Insightful Visualizations of National Researcher Networking Data

Katy Börner
Cyberinfrastructure for Network Science Center, Director
Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
katy@indiana.edu

With special thanks to the members at the Cyberinfrastructure for Network Science Center, the Sci2 team, and the VIVO Collaboration

VIVO Conference, Washington, D.C.

August 26, 2011

Different Stakeholder Groups and Their Needs

Funding Agencies

- Need to monitor (long-term) money flow and research developments, identify areas for future development, stimulate new research areas, evaluate funding strategies for different programs, decide on project durations, funding patterns.

Scholars

- Want easy access to research results, relevant funding programs and their success rates, potential collaborators, competitors, related projects/publications **(research push).**

Industry

- Is interested in fast and easy access to major results, experts, etc. Influences the direction of research by entering information on needed technologies **(industry-pull)**.

Advantages for Publishers

- Need easy to use interfaces to massive amounts of interlinked data. Need to communicate data provenance, quality, and context.

Society

- Needs easy access to scientific knowledge and expertise.

Scholars Have Different Roles/Needs

Researchers and Authors—need to select promising research topics, students, collaborators, and publication venues to increase their reputation. They benefit from a global view of competencies, reputation and connectivity of scholars; hot and cold research topics and bursts of activity, and funding available per research area.

Editors—have to determine editorial board members, assign papers to reviewers, and ultimately accept or reject papers. Editors need to know the position of their journals in the evolving world of science. They need to advertise their journals appropriately and attract high-quality submissions, which will in turn increase the journal's reputation and lead to higher quality submissions.

Reviewers—read, critique, and suggest changes to help improve the quality of papers and funding proposals. They need to identify related works that should be cited or complementary skills that authors might consider when selecting project collaborators.

Teachers—teach classes, train doctoral students, and supervise postdoctoral researchers. They need to identify key works, experts, and examples relevant to a topic area and teach them in the context of global science.

Inventors—create intellectual property and obtain patents, thus needing to navigate and make sense of research spaces as well as intellectual property spaces.

Investigators—scholars acquire funding to support students, hire staff, purchase equipment, or attend conferences. Here, research interests and proposals have to be matched with existing federal and commercial funding opportunities, possible industry collaborators and sponsors.

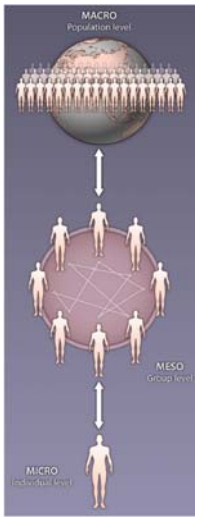
Team Leads and Science Administrators—many scholars direct multiple research projects simultaneously. Some have full-time staff, research scientists, and technicians in their laboratories and centers. Leaders need to evaluate performance and provide references for current or previous members; report the progress of different projects to funding agencies.

Why Use National Researcher Networking Data?

- **Structured data** – Easy to process by computers.
- **Comprehensive** – Not only publication but also funding, teaching, patenting activity is captured.
- **High quality** – faculty record, funding, course data has "touched" money.
- **Linked** to other data silos via Linked Open Data.
- **(Inter)National** – Science is a global enterprise and needs to be studied/understood globally.
- **Open** – Anybody can access detailed data, re-run analysis.

Many NRN instances hold and expose **Thomson Reuters, Elsevier, MEDLINE, NSF, NIH** and other data.

Science of (team) science research and practice requires an interdisciplinary, multi-level, mixed-methods approach.



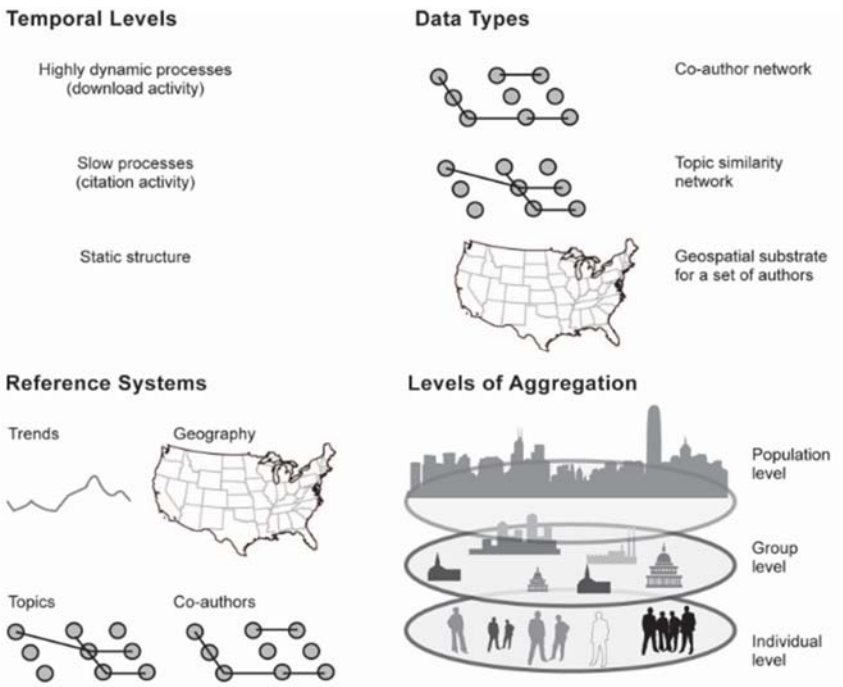
TEAM SCIENCE

A Multi-Level Systems Perspective for the Science of Team Science

Katy Börner,[1*] Noshir Contractor,[2] Holly J. Falk-Krzesinski,[3] Stephen M. Fiore,[4] Kara L. Hall,[5] Joann Keyton,[6] Bonnie Spring,[7] Daniel Stokols,[8] William Trochim,[9] Brian Uzzi[10]

