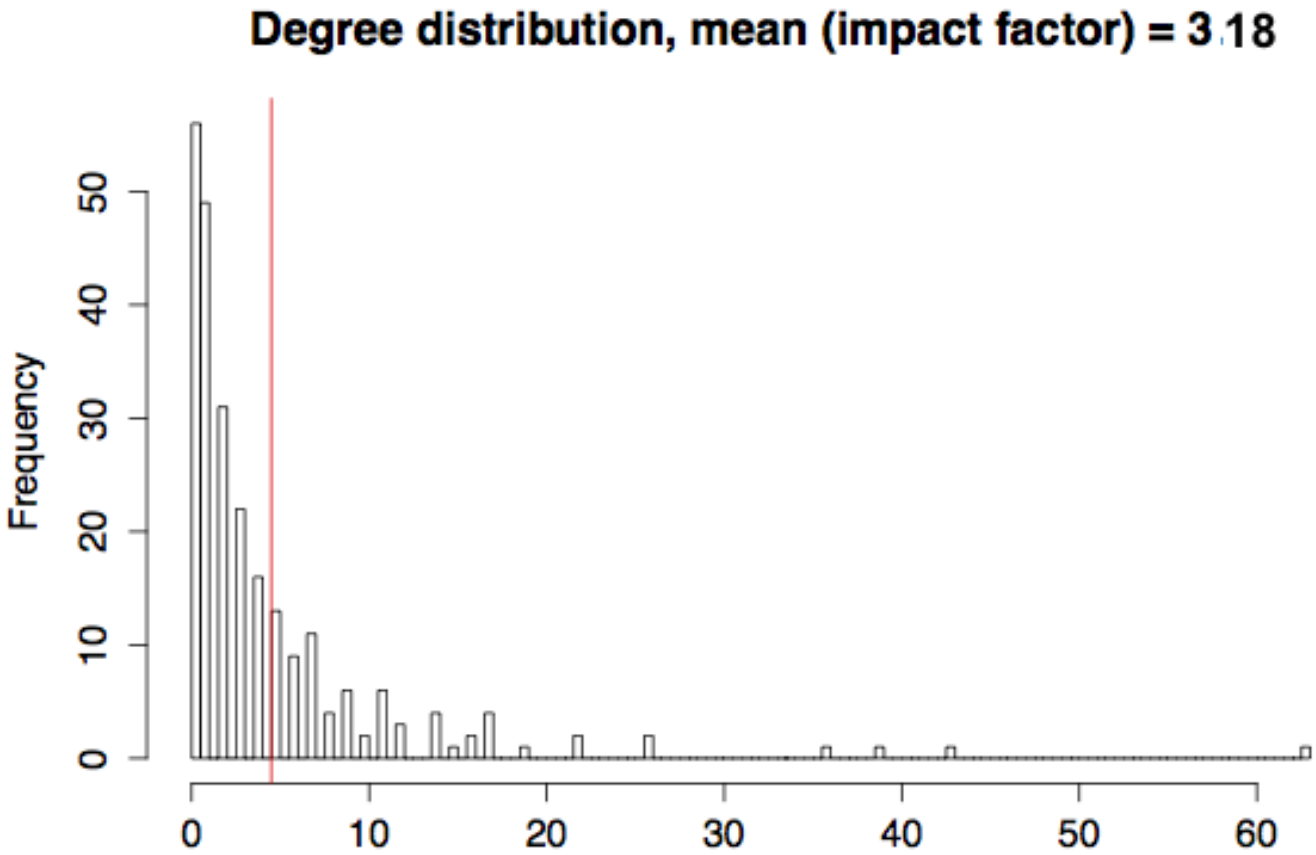
# Data Collection Architecture



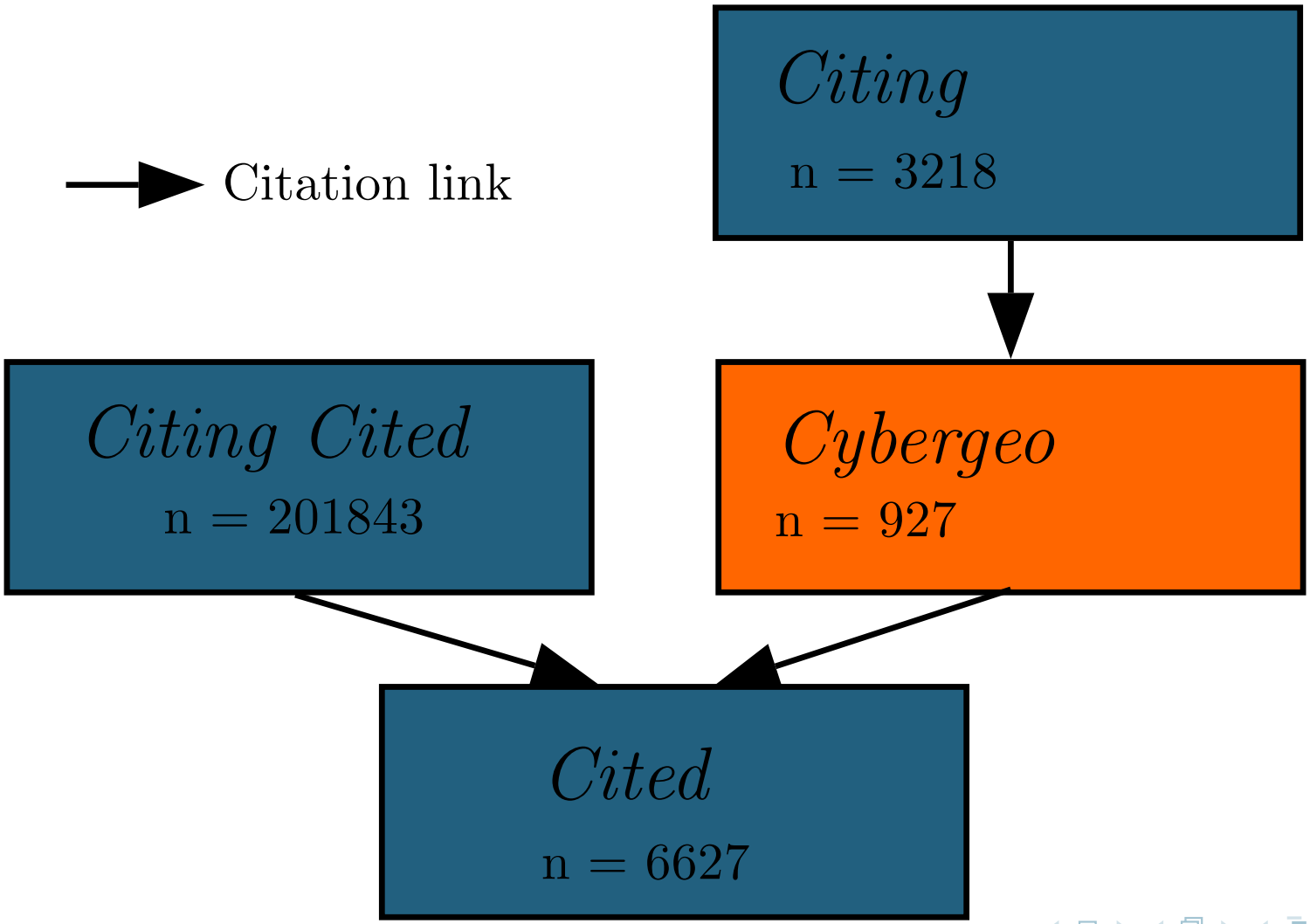
# Network Properties

→ ≃ 947 cybergeo articles can be studied, among ≃ 1200

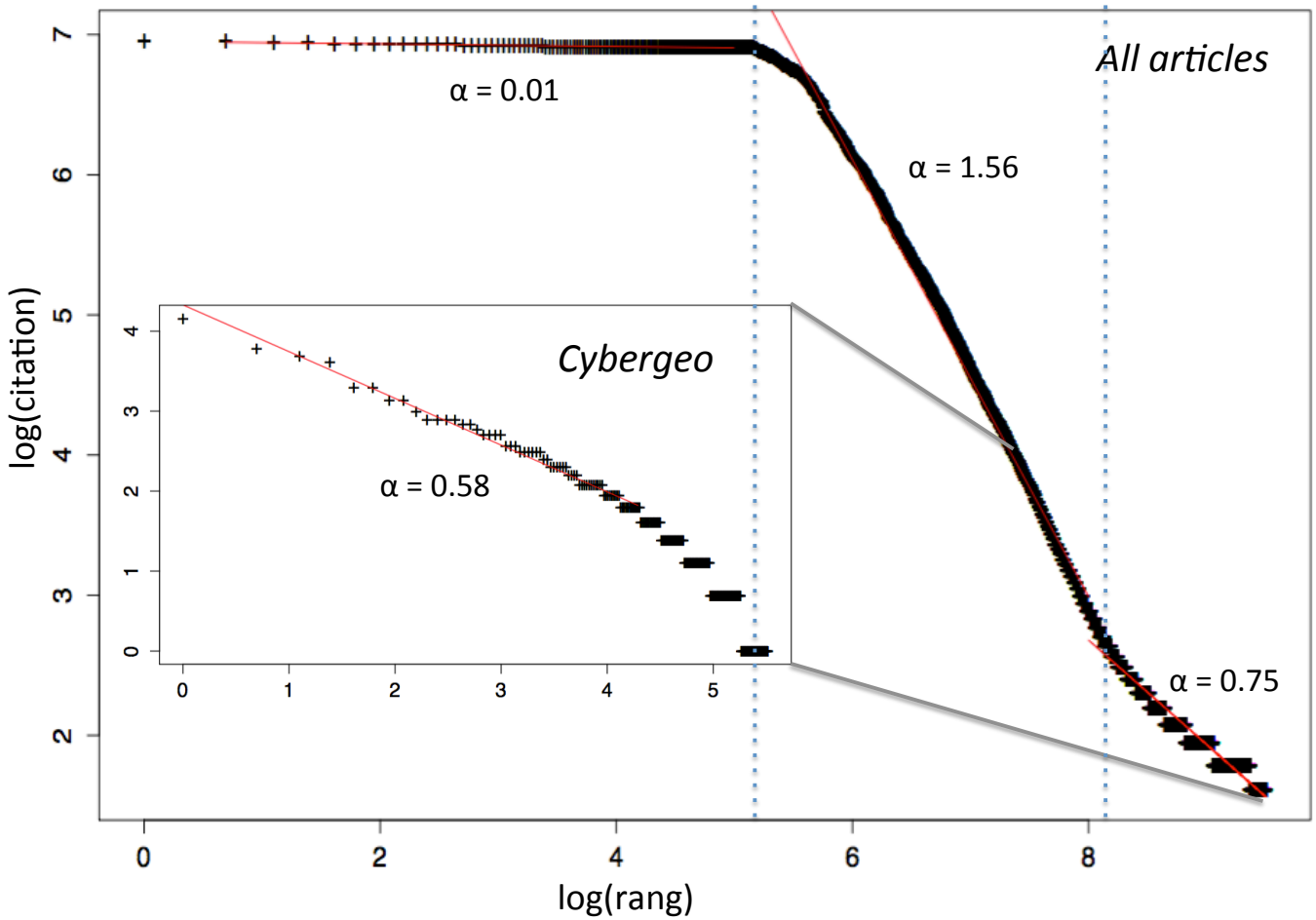
→ *418670 Nodes et 570352 Links ; Diameter : 9 ; Density : 3.25E-6 ; average degree : 2.724284*



# Citation Network Structure

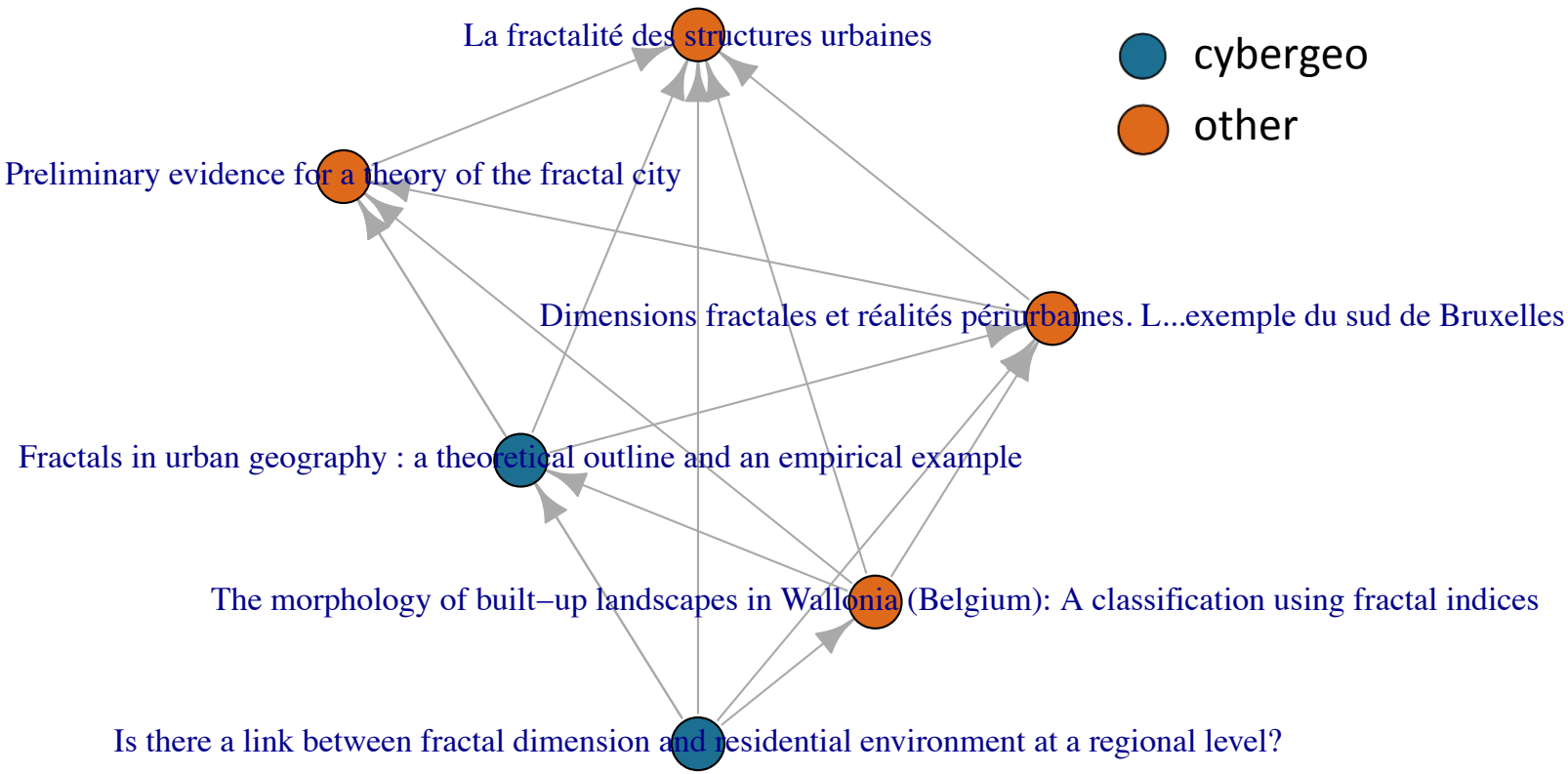


# Hierarchy in citations




*Superposition of different hierarchical regimes*

# Cliques


La fractalité des structures urbaines
Preliminary evidence for a theory of the fractal city
