

Science-Metrix

**Integration of researchers into new research communities:
The use of social network analysis to tackle integration in
research communities**

XXXVI Sunbelt Conference 2016 | April 9, 2016

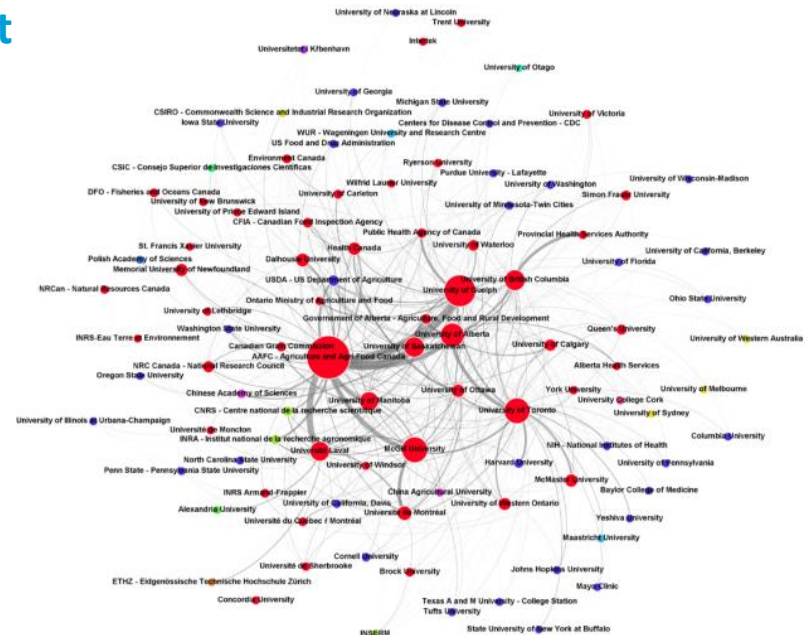




Context of the presentation

- ❑ Science-Metrix is a company dedicated to the preparation of bibliometric studies
- ❑ We always aim to further develop our expertise → diversified paths of evidence
- ❑ Network analyses have been going strong for decades
 - ❑ However, the recent rise of social networks appears to have driven the desire for network metrics (collaboration networks of countries, organizations, researchers)
- ❑ New needs → integrated network indicators added to our set of tools
 - ❑ New quantitative analyses as opposed to qualitative descriptions; **what you see in a network is not necessarily what you get**

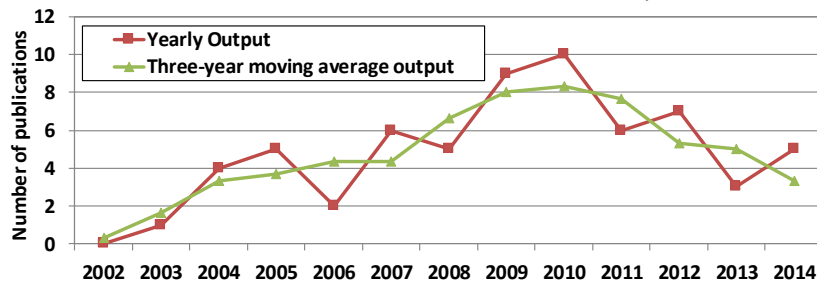
What does this mean?





Methods

- ❑ Questions: How can we mix network analyses with the concept of researcher mobility? How can network indicators be used to analyze the integration of mobile researchers in a research community?
- ❑ Using standard and **easily computed network indicators** → provide answers to some of the following questions:
 - ❑ Integration by collaborating with **established central researchers in network**?
 - ❑ Inception of **own cluster**, detached from the main structure?
 - ❑ **Mix** of both above?
- ❑ Case study for presentation: scientific papers indexed in **Web of Science** for the **Department of Physics, University of Sherbrooke**
 - ❑ Two reasons for selection: (1) small scale, and (2) knowledge of actors (my alma mater, in fact)
- ❑ Resulted in **90 active researchers** between 1999 and 2014
 - ❑ Includes undergraduate and graduate students
- ❑ **Technical challenges** with data preparation (researcher portfolios, noisy yearly data)
 - ❑ Not much time to address these, but I welcome questions or discussions after the presentation!