Published 15 September 2010; Volume 2 Issue 49 49cm24

This Commentary describes recent research progress and professional developments in the study of scientific teamwork, an area of inquiry termed the "science of team science" (SciTS, pronounced "sahyts"). It proposes a systems perspective that incorporates a mixed-methods approach to SciTS that is commensurate with the conceptual, methodological, and translational complexities addressed within the SciTS field. The theoretically grounded and practically useful framework is intended to integrate existing and future lines of SciTS research to facilitate the field's evolution as it addresses key challenges spanning macro, meso, and micro levels of analysis.

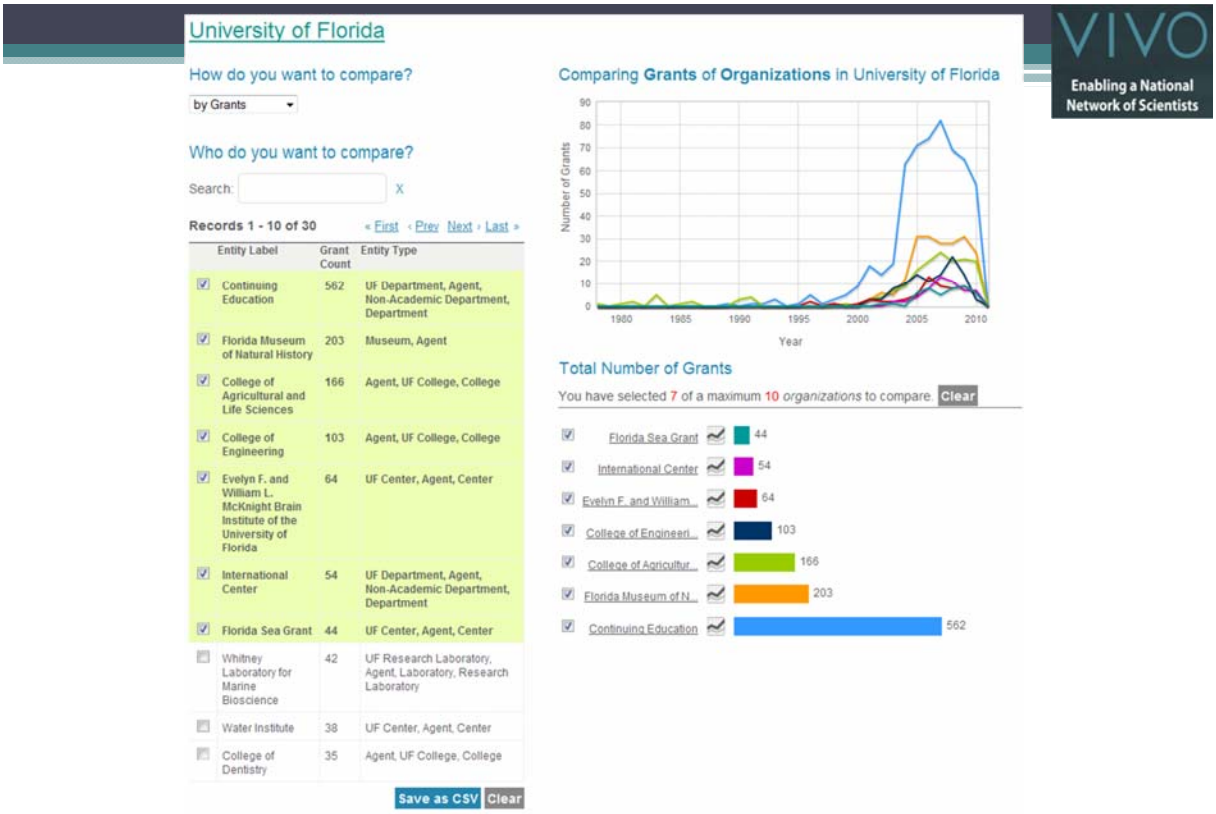


Katy Börner, Kevin W. Boyack, Staša Milojević, Steven Morris. (2011) An introduction to modeling science: Basic model types, key definitions, and a general framework for the comparison of process models. In *Scharnhorst, Börner, van den Besselaar (Eds) Models of Science Dynamics. Springer Verlag.*

