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 !
Jeudi 26 mai 2016

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 a purely quantitative bibliometric 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

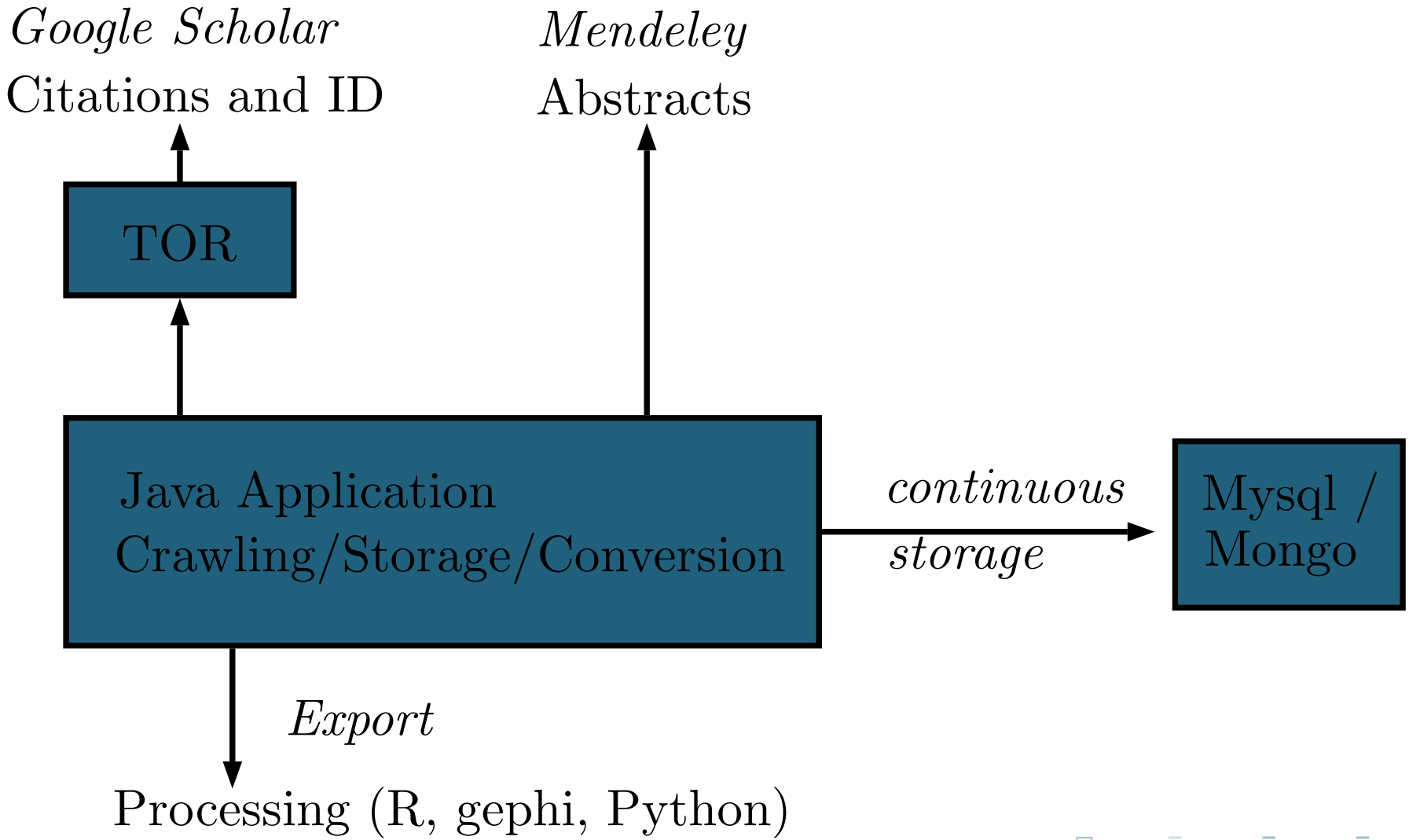
Citation data : cybergeo not indexed

→ `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)