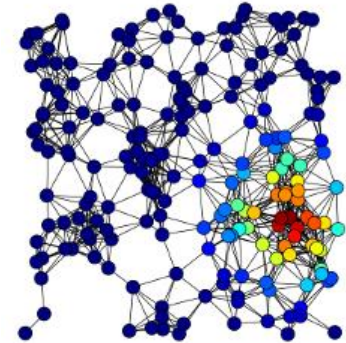
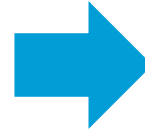


Three authors
Smith J. (Jonathan)
Smith J. (Jason)
Smith J. (Jennifer)
Who is who?

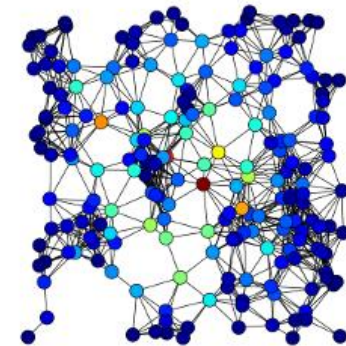


Selected network indicators: Eigencentrality and betweenness centrality

- ❑ **Eigencentrality**: A measure of the **influence** of a node in a network. Assigns relative scores to all nodes based on concept that connections to high-scoring nodes contribute more to the score of the node in question than equal connection to low-scoring nodes (similar measures: PageRank, Katz centrality).



- ❑ **Betweenness centrality (Betweenness)**: Quantifies the number of times a node acts as a bridge along the shortest path between two other nodes.



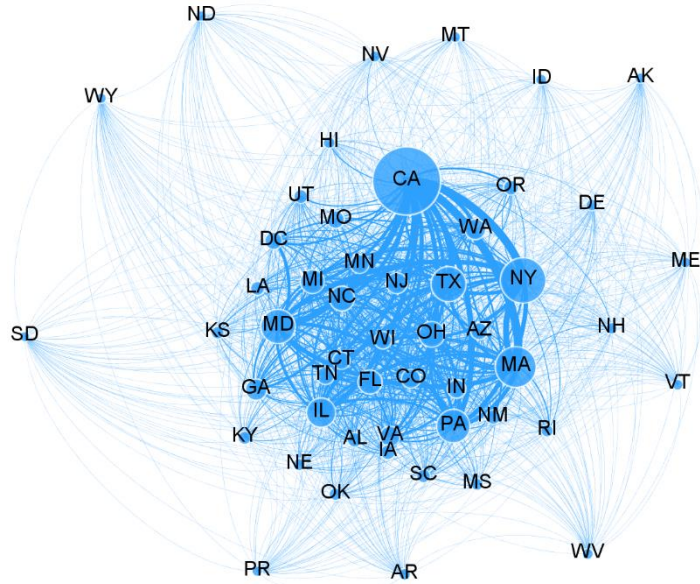
- ❑ Why these two indicators? High relevance in context of researcher network.
 - ❑ Eigencentrality: Indicates **global centrality** and **influence**
 - ❑ Betweenness: Measure of **“strategic” positioning**, less affected by sizes than eigencentrality

Source: Tapiocozzo (Own work), CC BY-SA 4.0,
<https://commons.wikimedia.org/w/index.php?curid=39064835>