Dimensions fractales et réalités périurbaines. L...exemple du sud de Bruxelles
Fractals in urban geography : a theoretical outline and an empirical example
The morphology of built–up landscapes in Wallonia (Belgium): A classification using fractal indices
Is there a link between fractal dimension and residential environment at a regional level?
cybergeo
other

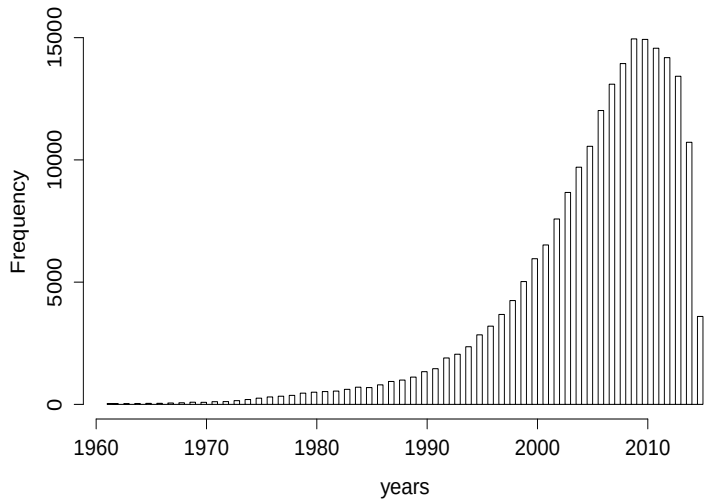
# Semantic Network

**Semantic Data :** Collection of abstract/date/authors/keywords for the 400000 references via Mendeley API $\rightarrow \sim$ 215000 references with full data.