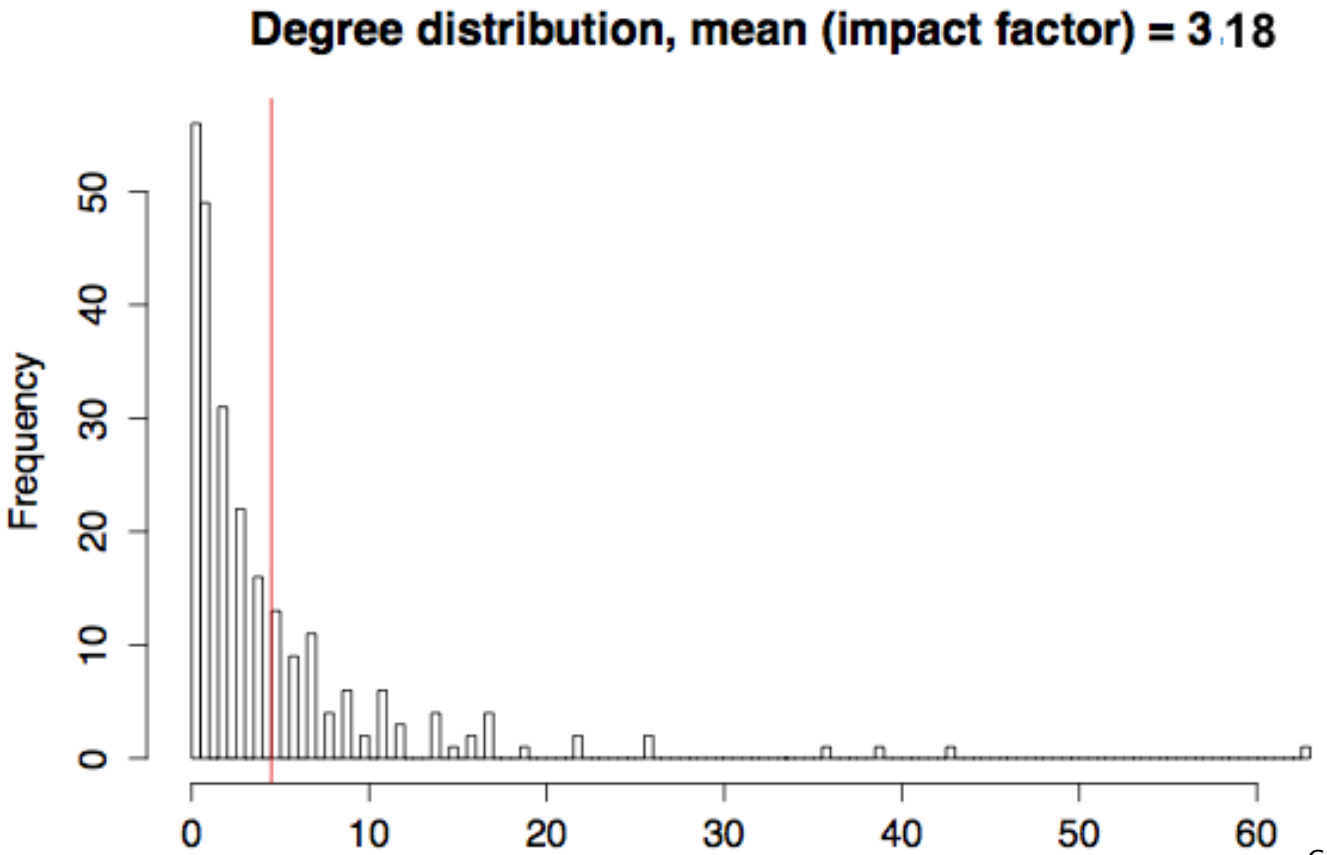
Data Collection Architecture



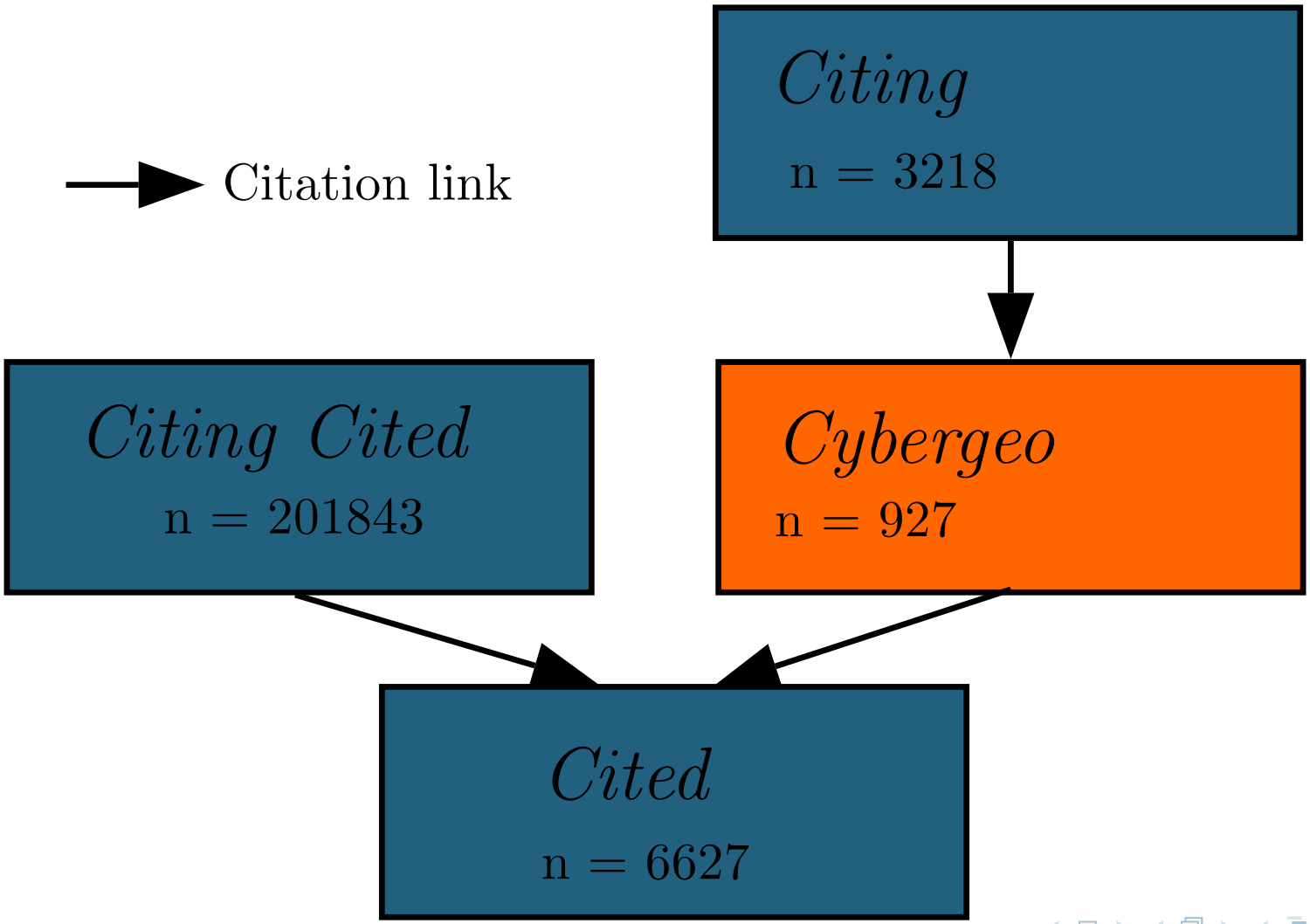
Network Properties

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

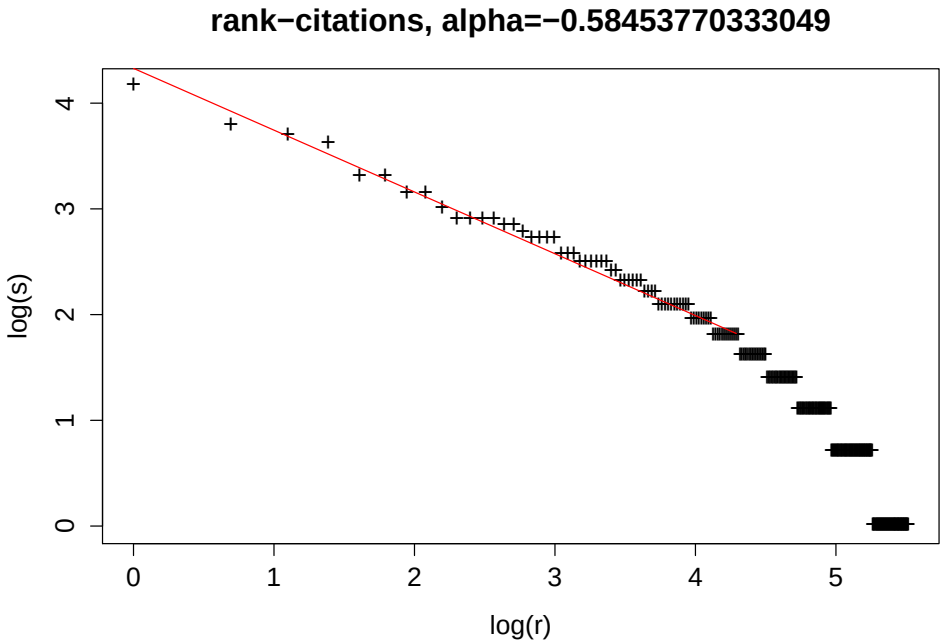
→ *418670 Nodes et 570352 Links ; Diameter : 9 ; Density : 3.25E-6 ; average degree : 2.724284*