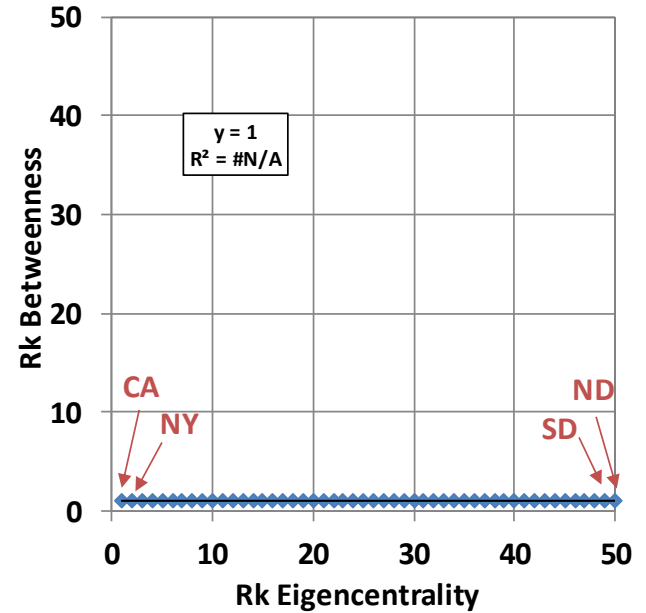


Correlation between eigencentrality and betweenness? Why choose both? Because of network structure!

Collaboration network: US states-level



Source: Prepared by Science-Metrix using Gephi and data from the Web of Science.

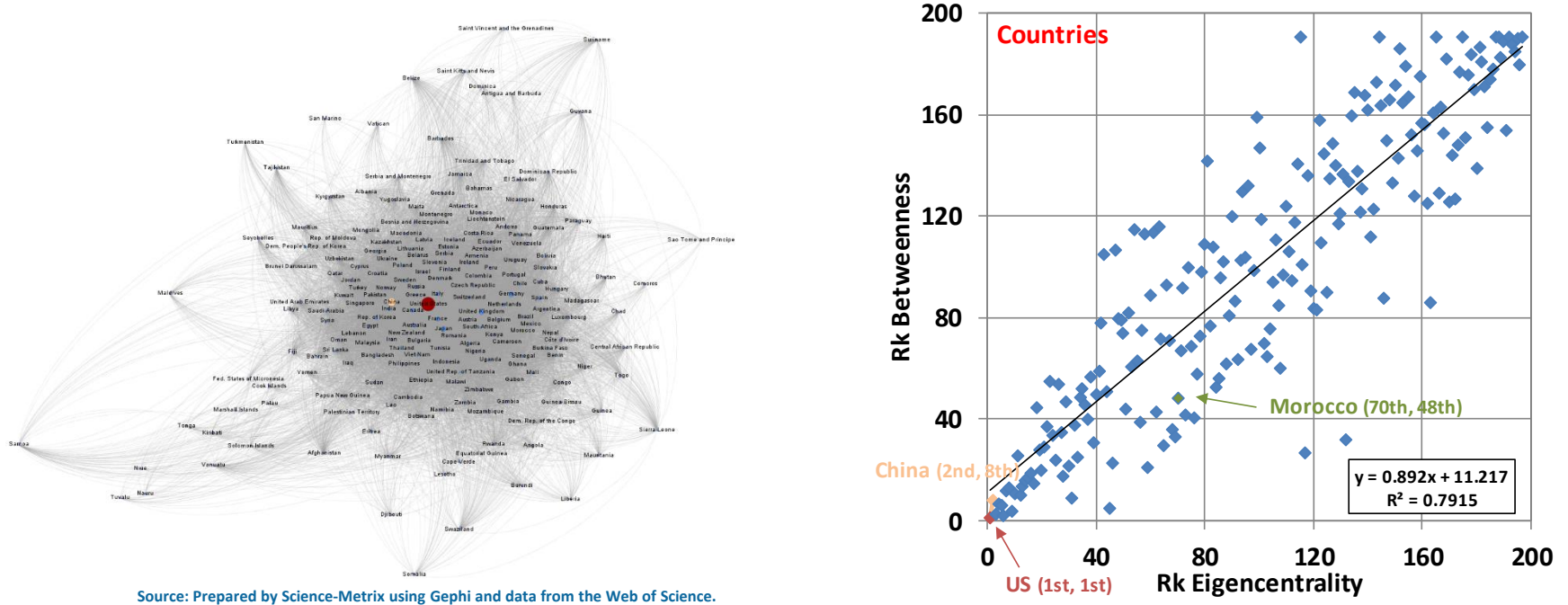


- ❑ More central and influential US states are in the center, linked to one another strongly and performing according to eigencentrality
- ❑ Network is complete (i.e., all nodes directly linked), so all states have **same betweenness**
- ❑ Here, betweenness is not useful, but we can rely on eigencentrality