**Summary Statistics**

*Language :* English 206607, French 4109, Spanish 2029, German 892, Portuguese 891, Dutch 124, others 182

*Yearly count*



# Keywords Extraction

*Text-mining in python with* `nltk` *[Bird, 2006]*, method adpated from [Chavalarias and

- Language detection using *stop-words*
- Parsing and tokenizing / pos-tagging (word functions) / stemming done differently depending on language :
  - English : `nltk` built-in pos-tagger, combined to a PorterStemmer
  - French or other : use of `TreeTagger` [Schmid, 1994]
- Selection of potential *n-grams* (with $1 \leq n \leq 4$) : English $\bigcap\{NN \cup VBG \cup JJ\}$ ; French $\bigcap\{NOM \cup ADJ\}$
- Database insertion for instantaneous utilisation (10j $\rightarrow$ 2min)
- Estimation of *n-grams* relevance, following co-occurrences statistical distribution

# Construction of Semantic Network

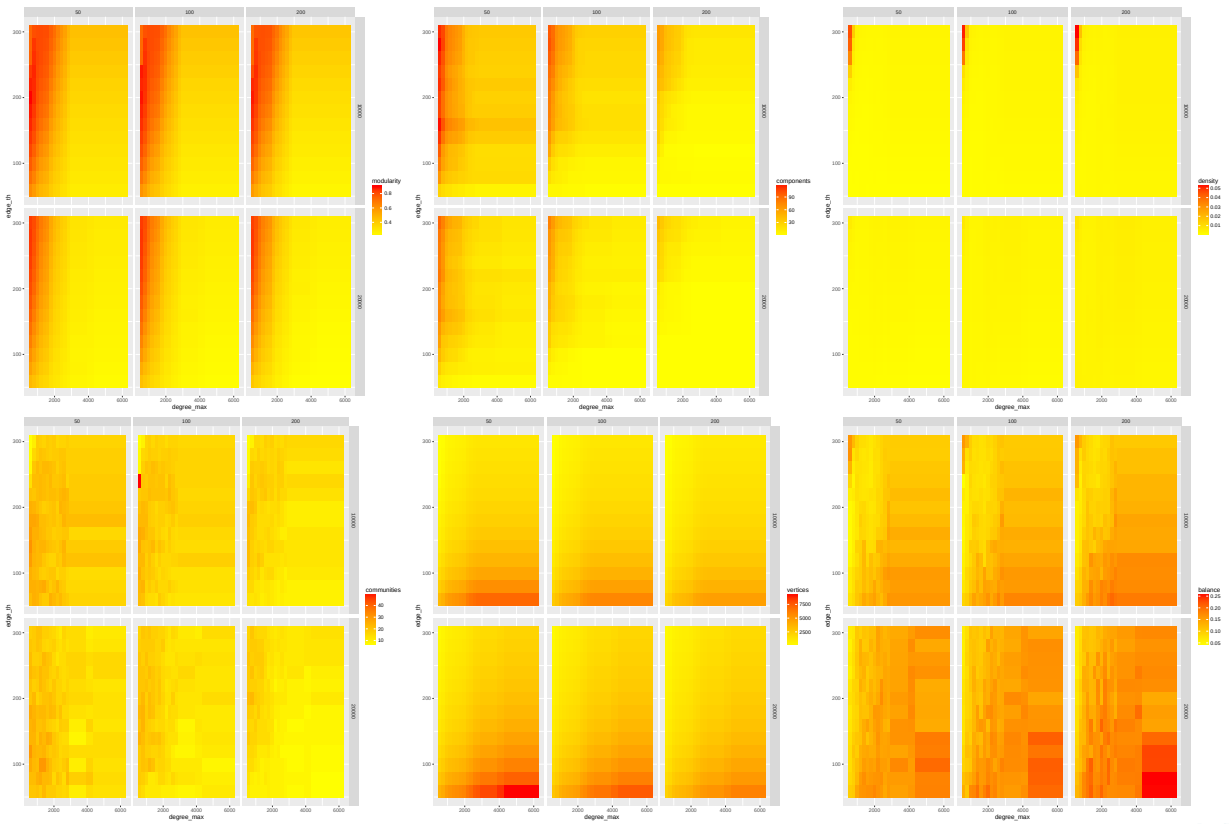
- **Nodes :** Keywords with largest relevance
- **Links :** Weighted co-occurrences
- Manual suppression of parasite words (e.g. : copyright statements !)
- Low weight link filtering
- Suppression of *hubs* (ex. `model`, `space`, `structure`, `process`) that suppress community structure
- Community detection by greedy modularity maximization (Louvain method [Blondel et al., 2008])

# Parameters influence

*Importance of* **fine tuning** *:*

→ Sensitivity of models **and** data analysis to parameters. Systematic exploration mandatory, via OpenMole for example.

→ Place of expert decision-making : no qualitative-quantitative dichotomy




*Multi-criteria optimization (modularity, size, balance) on network construction parameters*

# Obtained disciplines

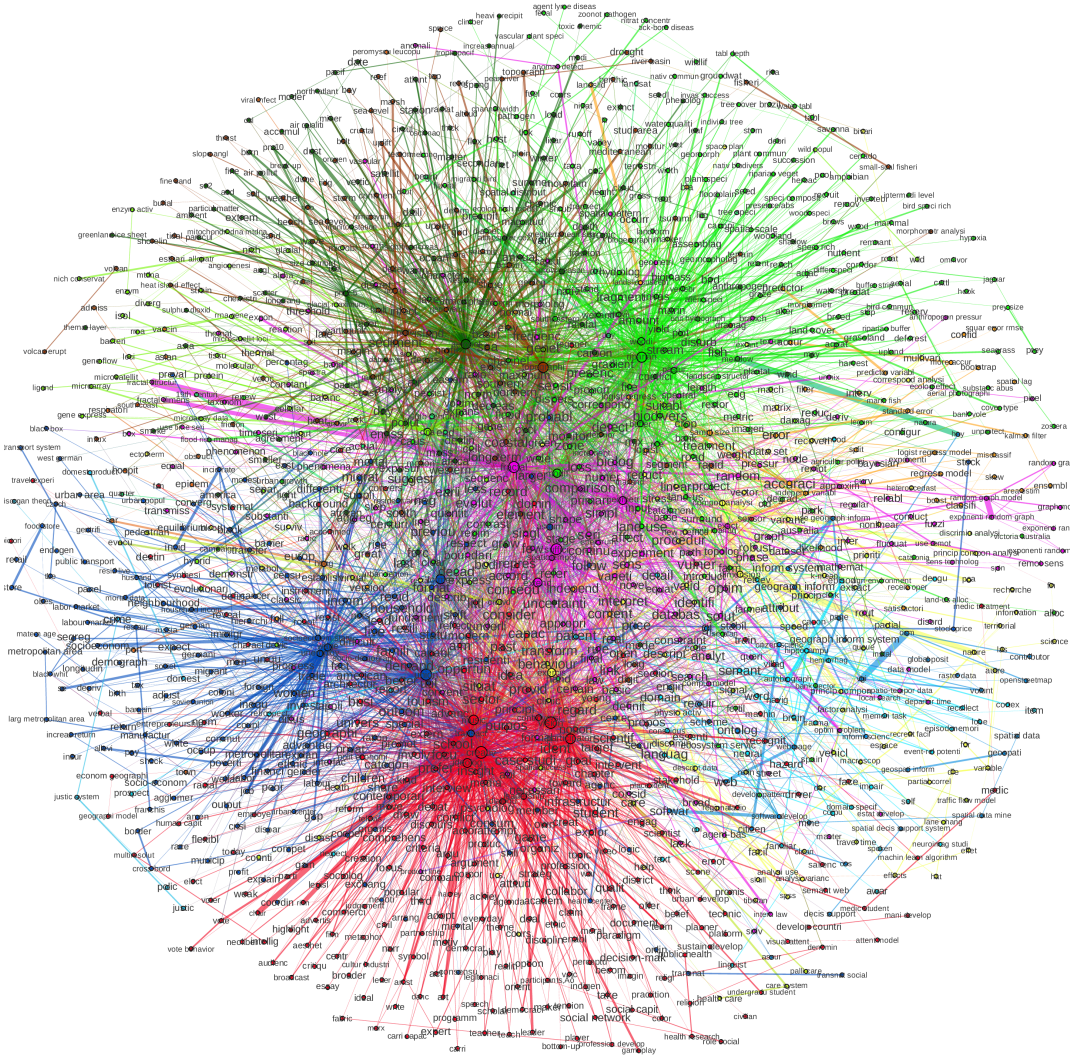
*Communities obtained with* $\theta_V = 1200, \theta_E = 50$