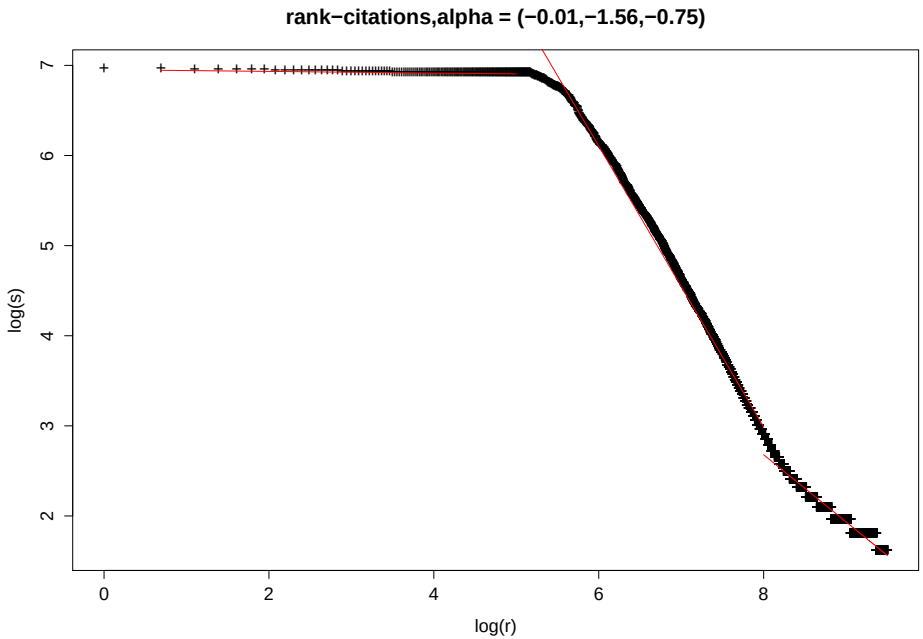


Citation Network Structure



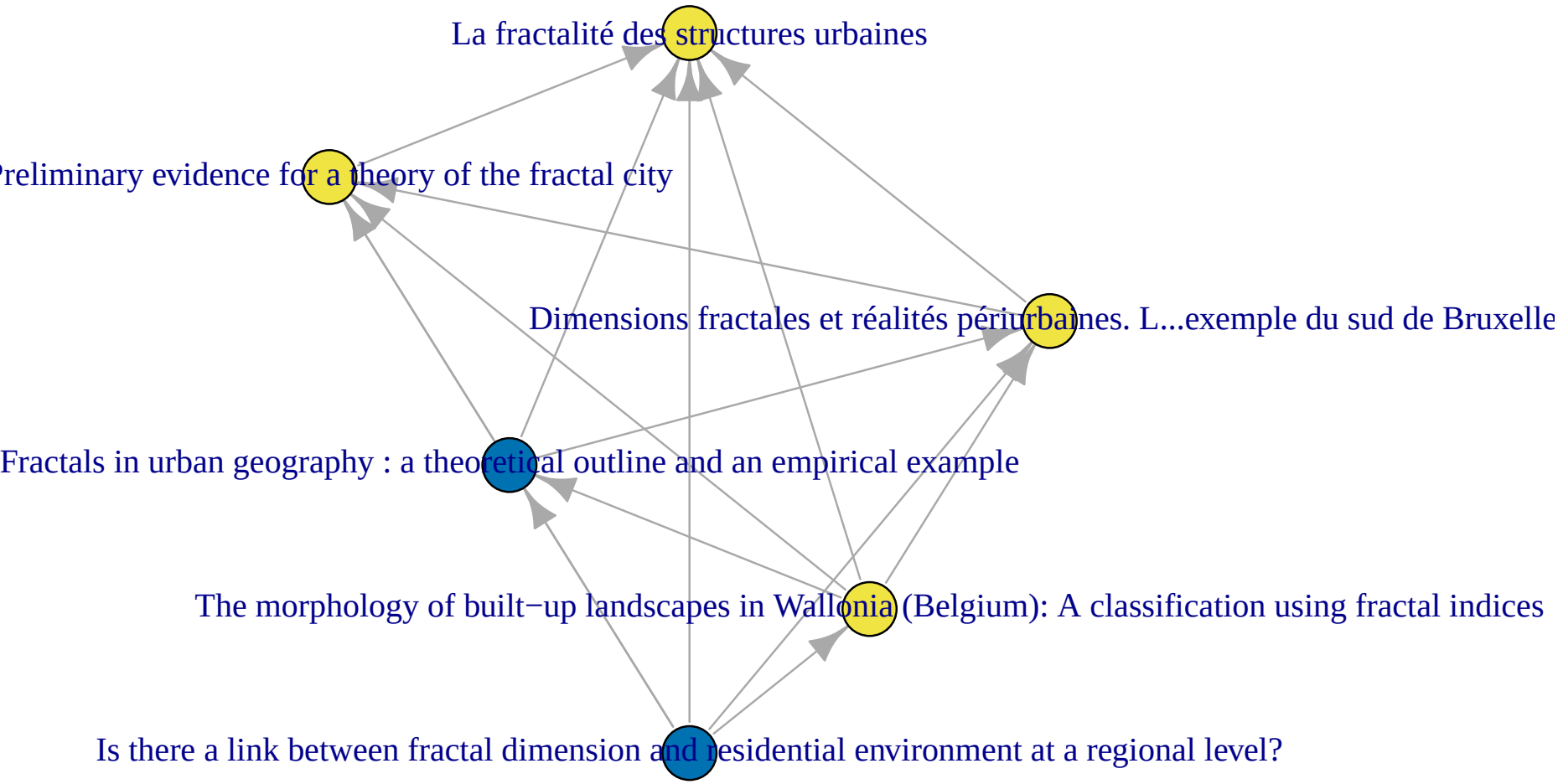
Degrés : Loi rang-taille





Gauche : Cybergéo ; Droite : Ensemble du réseau

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 Bruxelle
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?

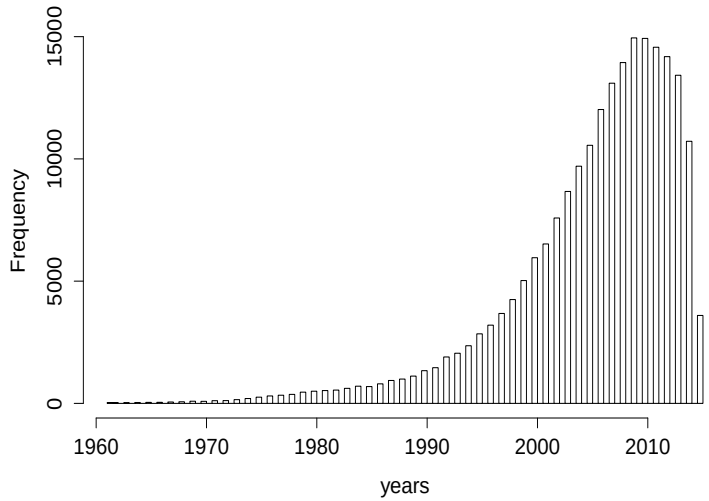
Réseau sémantique

Réseau sémantique. Collection des résumés/années/auteurs/mots-clés pour les 400000 références via l'API Mendeley $\rightarrow \sim$ 215000 références avec données complètes.

Statistiques

Langues : anglais 206607, francais 4109, espagnol 2029, allemand 892, portugais 891, néerlandais 124, autres 182

Repartitions par années :



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

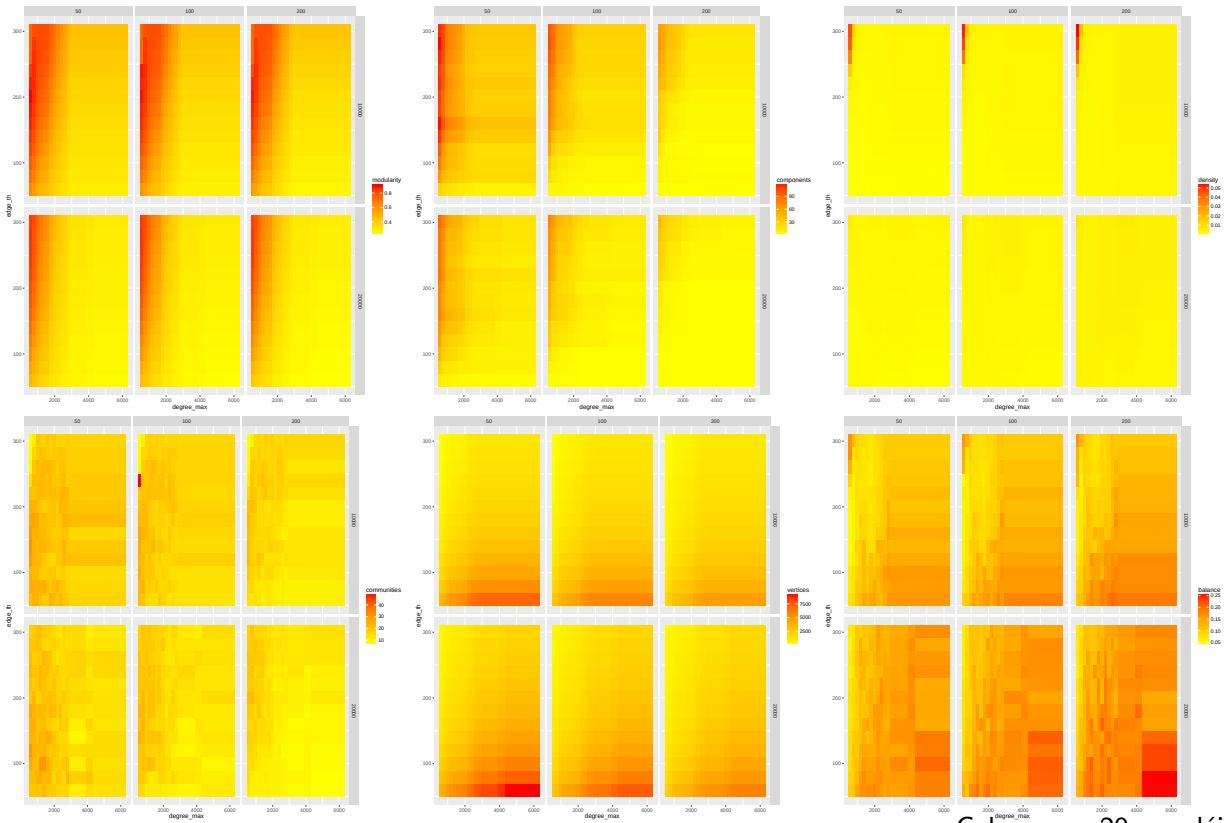
- **Noeuds :** Mots-clés avec la plus grande pertinence cumulée
- **Liens :** Co-occurrences pondérées
- Filtrage des liens en dessous d'un seuil ; ajustement manuel de mots parasites
- Detection de communautés par maximisation de modularité [Blondel et al., 2008] après suppression des *hubs* (ex. `model`, `space`, `structure`, `process`)