Correlation between eigencentrality and betweenness? Depends on the network! (cont'd)

Collaboration network: country-level

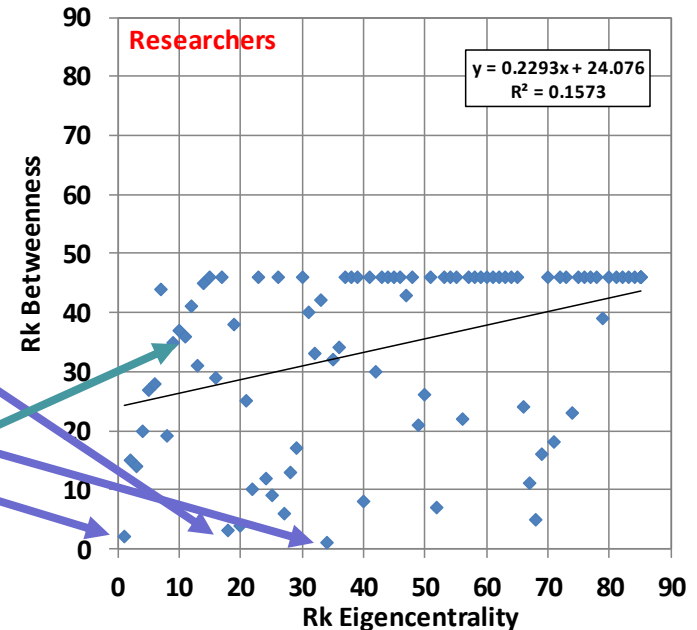
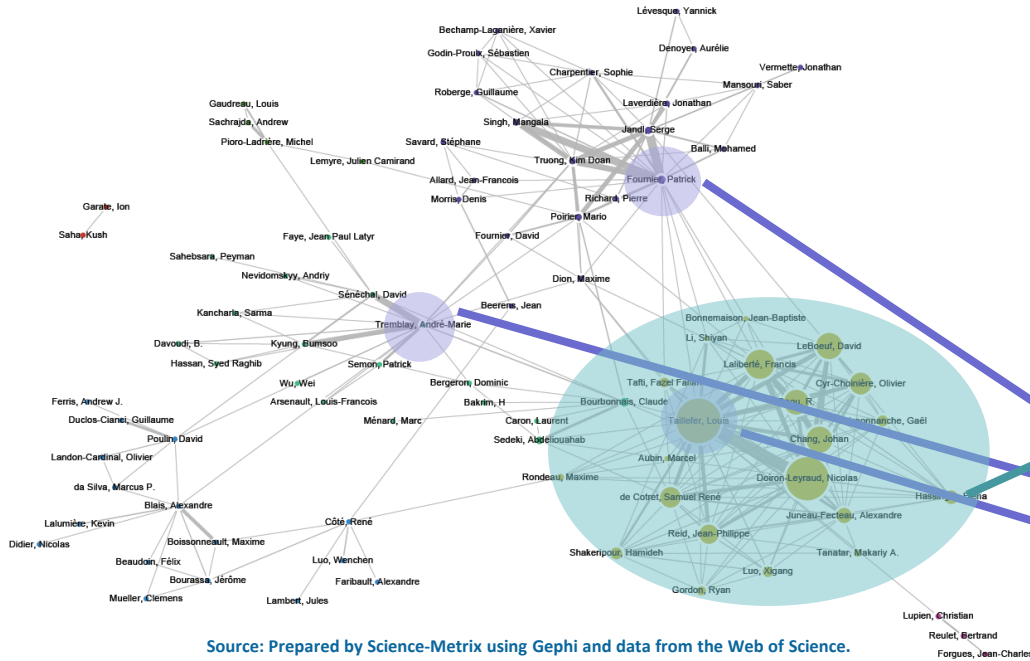


- More central and influential countries are in the center, linked to one another strongly and performing strongly for both indicators
- Network mostly complete (i.e., all nodes directly linked), so strong correlation between both indicators
- However, there are a few cases where there's a difference in rankings:
 - localized centrality (\uparrow eigencentrality, \downarrow betweenness)
 - important strategic position (\downarrow eigencentrality, \uparrow betweenness)



Correlation between eigencentralty and betweenness? Depends on the network! (cont'd)

Collaboration network: researcher-level



Source: Prepared by Science-Matrix using Gephi and data from the Web of Science.