- Political sciences/critical geography (535) : `decision-mak, polit ideolog, democraci, stakehold, neoliber`
- Biogeography (394) : `plant densiti, wood, wetland, riparian veget`
- Economic geography (343) : `popul growth, transact cost, socio-econom, household incom`
- Environnment/climate (309) : `ice sheet, stratospher, air pollut, climat model`
- Complex systems (283) : `scale-fre, multifract, agent-bas model, self-organ`
- Physical geography (203) : `sedimentari, digit elev model, geolog, river delta`
- Spatial analysis (175) : `spatial analysi, princip compon analysi, heteroscedast, factor analysi`

# Obtained disciplines (continued)

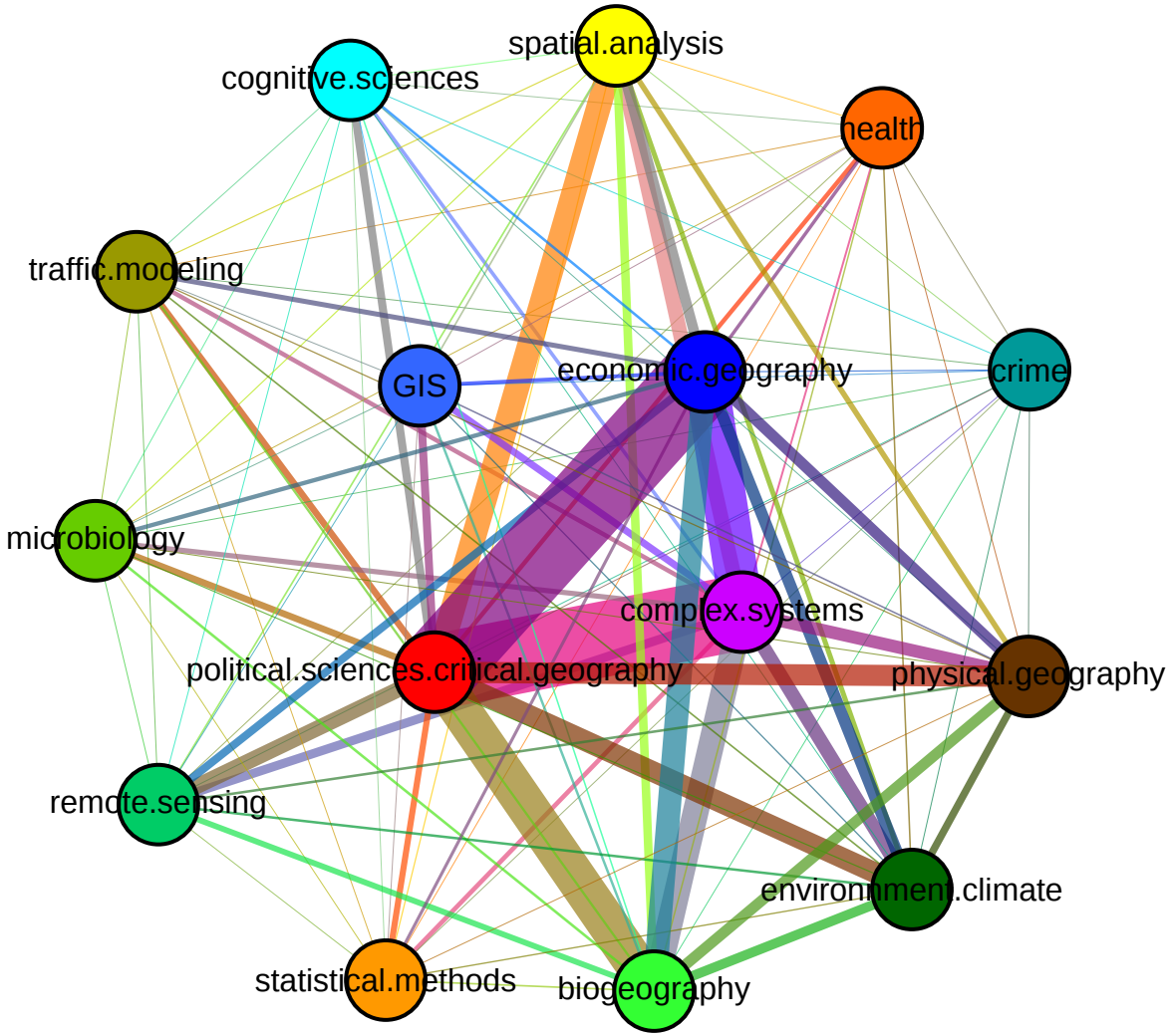
- Microbiology (118) : `chromosom, phylogenet, borrelia`
- Statistical methods (88) : `logist regress, classifi, kalman filter, sampl size`
- Cognitive sciences (81) : `semant memori, retrospect, neuroimag`
- GIS (75) : `geograph inform scienc, softwar design, volunt geograph inform, spatial decis support`
- Traffic modeling (63) : `simul model, lane chang, traffic flow, crowd behavior`
- Health (52) : `epidem, vaccin strategi, acut respiratori syndrom, hospit`
- Remote sensing (48) : `land-cov, landsat imag, lulc`
- Crime (17) : `crimin justic system, social disorgan, crime`