Influence des paramètres

Importance d'un règlage fin :

→ Sensibilité des modèles **et** traitements de données aux parametres. Exploration systématique via OpenMole par exemple.

→ Importance du jugement d'expert : pas de dichotomie "quanti-quali"



Domaines extraits

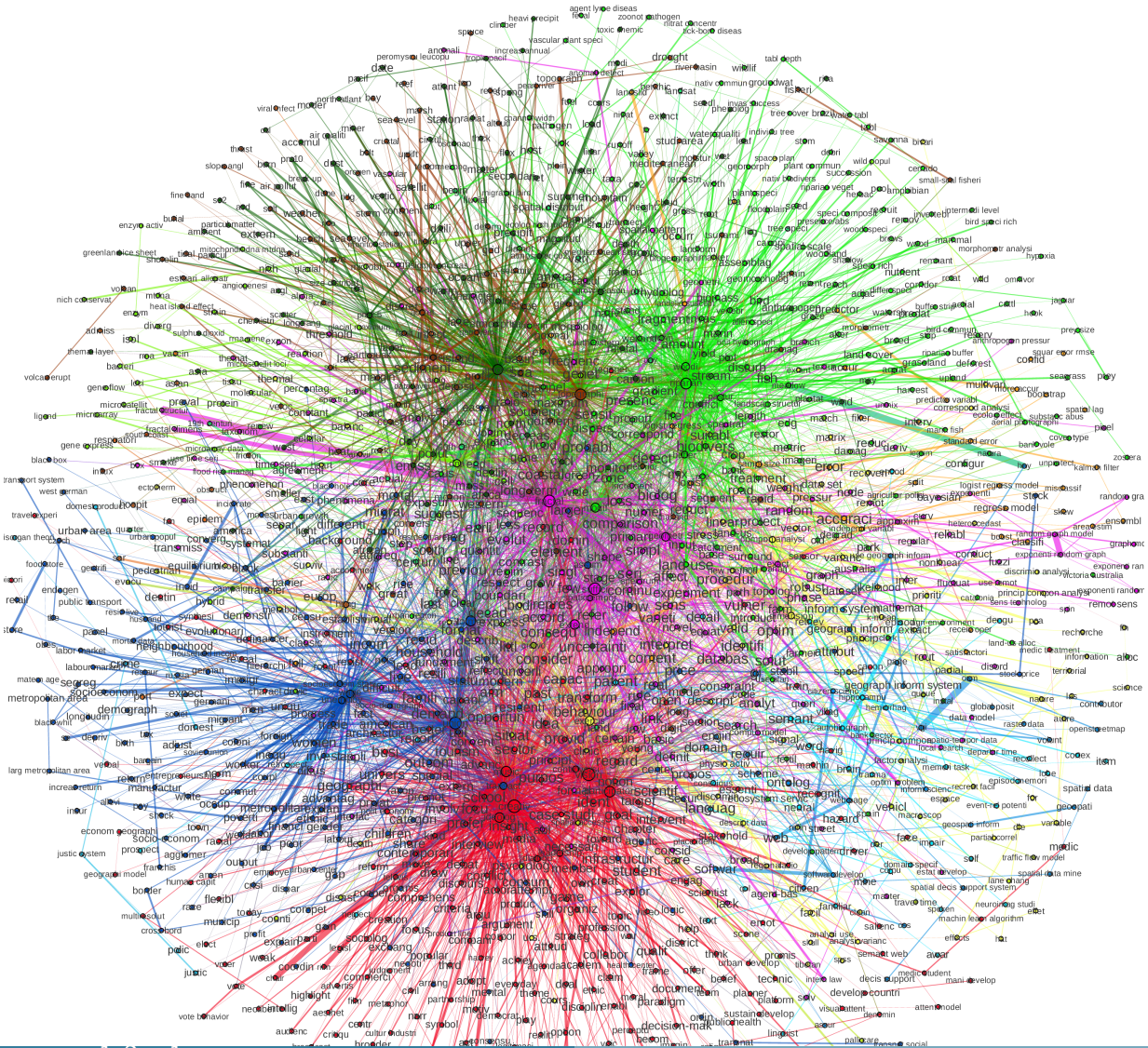
Communautés obtenues pour $\theta_V = 1200, \theta_E = 50$ *:*

- 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`

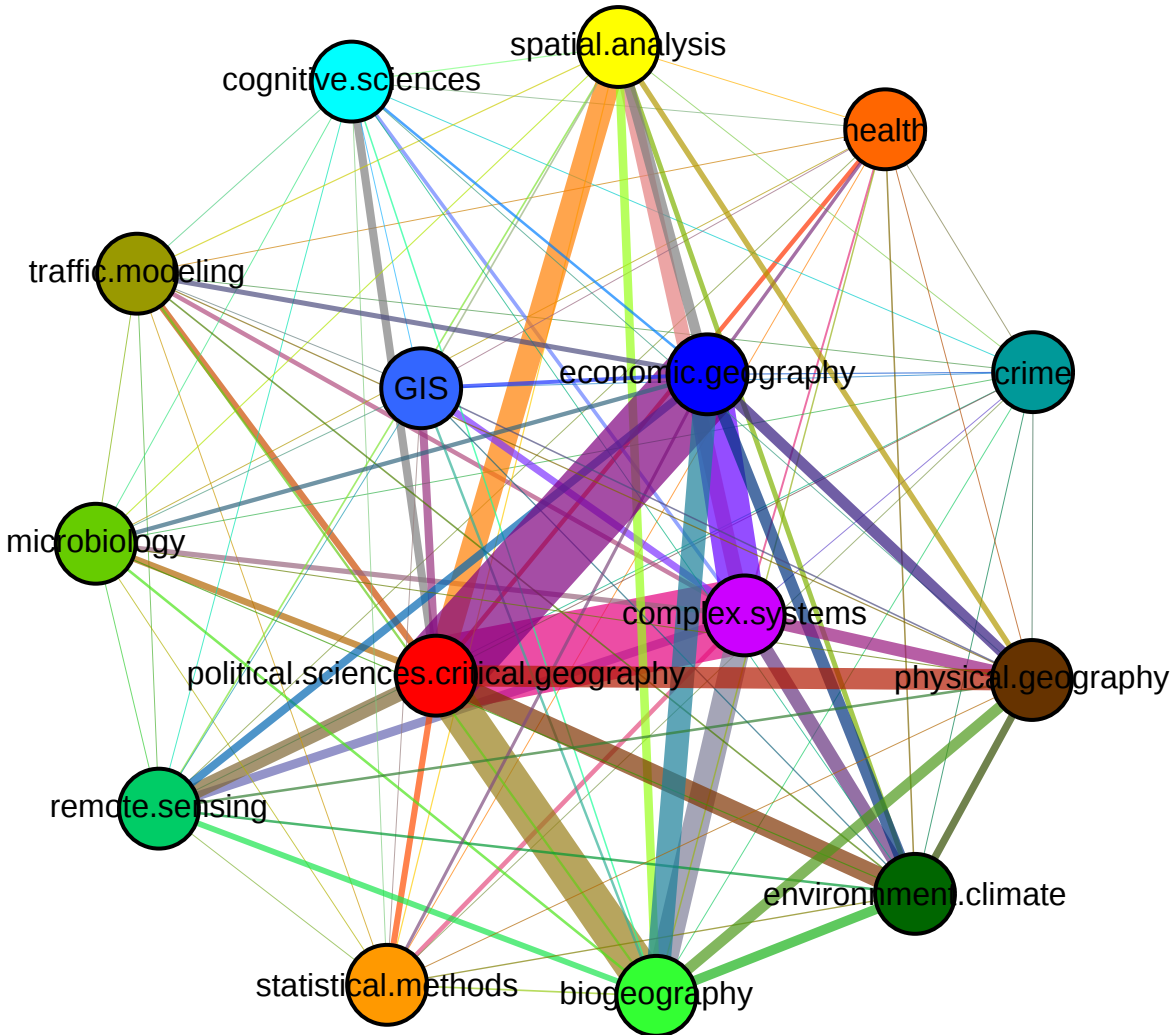
Domaines extraits (suite)