- ❑ More independent structures (**components**) in researcher network (**groups**) → weaker correlation between eigencentralty and betweenness
- ❑ **Eigencentralty**: researchers in **bottom cluster** dominate
- ❑ **Betweenness**: researchers **linking the structures** dominate (**key bridges**)
- ❑ **Eigencentralty is a good measure of centrality and influence**, but **betweenness** provides important information regarding the **strategic position in the network** (particularly when researchers with big labs are involved, look at collaboration beyond the realms of own lab)



Correlation between eigencentrality and betweenness?

Depends on the network!

Summary

- ❑ **Complete network:**
 - ❑ Can only use eigencentrality

- ❑ **Intermediate network:**
 - ❑ Similar findings for both → cases where they differ present interesting cases (e.g., China, Morocco)

- ❑ **Highly clustered networks (such as researcher networks):**
 - ❑ **Betweenness** becomes highly interesting for identifying **key actors in linking substructures**, while **eigencentrality** can be a measure of **global centrality** or **local centrality** (e.g., high eigencentrality for larger labs compared to smaller ones, betweenness alleviates the size advantage)

- ❑ Could have selected other network indicators (closeness for instance)



Cases studies: Three researchers within the department

1. **The Internationally Recognized Researcher** coming from abroad and starting his own cluster separately
2. **The New Recruit** just finishing his post-doc in Maryland and starting his tenure, quickly ties links with main cluster in the department's network
3. **The Soon to Be Retiring Top Researcher** within the department

Pr. Louis Taillefer

(internationally recognized High-Tc superconductivity expert)



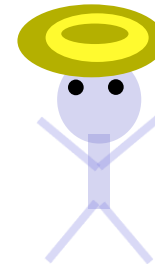
Pr. Patrick Fournier

(starting his Pr. career)



Pr. Mario Poirier

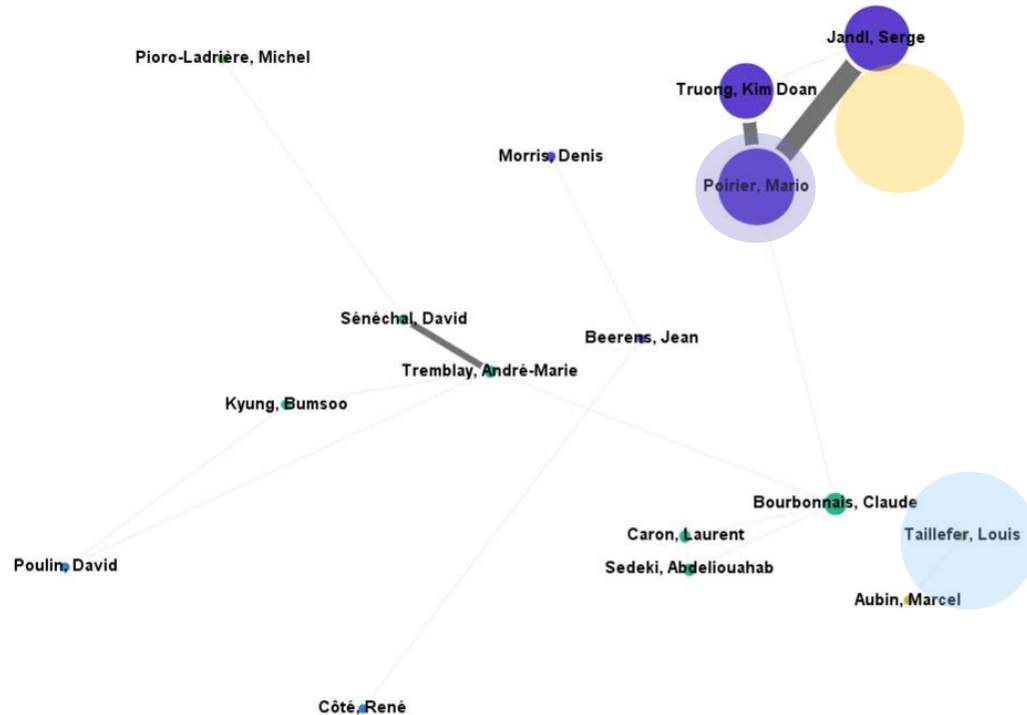
(soon to be retired)