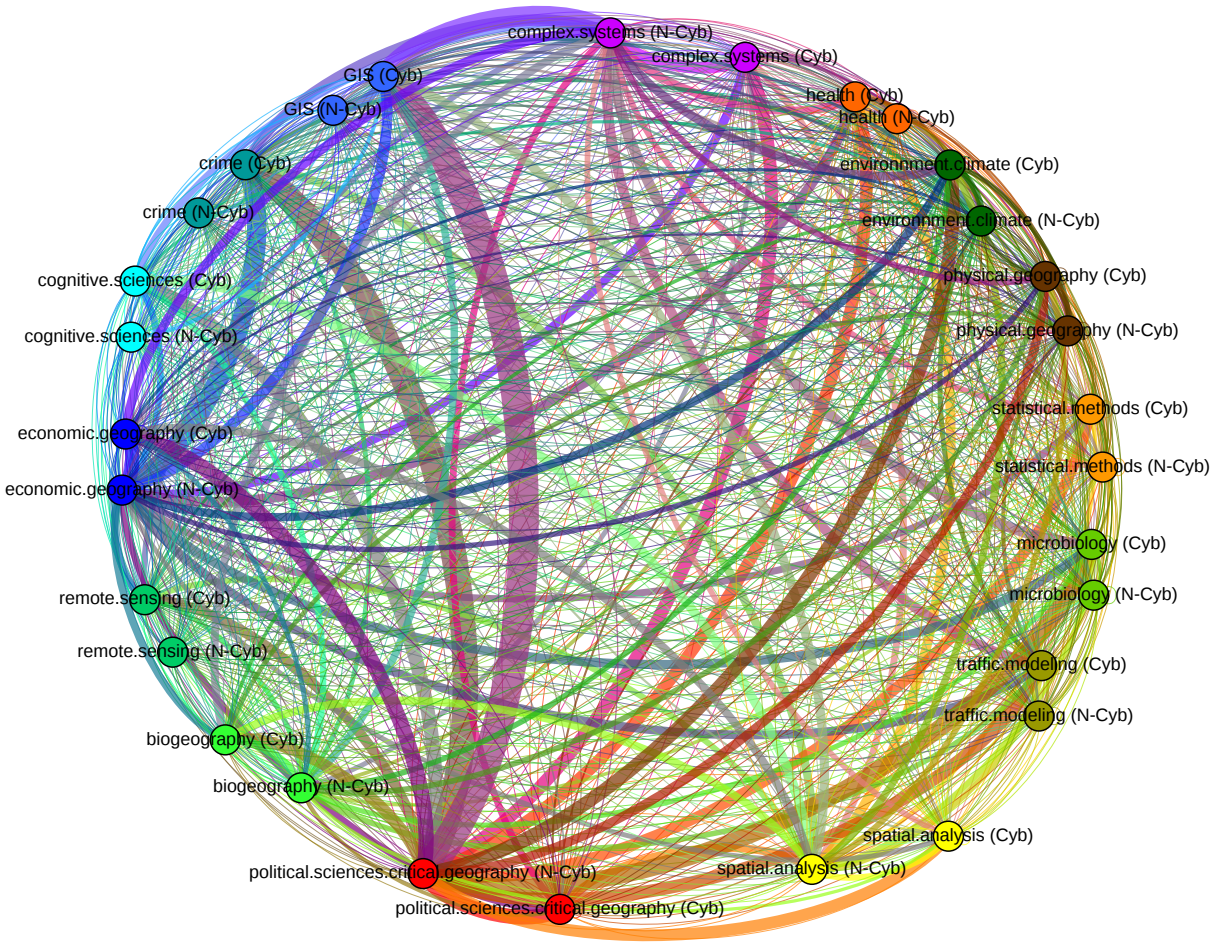
# Network



| | | |
|---|---|---|
| | political sciences/critical geography | (19,92 %) |
| | biogeography | (16,24 %) |
| | economic geography | (13,31 %) |
| | complex systems | (11,35 %) |
| | environnment/climate | (8,57 %) |
| | physical geography | (7,82 %) |
| | spatial analysis | (5,94 %) |
| | microbiology | (3,83 %) |
| | cognitive sciences | (2,93 %) |
| | statistical methods | (2,86 %) |
| | GIS | (2,48 %) |
| | traffic modeling | (1,8 %) |
| | remote sensing | (1,28 %) |
| | health | (1,13 %) |
| | crime | (0,53 %) |

# Interdisicplinarity

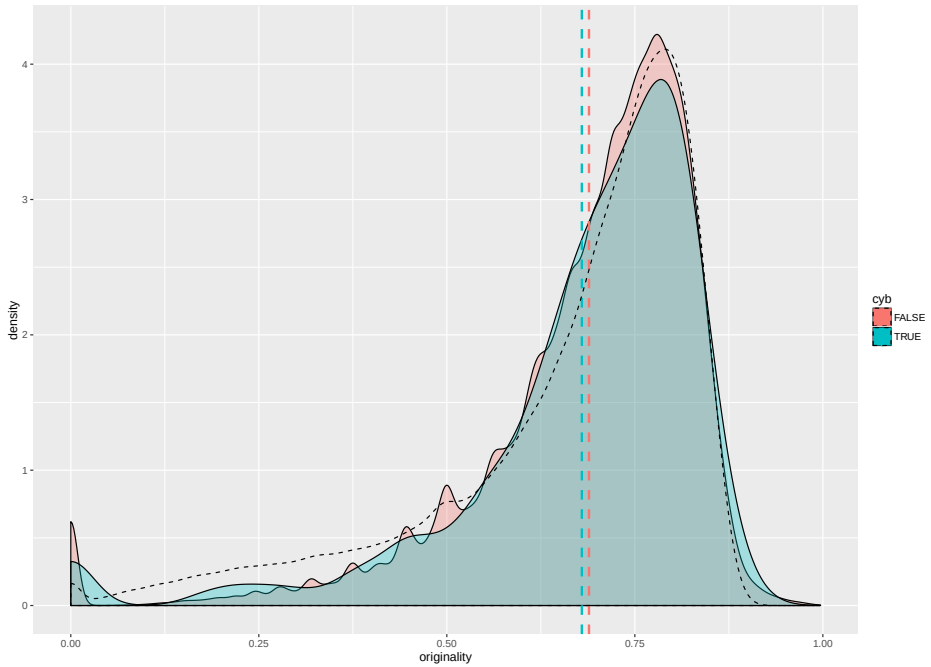



complex.systems (N-Cyb)
complex.systems (Cyb)
GIS (Cyb)
GIS (N-Cyb)
health (Cyb)
health (N-Cyb)
crime (Cyb)
environment.climate (Cyb)
crime (N-Cyb)
environment.climate (N-Cyb)
cognitive.sciences (Cyb)
physical.geography (Cyb)
cognitive.sciences (N-Cyb)
physical.geography (N-Cyb)
statistical.methods (Cyb)
economic.geography (Cyb)
statistical.methods (N-Cyb)
economic.geography (N-Cyb)
microbiology (Cyb)
microbiology (N-Cyb)
remote.sensing (Cyb)
remote.sensing (N-Cyb)
traffic.modeling (Cyb)
traffic.modeling (N-Cyb)
biogeography (Cyb)
biogeography (N-Cyb)
spatial.analysis (Cyb)
spatial.analysis (N-Cyb)
political.sciences.critical.geography (N-Cyb)
political.sciences.critical.geography (Cyb)

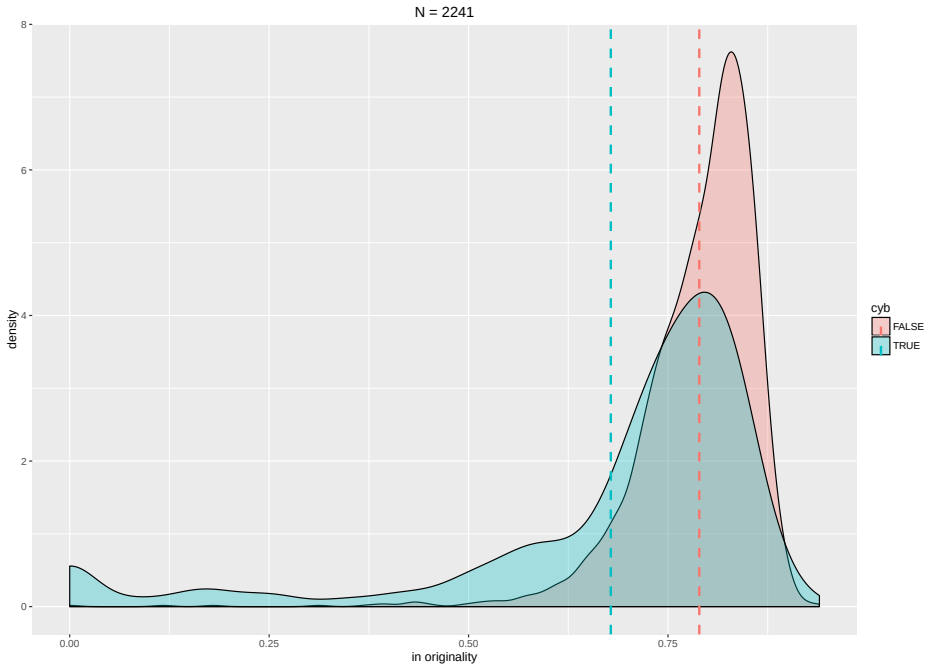
# Degré d'interdisciplinarité par articles