- 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`

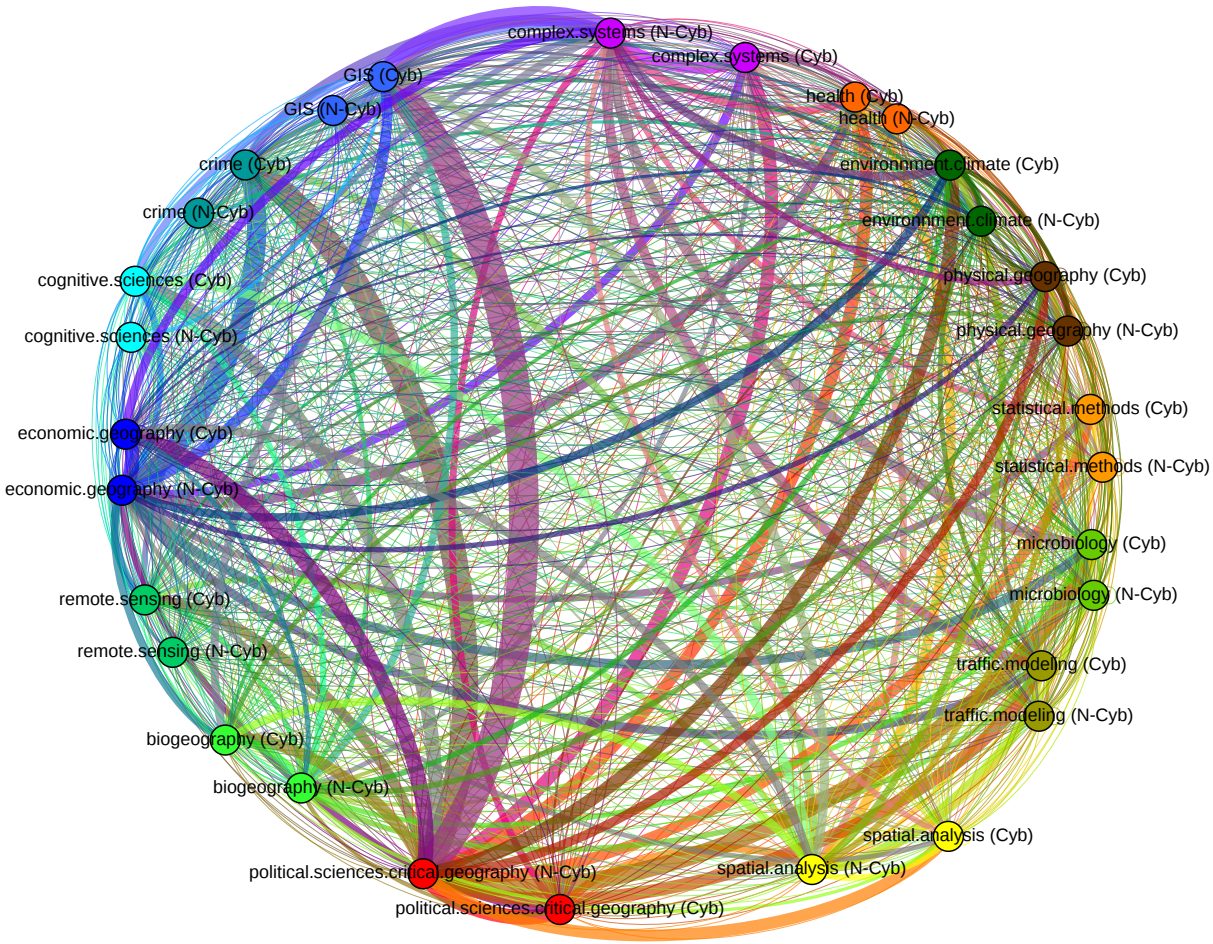
Réseau



Interdisicplinarité



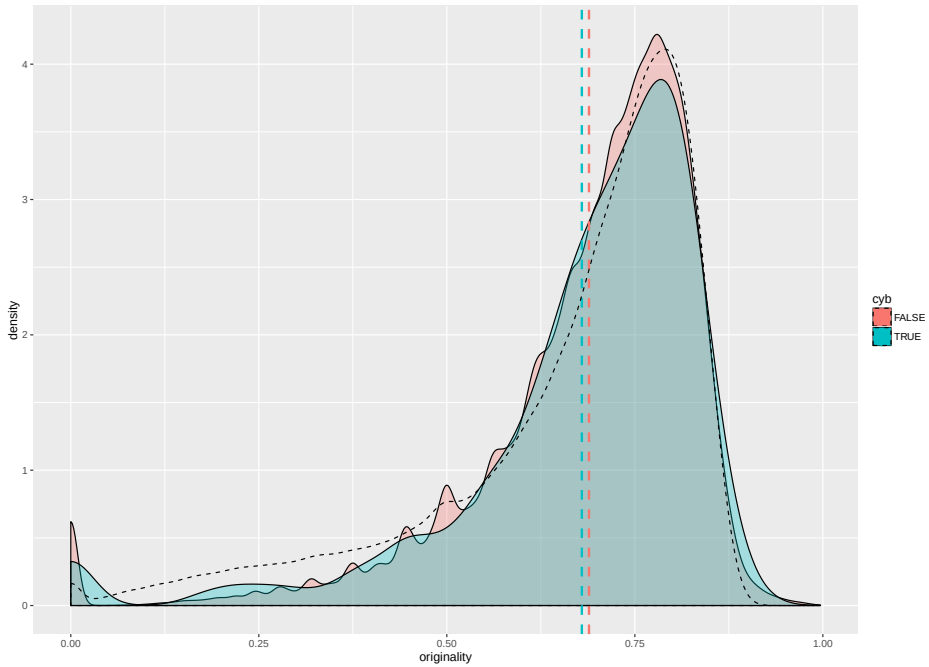
Interdisicplinarité de citation



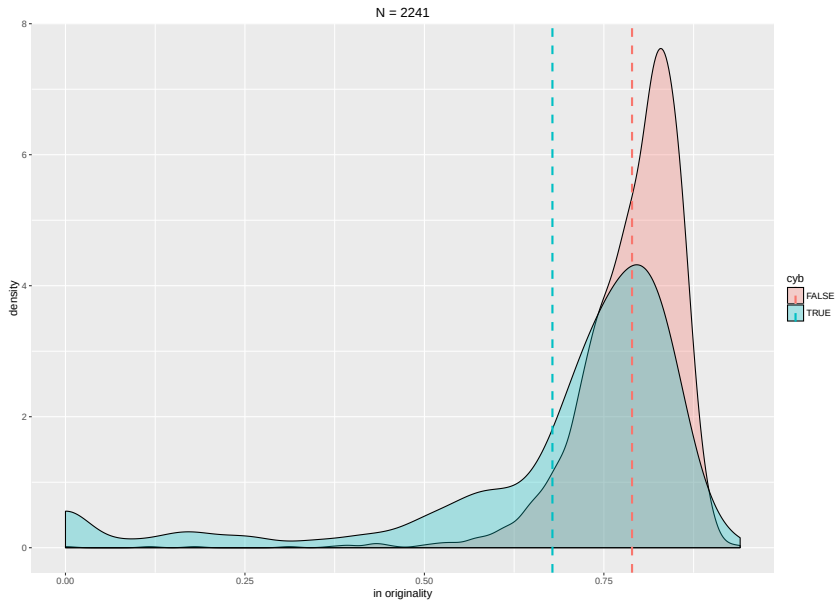
Degré d'interdisciplinarité par articles