Evolution of collaboration network within the department, 1999–2013

1999



- Core of the network: three professors (Poirier, Jandl, and later Fournier)

- Shift in 2009: Taillefer's cluster became large enough to overtake the core cluster

Because of the nature of eigenvector centrality, most graduate students in this cluster overtook other professors in the network.

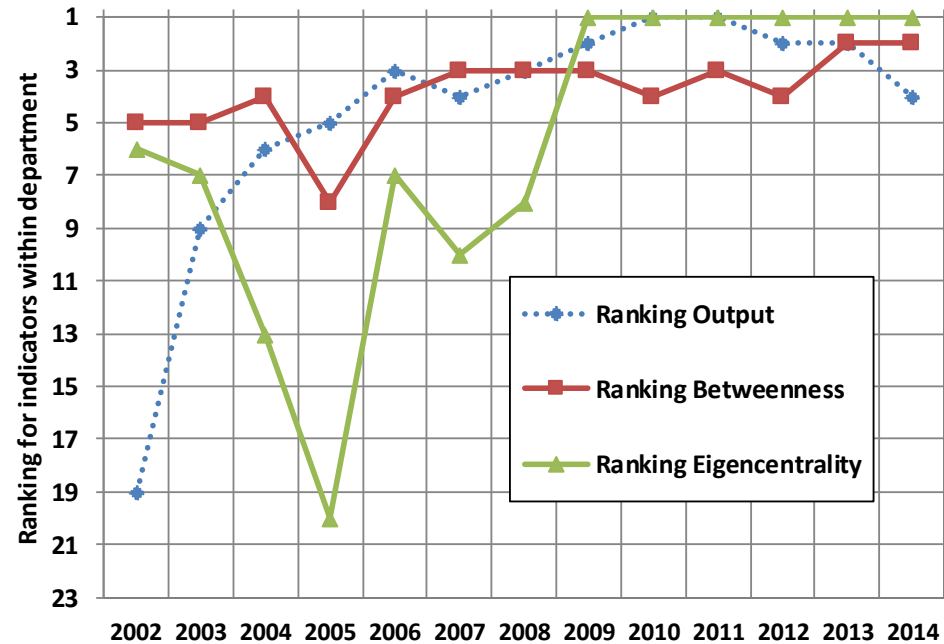
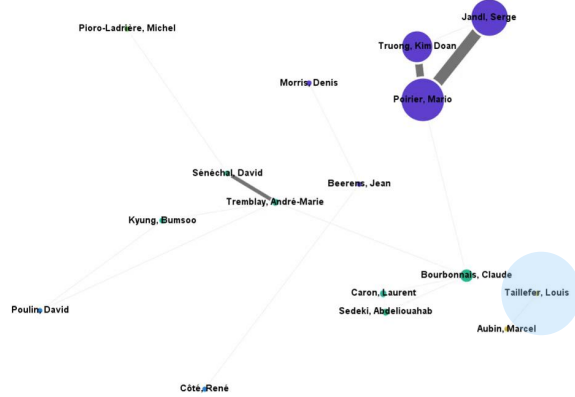
Source: Computed by Science-Metrix using the Web of Science.