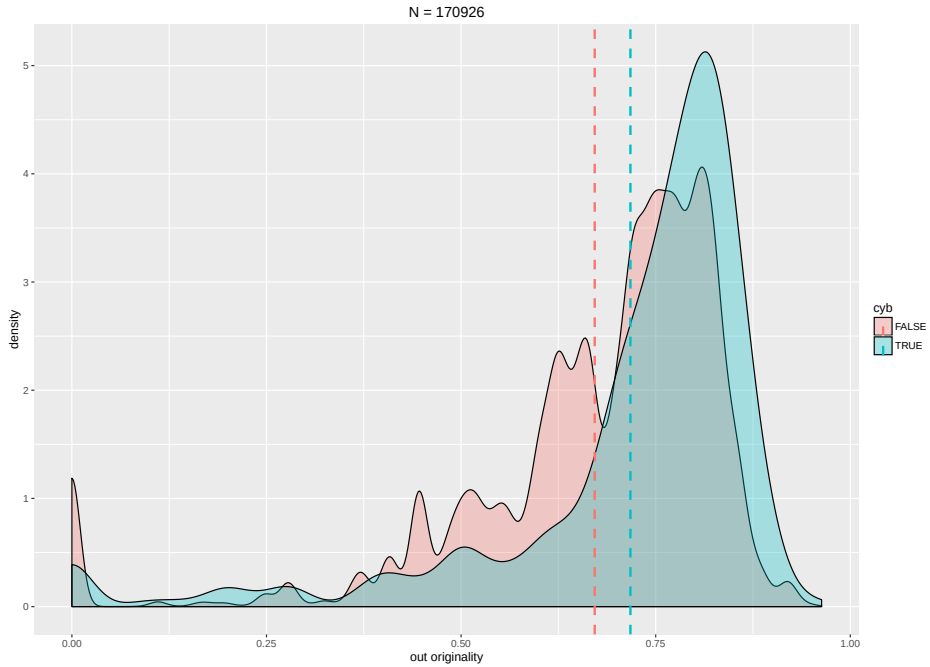
Un article peut être associé aux communautés sémantiques par ses mots clés : probas $p_i$ pour chaque communauté.
Mesure d'interdisciplinarité (pour un article, au premier ordre) :

$$o = 1 - \sum p_i^2$$



# Citation interdisciplinarity



# Conclusion

→ A very rich scientific environment and a certain interdisciplinarity

→ Approach to be combined with other classifications (thematic (POC), keywords (HC), geographical (CC)) to unveil patterns in geographical practices around the journal

→ Generic method that can be applied to any network whose nodes have a textual description

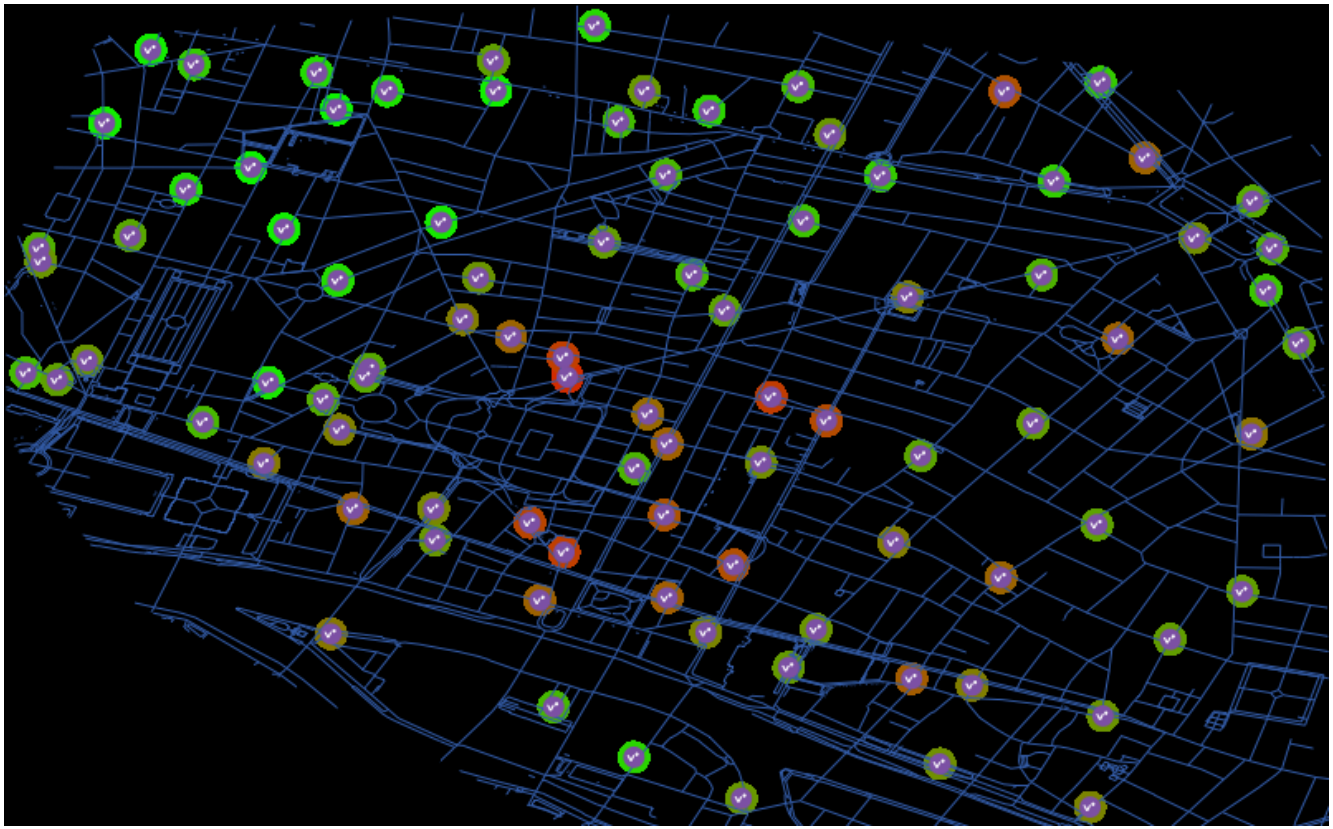
# Reserve Slides

*Reserve Slides*

# Data Collection

*Crawling of semi-open data : examples in geography*

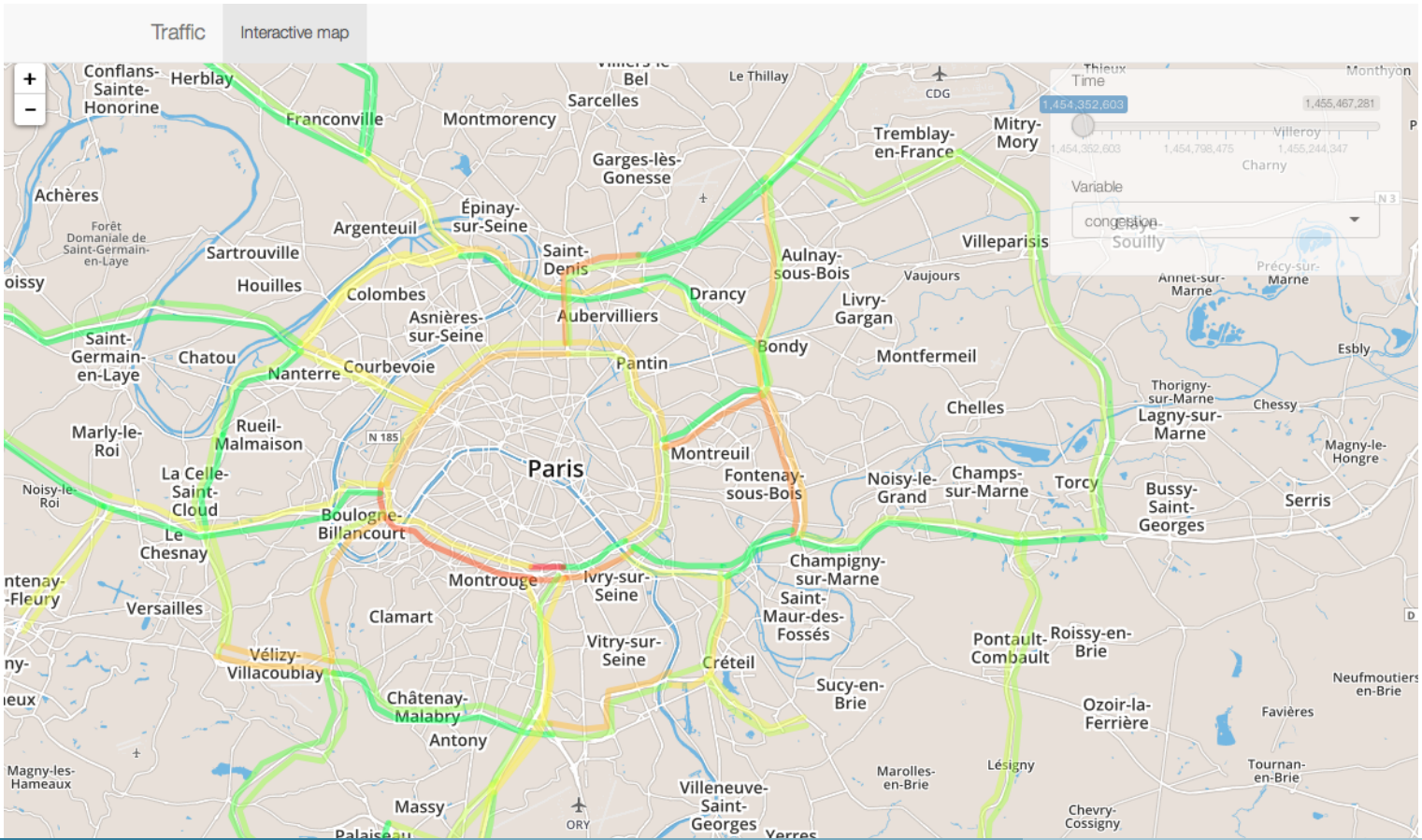
Mobility data : bike-sharing docking stations status (API)
[?]