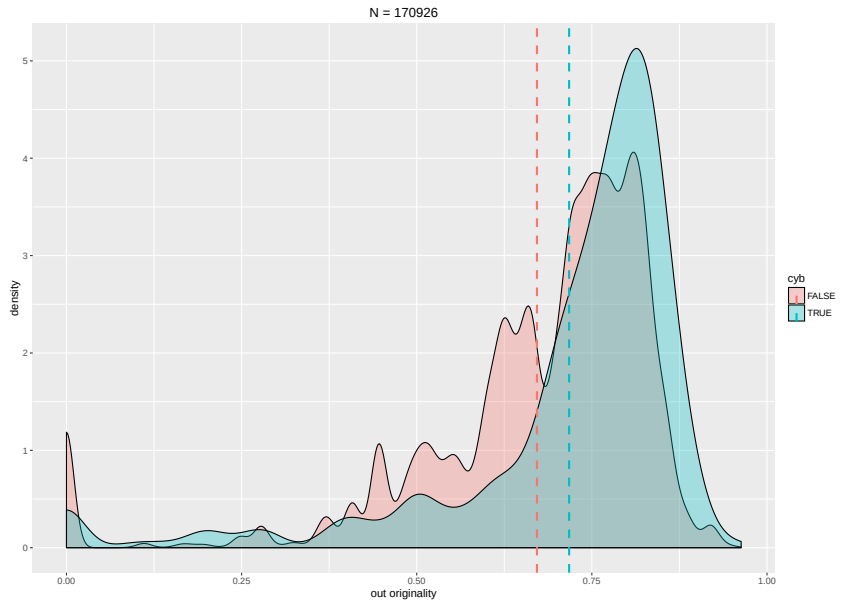
Un article peut être associé aux communautés sémantiques par ses mots clés : probas p_i pour chaque communauté.
Mesure d'interdisciplinarité (pour un article, au premier ordre) :

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



Interdisciplinarité de citation





Conclusion

→ Un environnement disciplinaire très varié et une interdicisplinarité affirmée

→ Approche à croiser avec autres types de classifications (thématique (POC), mots-clés (HC), géographique (CC) pour en apprendre plus sur la revue et la pratique de la géographie qui lui est associée

→ Méthode générique pouvant s'appliquer à tout réseau dont les noeuds ont une description textuelle