First case: Professor Louis Taillefer

(internationally recognized researcher moving to new university)

1999



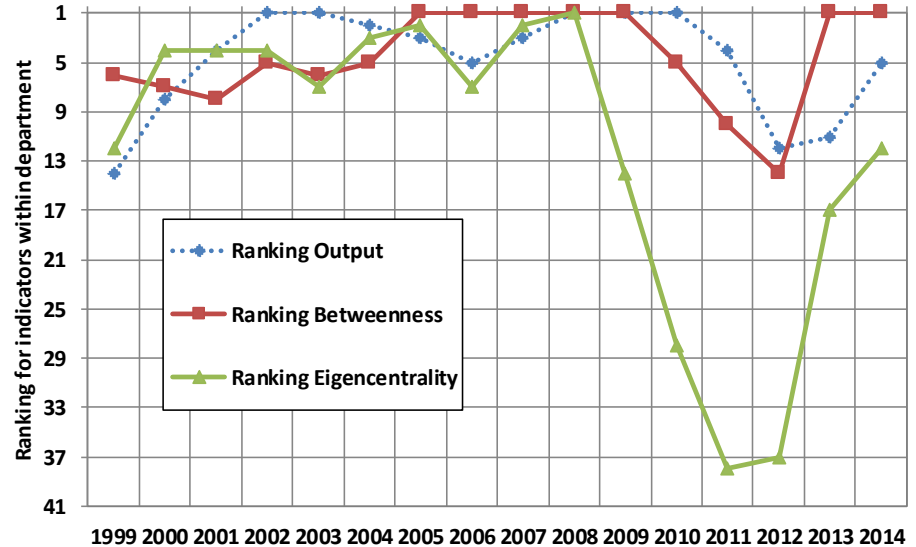
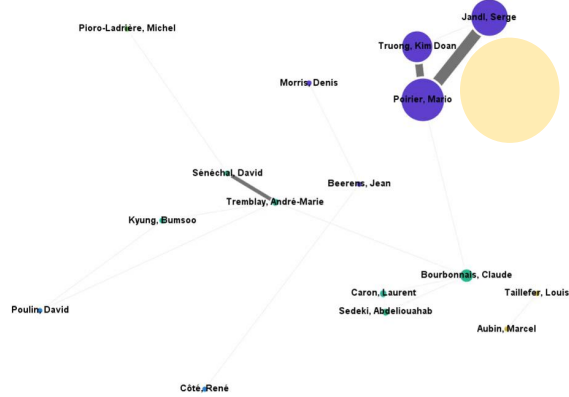
Source: Computed by Science-Metrix using the Web of Science.

- ❑ Went for creation of own lab, without much interaction with other established researchers (because of own distinct topic of research, at least at first)
- ❑ At first, difficult to score high for eigencentrality: his network is small with few connections
- ❑ Scores relatively low for betweenness also (only score above students, mostly below other Pr.)
- ❑ An important shift occurs after few years → lab becomes so large that all lab members overtake most of the other actors in network for eigencentrality (2009)
- ❑ Lab is now core of the network, overtaking main cluster at top. Still not the strongest for betweenness, but developed collaboration outside lab and is now 3rd
- ❑ Even at the end, after 6 years being the most central for eigencentrality, still has yet to take 1st place for betweenness from Patrick Fournier (second case, integration through main cluster)



Second case: Professor Patrick Fournier (a different integration process)

1999



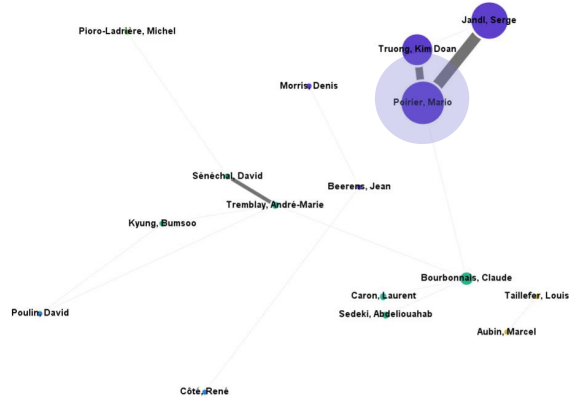
- ❑ In this second case, Professor Fournier becomes one of the most central actors in the network, both for eigencentrality and betweenness, by connecting with the core cluster (i.e., other professors in the network). He became most central according to betweenness more rapidly than for eigencentrality (opposite of Pr. Taillefer, “quality” before “quantity,” or “strategic positioning”).
- ❑ However, as Pr. Fournier reached 1st place for eigencentrality in 2008, Pr. Taillefer’s cluster became dominant in 2009, overtaking Pr. Fournier and resulting in a sharp decrease. Betweenness also decreased, but not as much, as this indicator exhibits stronger inertia (i.e., position remains “strategic”).