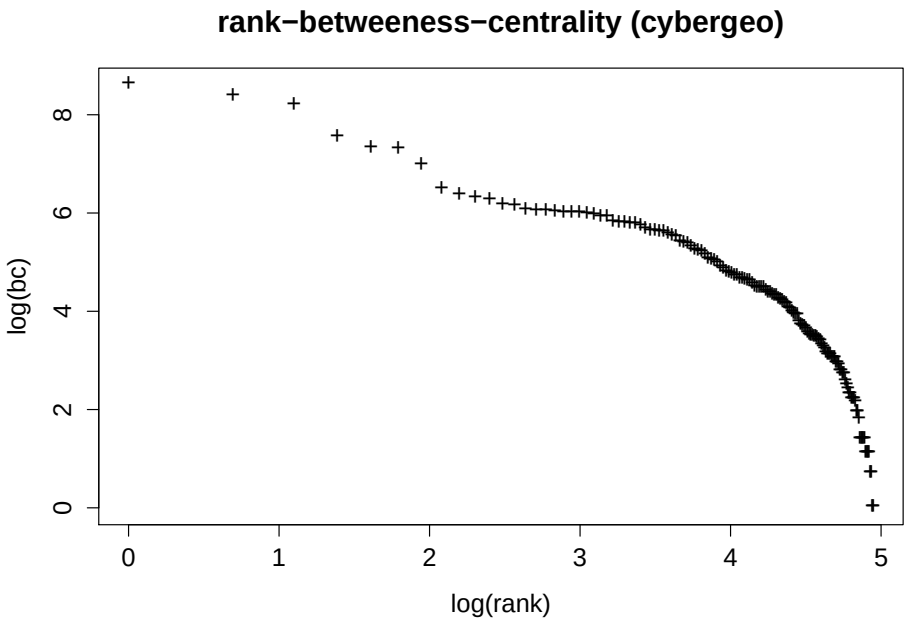
# Data Collection

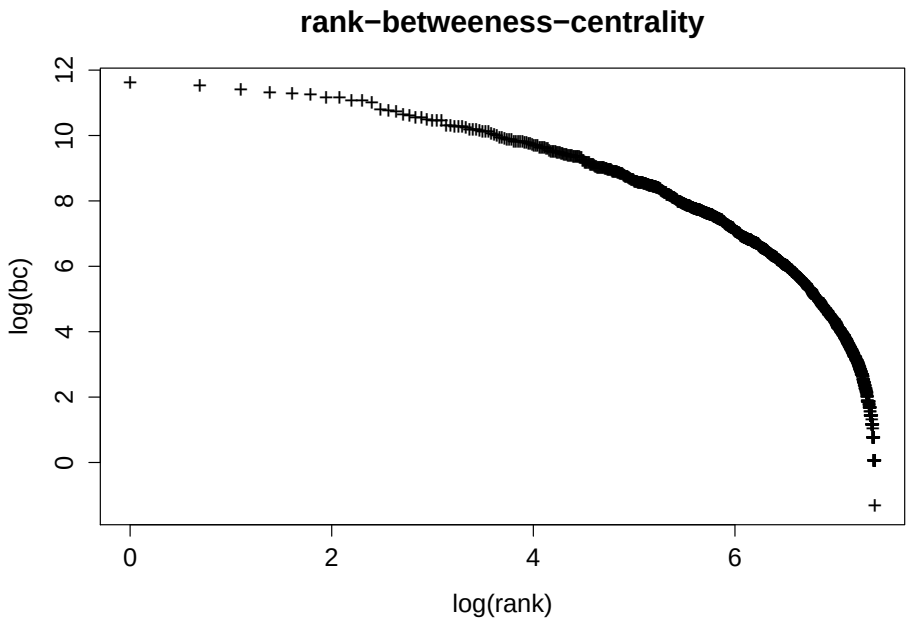
*Exemples in geography (continued)*

Road traffic : collect of *sytadin* data (no API : *scrapping* is necessary)



# Centrality (citation)

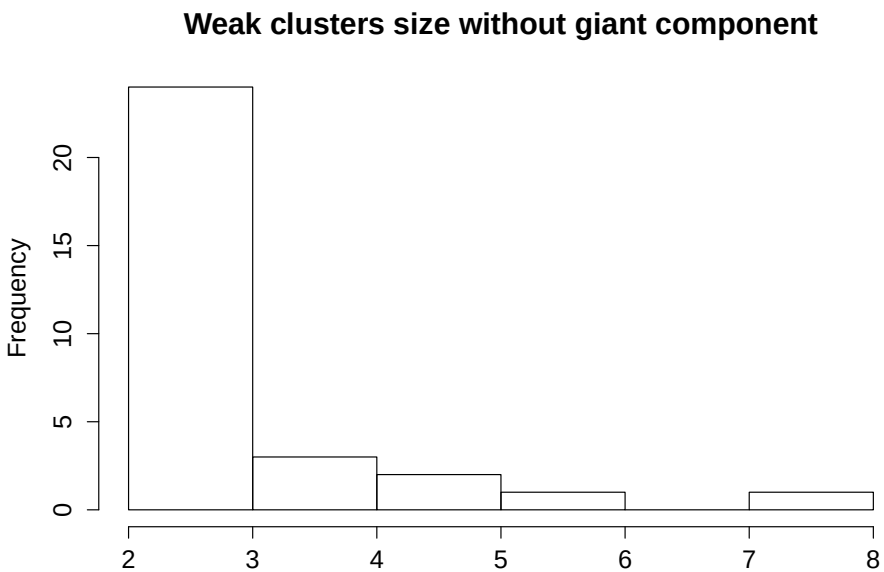


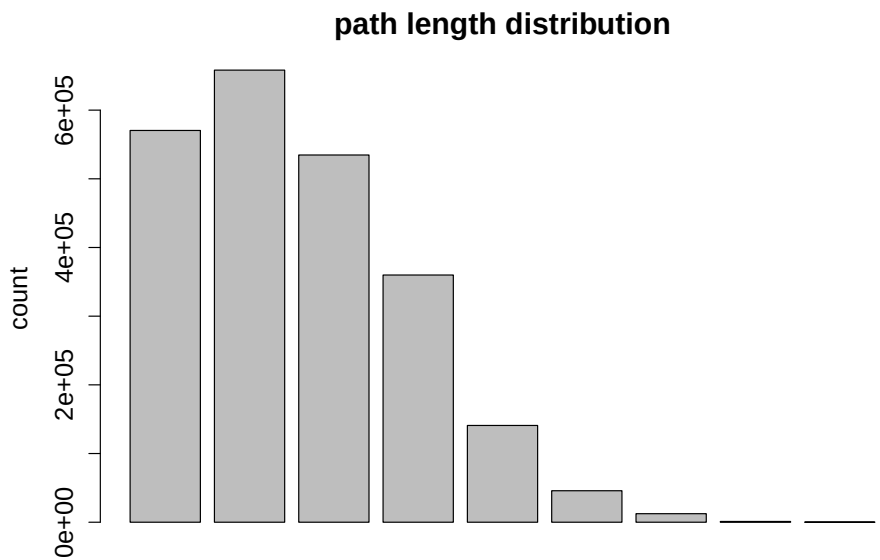




*Weak centralities (rq : impossibility of having strong clusters because of temporal causality). Left : Cybergeo ; Right : Whole Network*