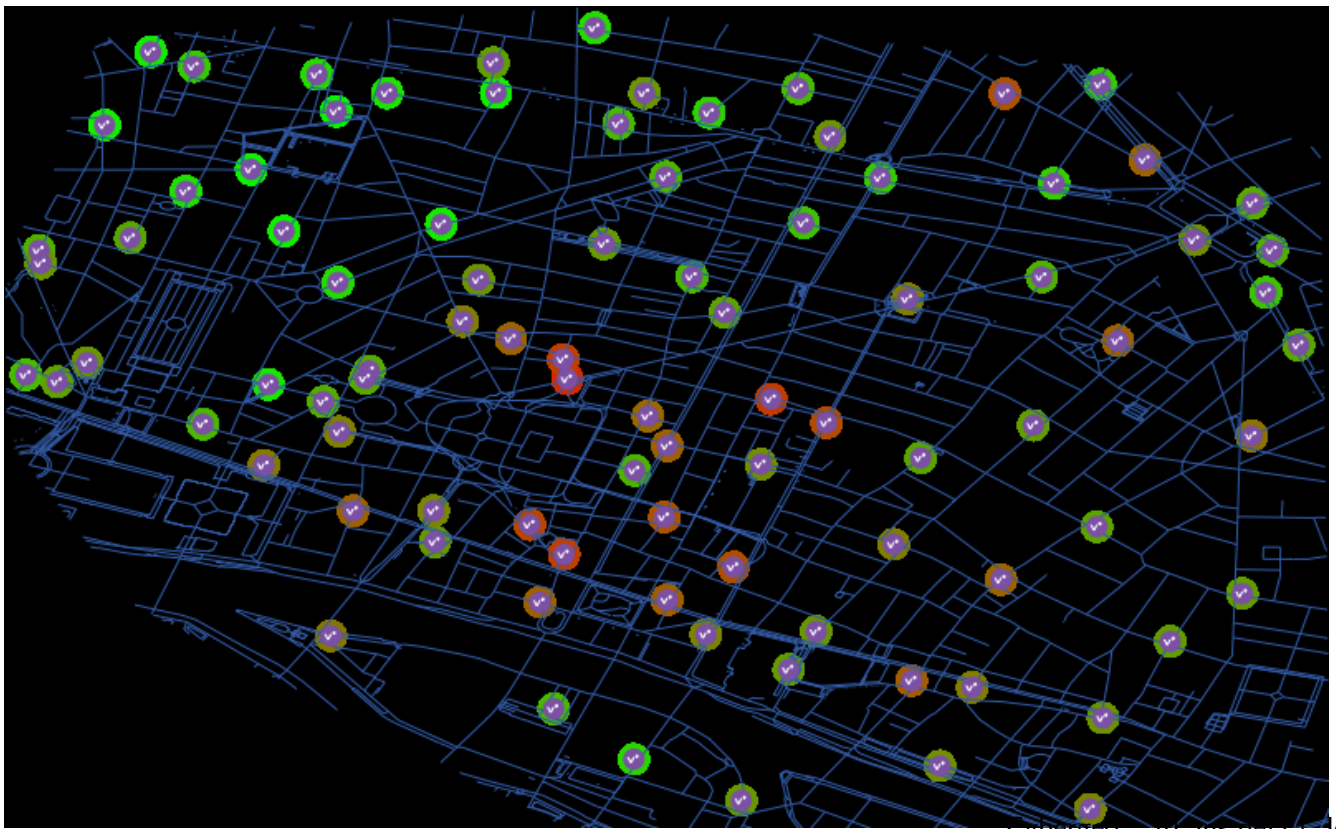
Reserve Slides

Reserve Slides

Collecte des données

Crawling de données semi-ouvertes : exemples en géographie

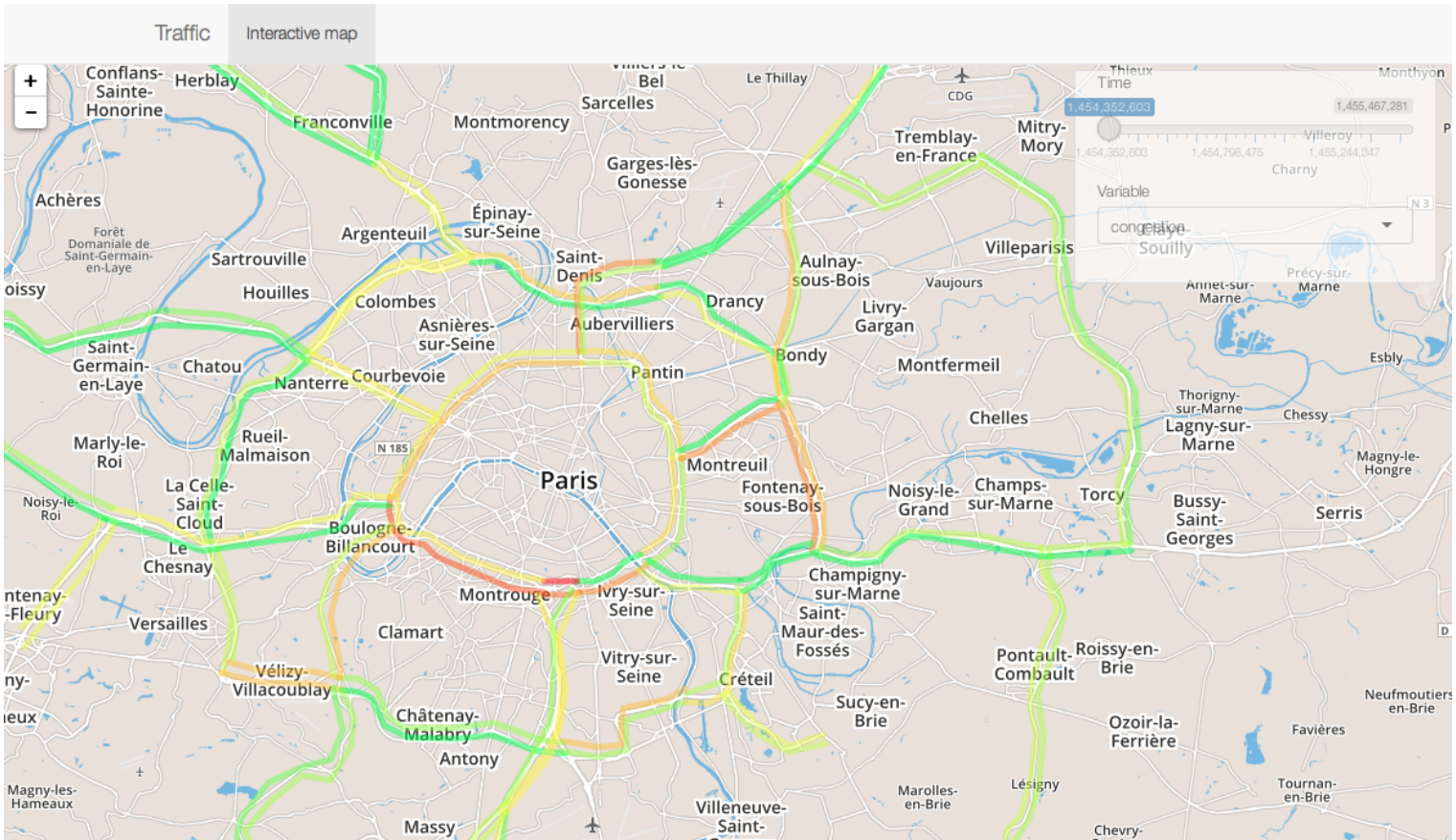
Données de mobilité : statuts des stations Vlib en temps réel (API)
[?]



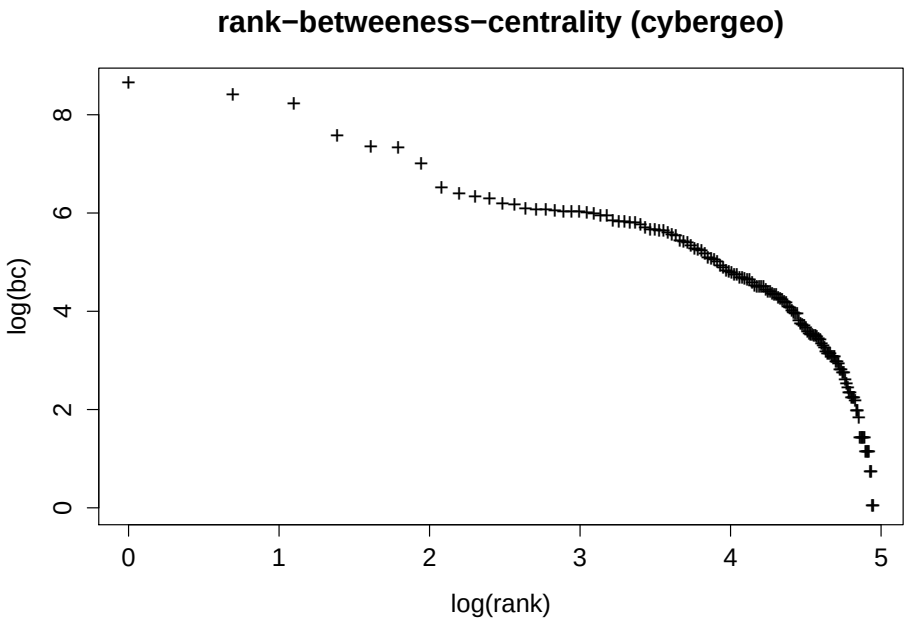
Collecte des données

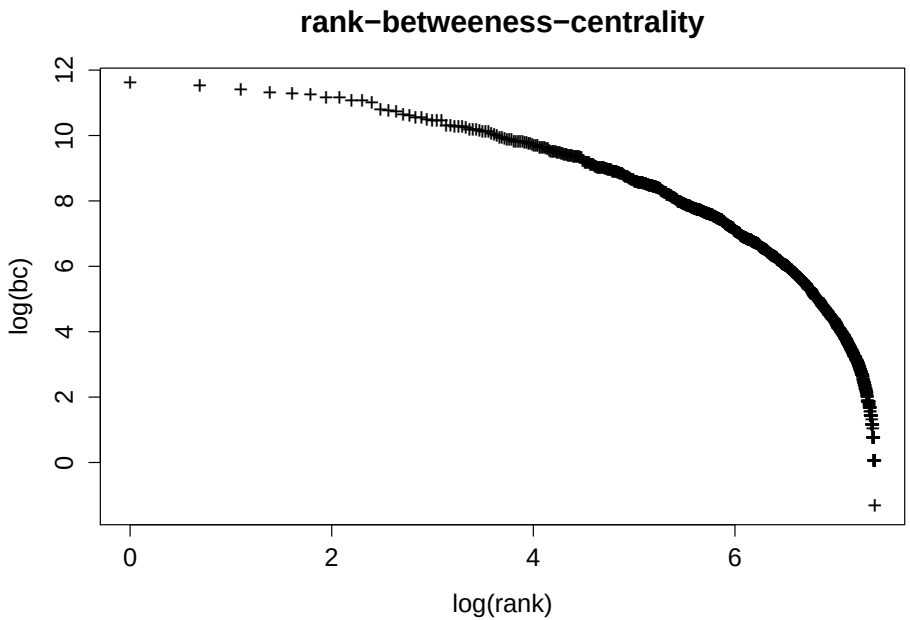
Exemples en géographie (suite)

Traffic routier : collecte de *sytadin* (pas d'API : *scrapping* nécéssaire)



Centralité (citation)