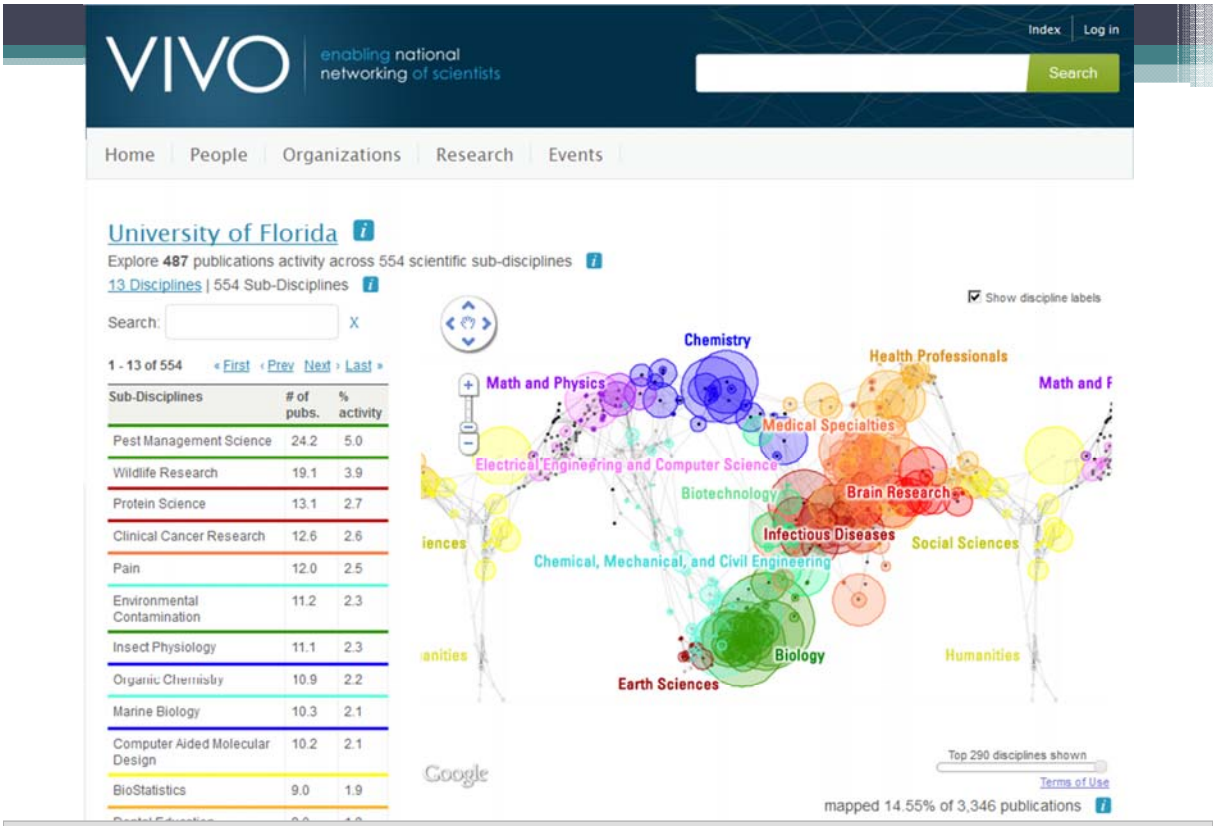
Standard VIVO Visualizations

Type of Analysis vs. Level of Analysis

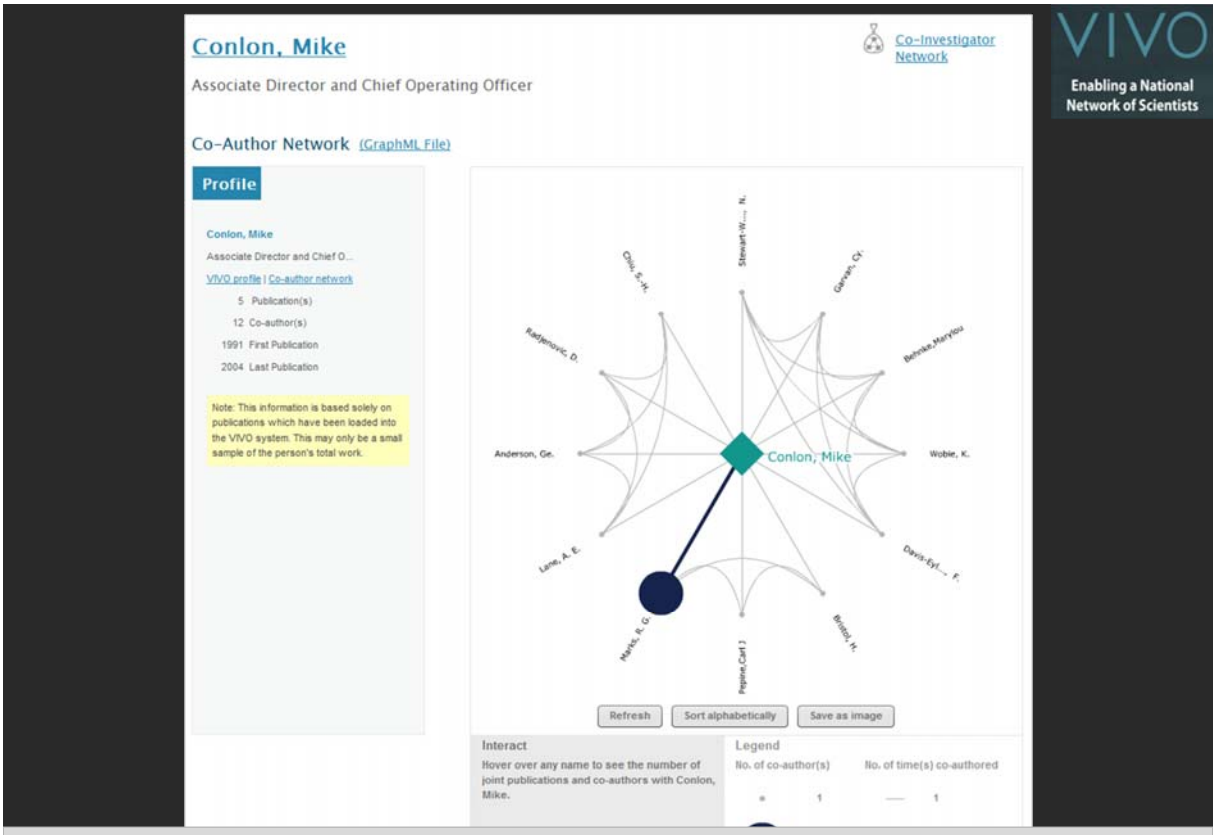
	Micro/Individual (1-100 records)	*Meso/Local (101–10,000 records)*	*Macro/Global (10,000 < records)*
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NS SA, all of sci
Temporal Analysis (When)	Funding portfolio of one individual	ic bursts f PNAS	113 Years of P Research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a st intellectual la	PNAS
Topical Analysis (What)	s.	research	VxOrd/Topic m NIH funding
Network Analysis (With Whom?)	NSF work of one	k	NIH's cy