Source: Computed by Science-Metrix using the Web of Science.



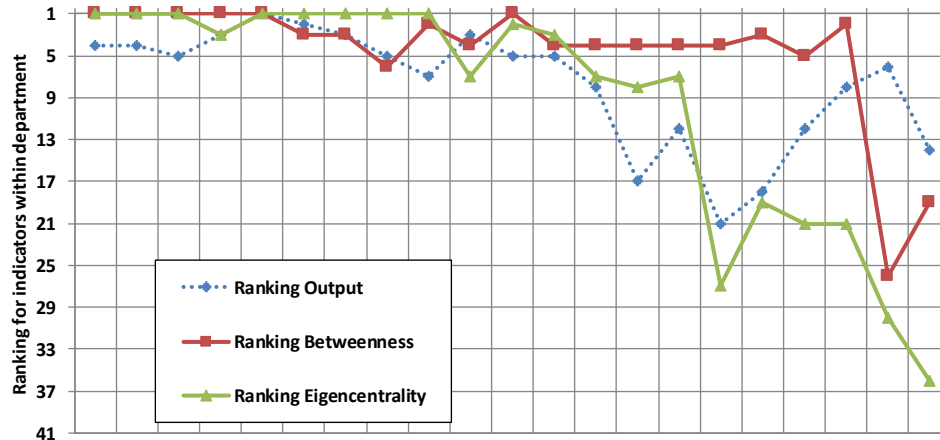
Third case: Professor Mario Poirier (retiring professor)

1999



Indicators can also identify researchers leaving communities (retiring).

- ❑ **Betweenness: strong inertia** compared to eigencentrality.
- ❑ Why? For as long as a researcher continues to act as a bridge between communities in the network (“strategic position”), they keep performing strongly for this indicator.
- ❑ Not reliant on level of output or level of collaboration (went from 2nd to 21st for eigencentrality from 2002 to 2012, but remained 2nd for betweenness).
- ❑ Researchers may lose in centrality, but if they maintain a structural role, they remain relevant according to betweenness.



1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

Source: Computed by Science-Metrix using the Web of Science.



Conclusion

- ❑ Traditionally, our network analyses have been mostly descriptive, with only a few metrics (number of papers, number of collaborations) to help describe the structures.
- ❑ With a few network indicators, analyses become much more robust.
- ❑ Particularly helpful for program evaluation where networking and collaboration are central measures of success.
- ❑ Increase in eigenvector centrality: Sign of more importance in the network. **However, if not coupled with integration according to betweenness centrality, can be a sign of localized integration and localized centrality (i.e., a researcher with large number of students).**
- ❑ **Betweenness centrality is usually more stable over time as it is less affected by scale effect, relying more on positions in the network (“strategic positioning”).**
- ❑ Academic networks—betweenness centrality may be more useful to identify centrality than eigencentality (at least to determine collaboration with other professors in the network).
- ❑ It’s easy to prepare indicators, but much more difficult to analyze what they mean!

Source: Computed by Science-Metrix using the Web of Science.



Future works

- ❑ Evolution of network indicators for the whole structure (network density, average degree, etc.) to assess global impacts on the networks
- ❑ Define new indicators based on current metrics to automatically distinguish professors and students
- ❑ **Could have selected other network indicators (closeness for instance), could be added later**
- ❑ **Include additional indicators to provide more paths of analysis**



Thanks for your attention!

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