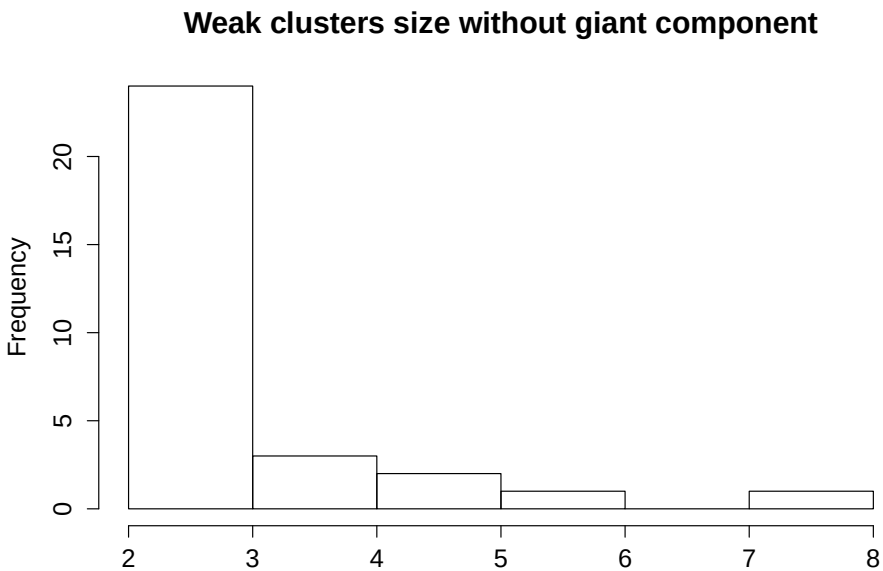


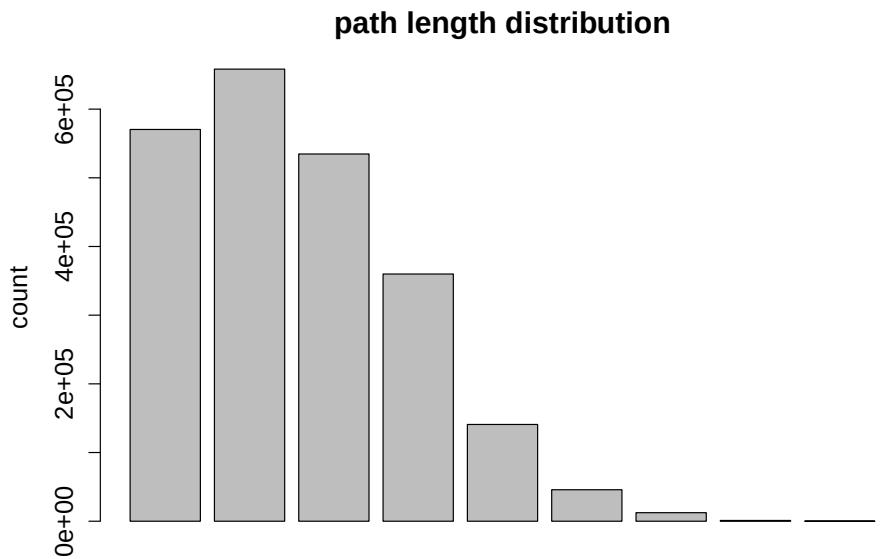


Centralités faibles (rq : impossibilité des clusters forts pour des citations car causalité temporelle). Gauche : Cybergéo ; Droite : Ensemble du réseau

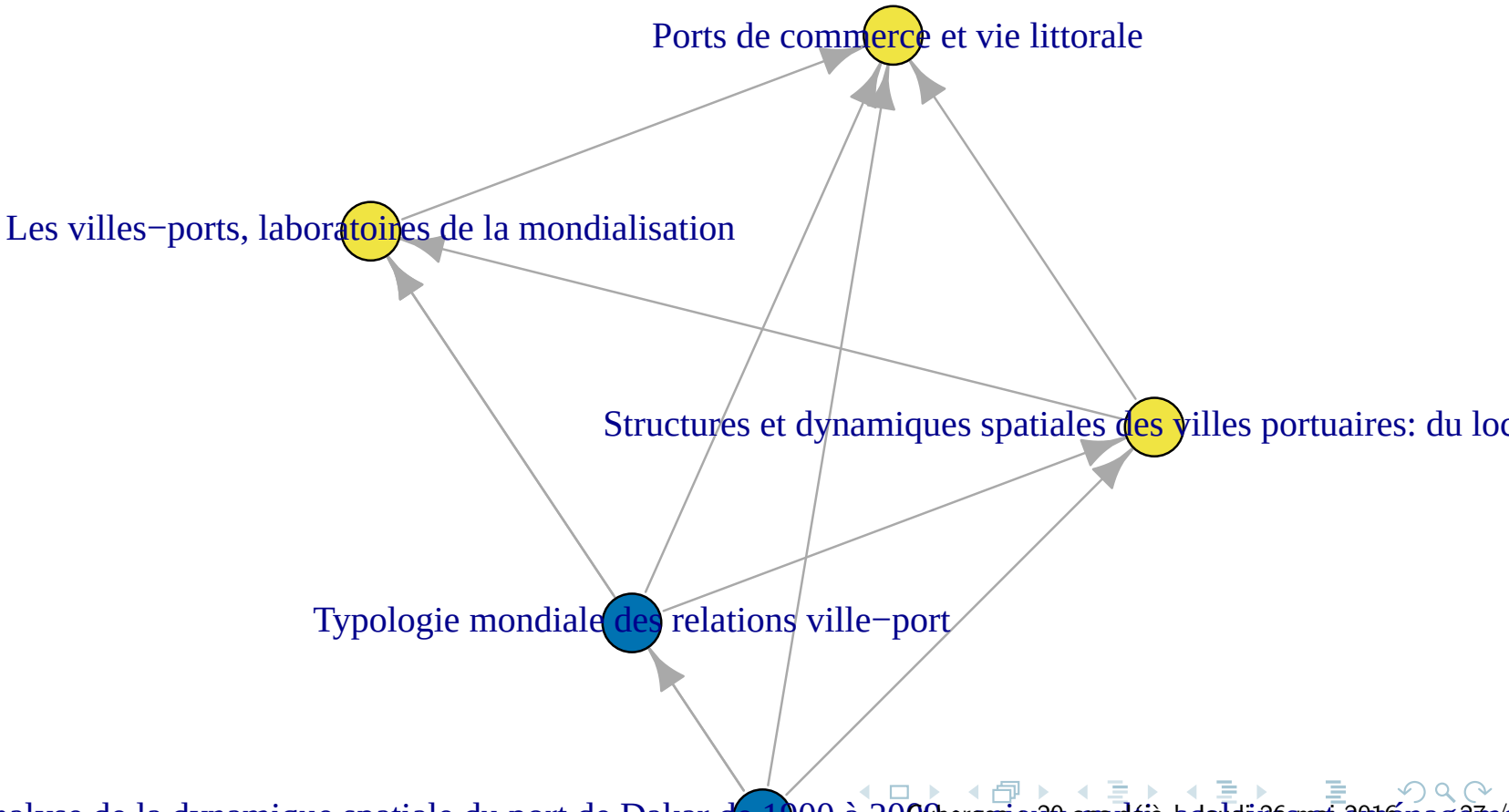
Clustering (citation)

Composante géante : plus de 99% des noeuds.





Cliques(citation)



Estimation de la pertinence

Estimation exacte de la pertinence via la repartition statistique des co-occurrences (score de χ^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 $\sum_i N_i^2 \simeq N < N_i >^2 \simeq 8 \cdot 10^7$

References I

Bird, S. (2006).
NItk: the natural language toolkit.
In Proceedings of the COLING/ACL on Interactive presentation sessions, pages 69–72. Association for Computational Linguistics.

Blondel, V. D., Guillaume, J.-L., Lambiotte, R., and Lefebvre, E. (2008).
Fast unfolding of communities in large networks.
Journal of statistical mechanics: theory and experiment, 2008(10):P10008.

Chavalarias, D. and Cointet, J.-P. (2013).
Phylomemetic patterns in science evolution—the rise and fall of scientific fields.
Plos One, 8(2):e54847.

References II

Cottineau, C., Le Néchet, F., Le Texier, M., and Reuillon, R. (2015).
Revisiting some geography classics with spatial simulation.
In Plurimondi. An International Forum for Research and Debate on Human Settlements, volume 7.

Mendeley (2015).
Mendeley reference manager.
http://www.mendeley.com/.

Noruzi, A. (2005).
Google scholar: The new generation of citation indexes.
Libri, 55(4):170–180.

Schmid, H. (1994).
Probabilistic part-of-speech tagging using decision trees.
In Proceedings of the international conference on new methods in language processing, volume 12, pages 44–49. Citeseer.

References III