Temporal Analysis (When) Temporal visualizations of the number of papers/funding award at the institution, school, department, and people level



Topical Analysis (What) Science map overlays will show where a person, department, or university publishes most in the world of science. (in work)



Network Analysis (With Whom?) Who is co-authoring, co-investigating, co-inventing with whom? What teams are most productive in what projects?

http://nrn.cns.iu.edu

Geospatial Analysis (Where) Where is what science performed by whom? Science is global and needs to be studied globally.

VIVO NRN on the Go

Overview, Interactivity, Details on Demand come to commonly used devices and environments

Develop VIVO Visualizations

See also Visualization in VIVO Workshop on Aug 24, 2011
http://wiki.cns.iu.edu/display/PRES/VIVO+Presentation

VIVO Presentation

4 Added by Chin Hua Kong, last edited by Chintan Tank on Aug 24, 2011 (view change)

August, 2011 Workshop

Material

- Java 1.5 or higher - A programming language and computing platform for developing cross OS softwares.
- Science of Science tool (Sci2) - An desktop application for information analysis and visualization.
- Gephi - An interactive visualization tool for networks and complex systems, dynamic and hierarchical graphs.
- VIVO August 2011 workshop data.zip - Hands on workshop data package

Slides

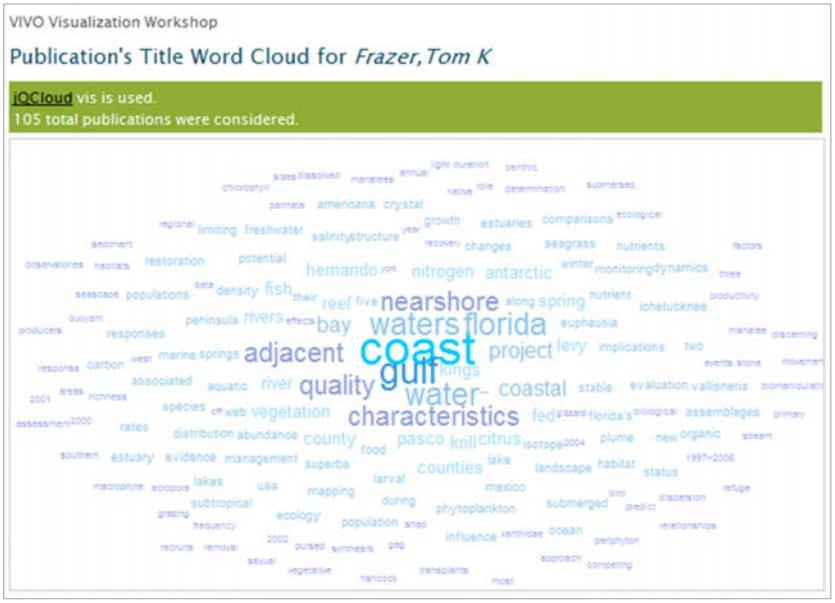
- Tutorial Slides presented at the VIVO Conference 2011
- Pre-Questionnaire and Post-Questionnaire

Demo Links

- Map of Science Visualization (dev link)
- Temporal Graph Visualization (dev link)
- National Researcher Networking Visualization
- Word Cloud Visualization dev link

Develop VIVO Visualizations

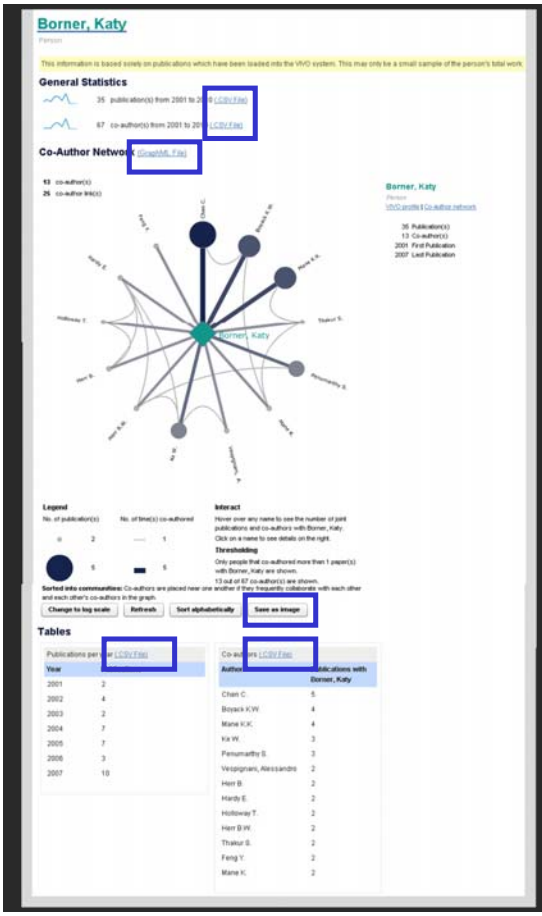
http://vivo-vis.slis.indiana.edu/vivo1/vis/word-cloud/n868