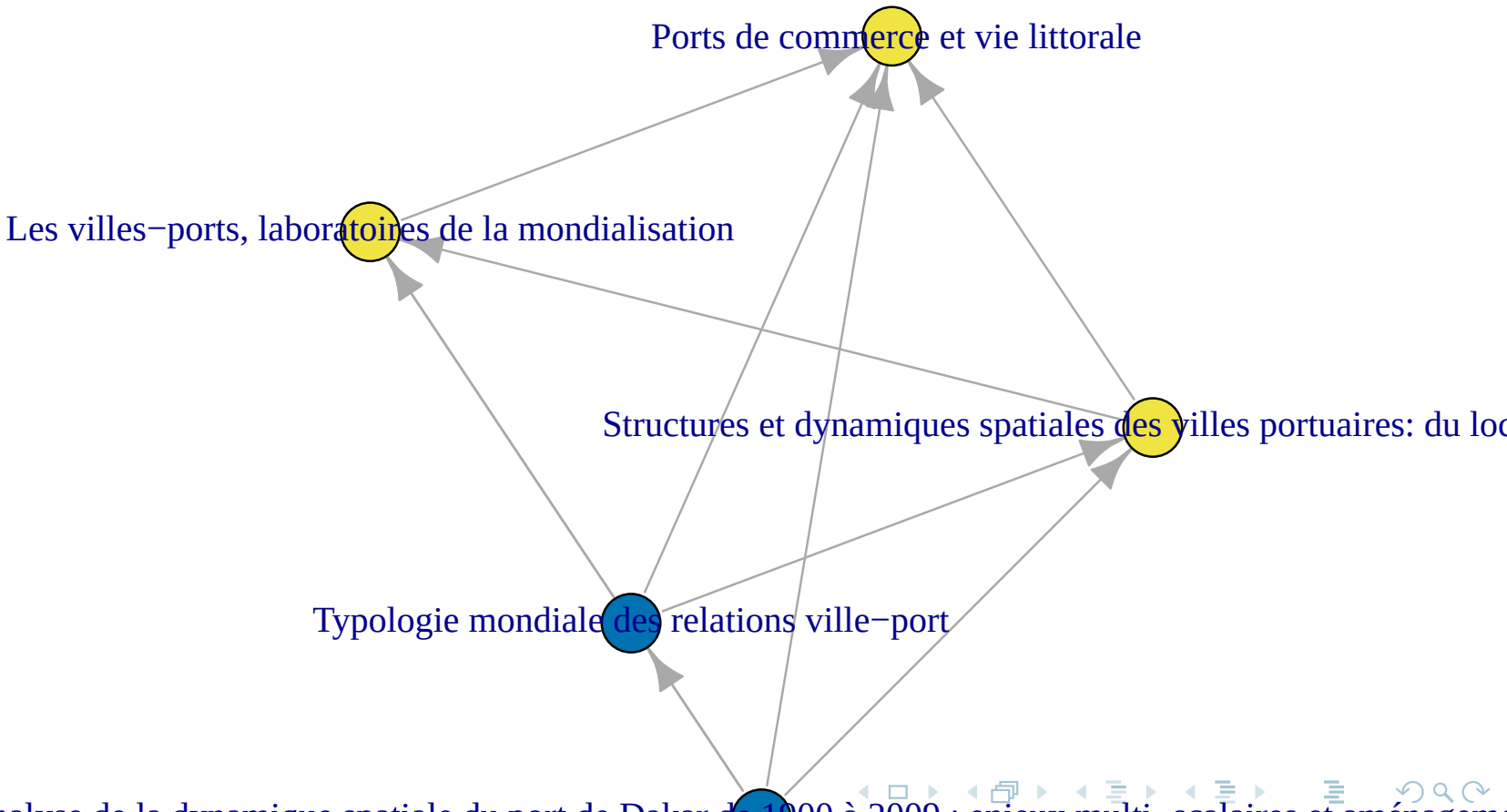
# Clustering (citation)

Giant component : more than 99% of nodes.

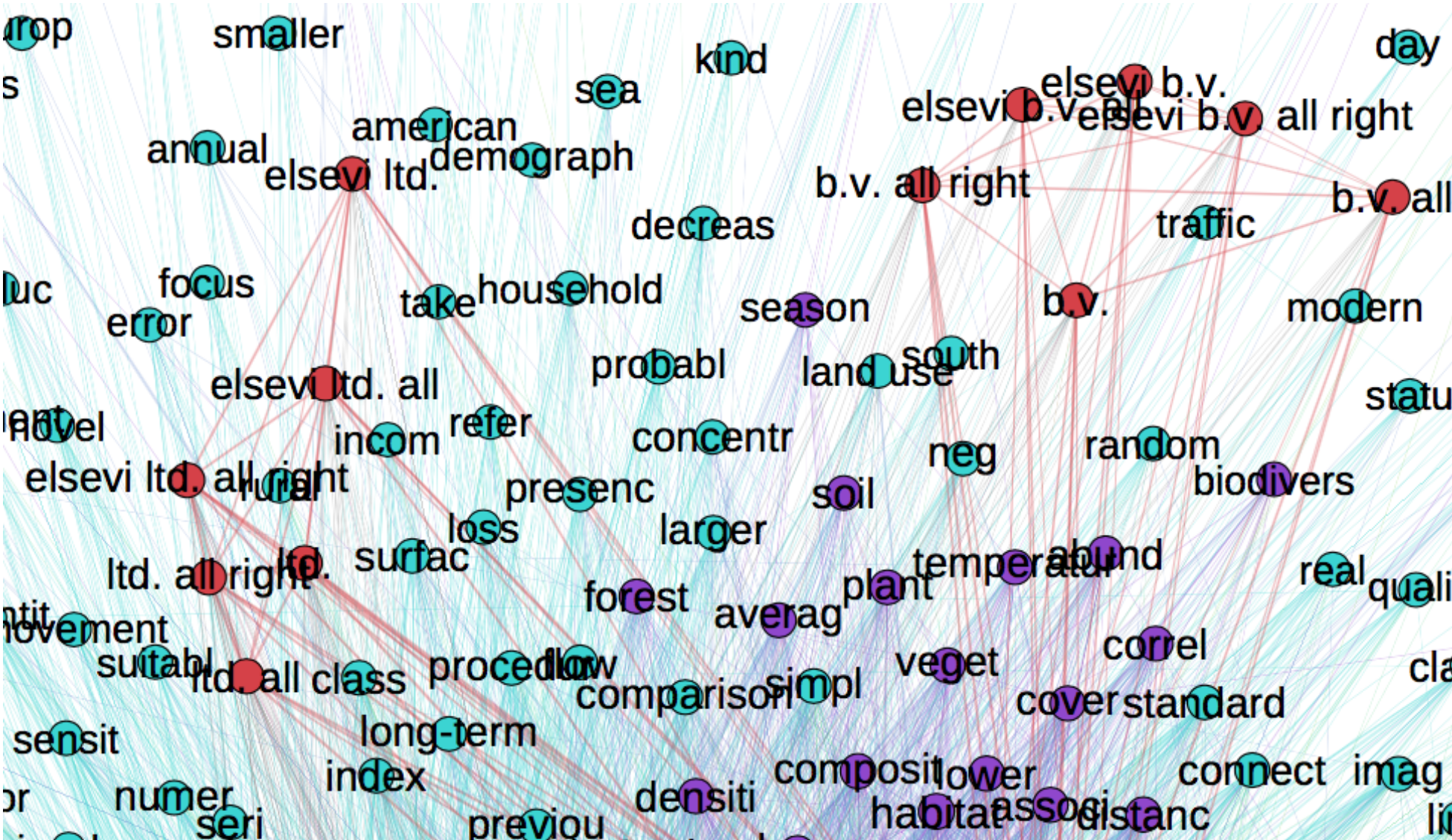


# Cliques(citation)



# Network Perturbation



# Relevance estimation

Estimation exacte de la pertinence via la repartition statistique des co-occurrences (score de $\chi^2$) : *termhood* définie, avec $M_{ij}$ nombre d'articles o $i$ et $j$ apparaissent simultanment,

$$t_i = \sum_{j \neq i} \frac{(M_{ij} - \sum_k M_{ik} \sum_k M_{jk})^2}{\sum_k M_{ik} \sum_k M_{jk}}$$

en $\Theta(\sum_i N_i^2)$ ($N_i$ taille des résumés) : difficile sur un corpus où $\sum_i N_i^2 \simeq N < N_i >^2 \simeq 8 \cdot 10^7$

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# References III