INDIANA UNIVERSITY

VIVO
Enabling a National Network of Scientists

Custom VIVO Visualizations



Download Data

General Statistics

- 36 publication(s) from 2001 to 2010 (.CSV File)
- 80 co-author(s) from 2001 to 2010 (.CSV File)

Co-Author Network

(GraphML File)

Save as Image (.PNG file)

Tables

- Publications per year (.CSV File)
- Co-authors (.CSV File)

http://vivo.iu.edu/vis/author-network/person25557

36 publication(s) from 2001 to 2010 (.CSV File)

Year	Publications
2001	2
2002	4
2003	2
2004	7
2005	7
2006	3
2007	10
2010	1

80 co-author(s) from 2001 to 2010 (.CSV File)

Year	Count	Co-Author(s)
2001	1	Chen C.
2002	3	Chen C.; McMahon T.; Feng Y.
2003	2	Chen C.; Boyack K.W.
2004	17	Sengupta A.; Penumarthy S.; Thakur S.; Sooriamurthi R.; Maru J.T.; Shiffrin R.M.; Mane K.; Moor K.A.;

Co-author network (GraphML File)

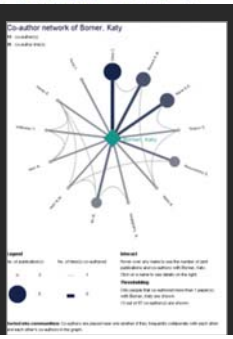
```
<?xml version="1.0" encoding="UTF-8"?>
<graphml xmlns="http://graphml.graphdrawing.org/xmlns"
 xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
 xsi:schemaLocation="http://graphml.graphdrawing.org/xmlns
 http://graphml.graphdrawing.org/xmlns/1.0/graphml.xsd">
<key id="label" for="node" attr.name="label" attr.type="string" />
<key id="number_of_authored_works" for="node" attr.name="number_of_authored_works" attr.type="int" />
<key id="num_unknown_publication" for="node" attr.name="num_unknown_publication" attr.type="int" />
<key id="num_latest_publication" for="node" attr.name="num_latest_publication" attr.type="int" />
<key id="latest_publication" for="node" attr.name="latest_publication" attr.type="int" />
<key id="profile_url" for="node" attr.name="profile_url" attr.type="string" />
```

Save as Image (.PNG file)

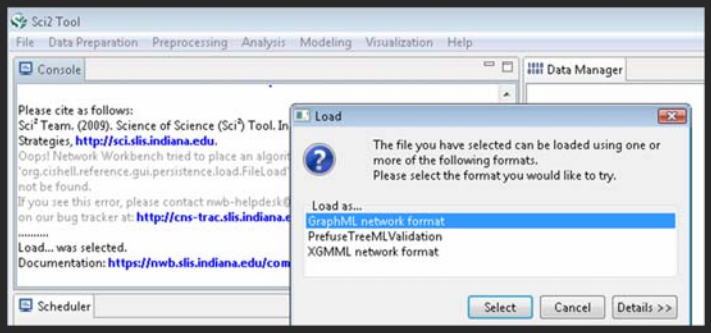
Publications per year (.CSV File), see top file.

Co-authors (.CSV File)

Co-Author	Count
Andrienko G.	1
Andrienko N.	1
Ben-Miled Z.	1
Blackwell A.	1
Boyack K.W.	4
Bozicevic M.	1
Brodbeck D.	1
Burkhard R.A.	1
Chen C.	5

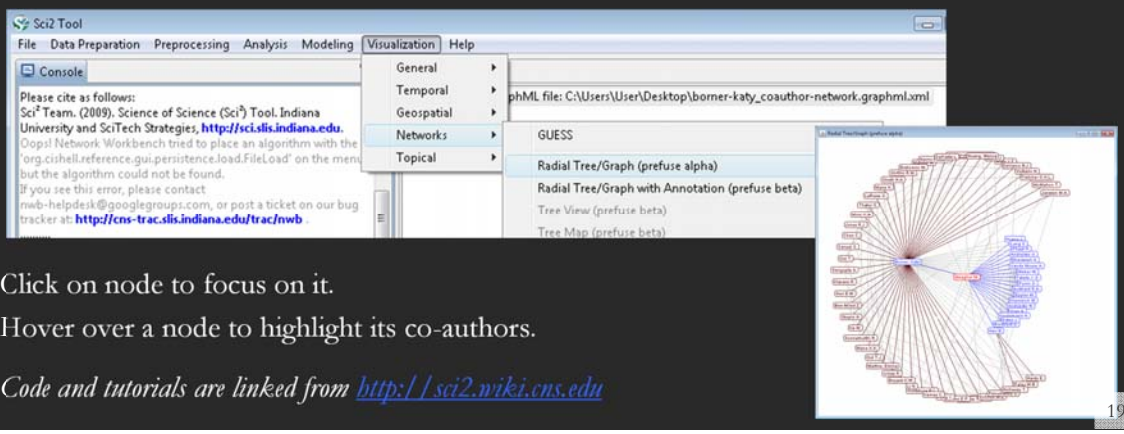


Run Sci2 Tool and Load Co-Author Network (GraphML File)



Network Analysis Toolkit
Nodes: 81
Edges: 390

Visualize the file using Radial Graph layout.

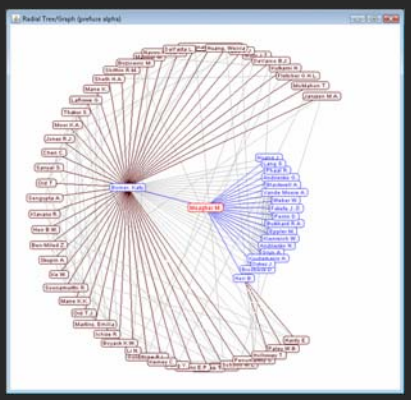


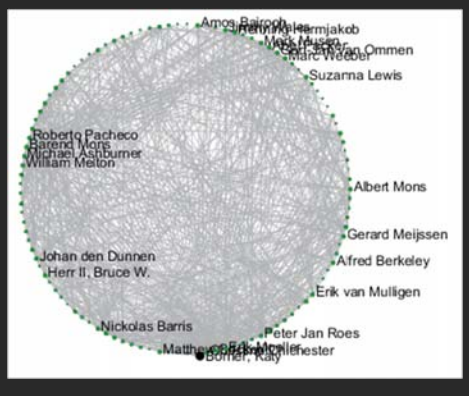
Click on node to focus on it.

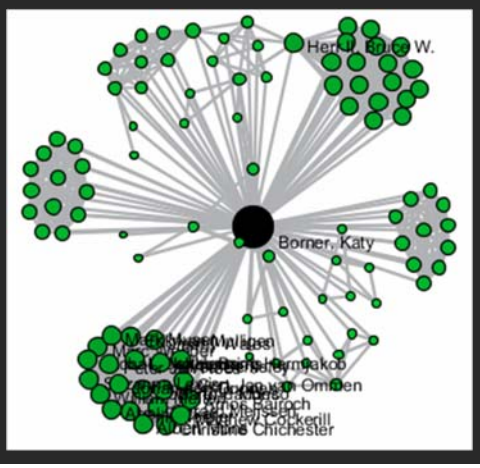
Hover over a node to highlight its co-authors.

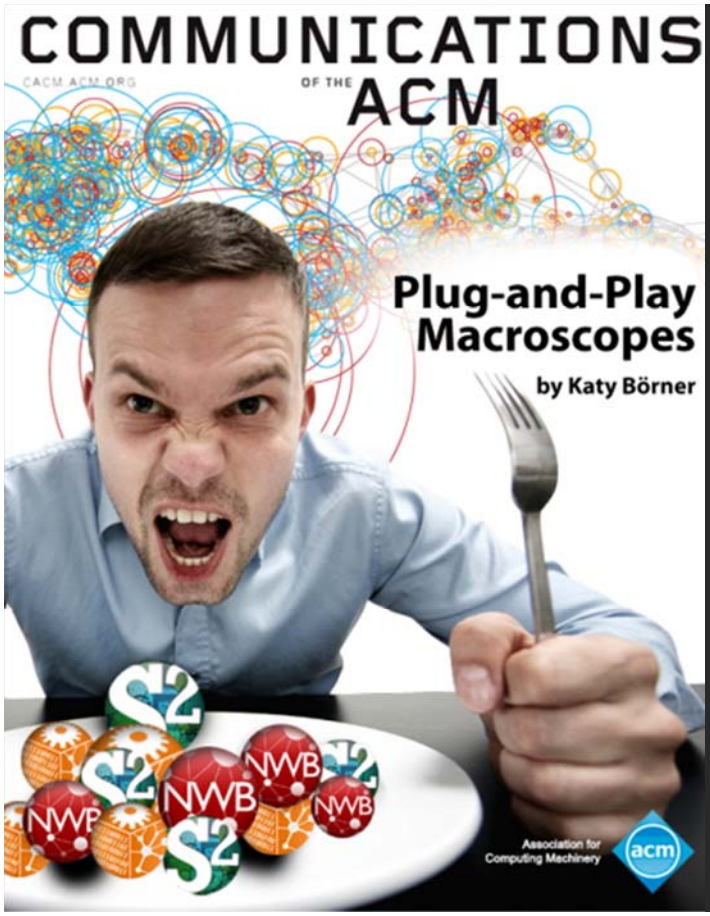
Code and tutorials are linked from http://sci2.wiki.cns.edu

Network Analysis Toolkit (NAT) was selected.
Nodes: 109
Isolated nodes: 0
Node attributes present: label, number_of_authored_works, num_unknown_publication, num_latest_publication, latest_publication, profile_url, num_earliest_publication, earliest_publication, url
Edges: 731
No self loops were discovered.
No parallel edges were discovered.
Average degree: 13.4128
This graph is weakly connected.
There are 1 weakly connected components. (0 isolates)
The largest connected component consists of 109 nodes.
Density (disregarding weights): 0.1242
.....
Node Degree was selected.









Börner, Katy. (March 2011). Plug-and-Play Macroscopes. *Communications of the ACM, 54(3), 60-69.*

Video and paper are at
http://www.scivee.tv/node/27704

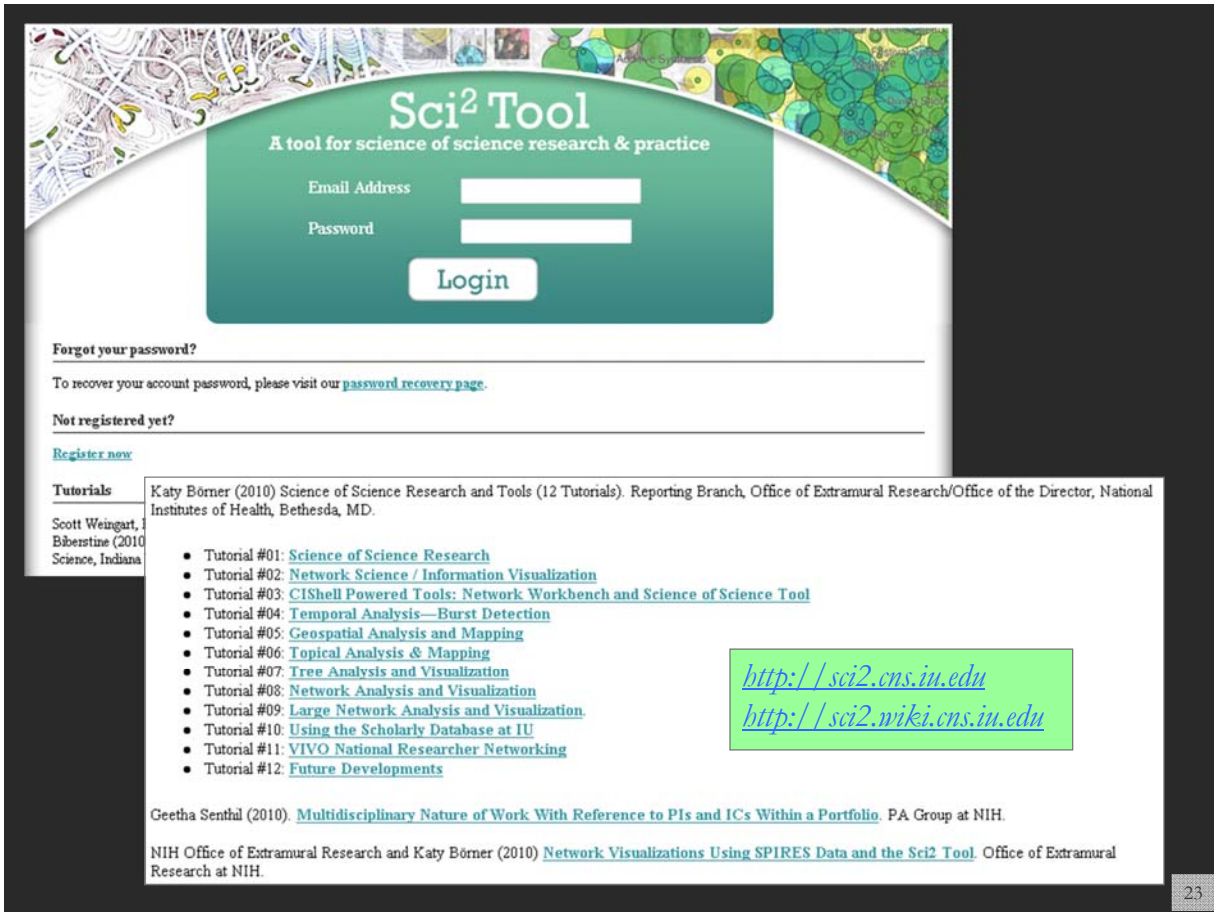
Plug-and-Play Macroscopes

While **microscopes** and **telescopes** are physical instruments, **macroscopes** resemble continuously changing bundles of software plug-ins.

Sharing algorithm components, tools, or novel interfaces becomes as easy as sharing images on Flickr or videos on YouTube. Assembling custom tools is as quick as compiling your custom music collection.

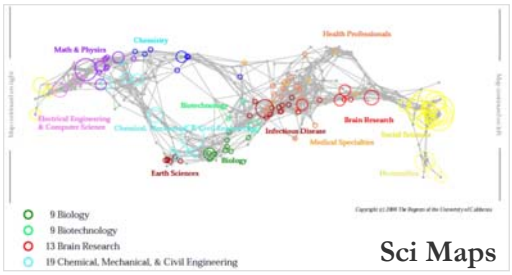
They provide a **common standard** for
- the design of **modular, compatible algorithm and tool plug-ins**
- that can be **easily combined into scientific workflows**, and
- **packaged as custom tools.**

Anyone can map. Anyone can replicate or advance workflows.

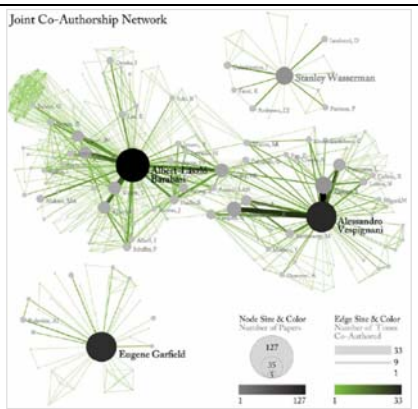


Sci² Tool – "Open Code for S&T Assessment" to run replicable workflows

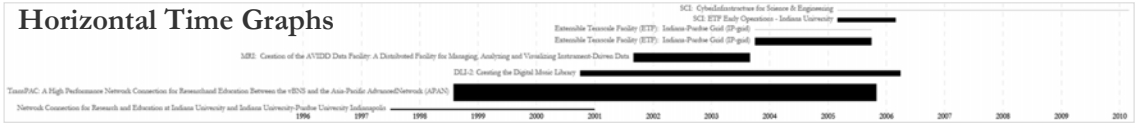
OSGi/CIShell powered tool, see http://cishell.org
http://sci2.cns.iu.edu | http://sci2.wiki.cns.iu.edu



Sci Maps

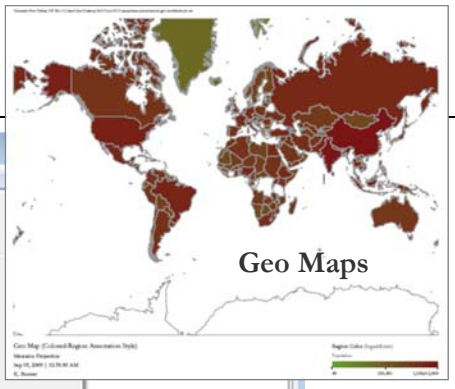


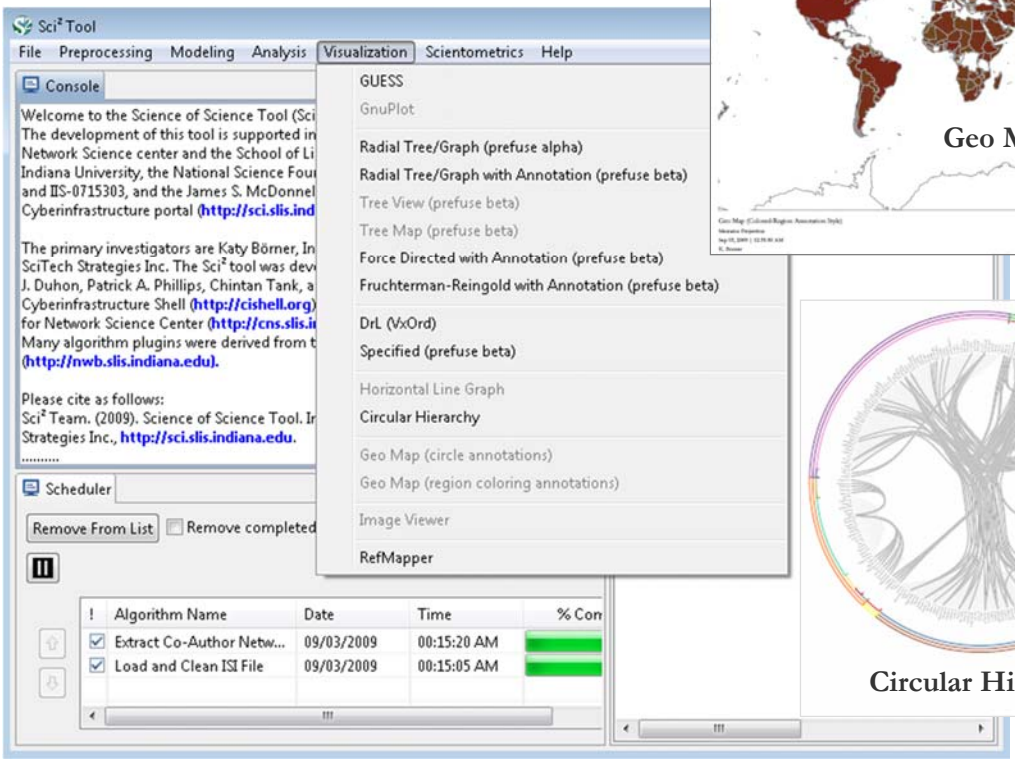
GUESS Network Vis



Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Duhon, Russell Jackson, Phillips, Patrick, Ma, Nianli, Zoss, Angela, Guo, Hanning & Price, Mark. (2009). Rete-Netzwerk-Red: Analyzing and Visualizing Scholarly Networks Using the Scholarly Database and the Network Workbench Tool. Proceedings of ISSI 2009: 12th International Conference on Scientometrics and Informetrics, Rio de Janeiro, Brazil, July 14-17 . Vol. 2, pp. 619-630.

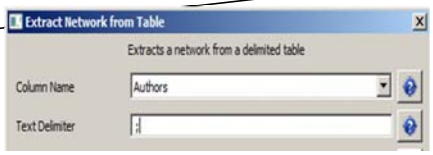
Sci² Tool



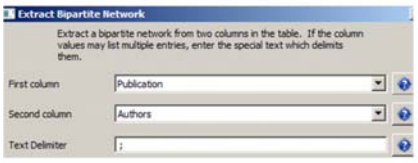


Network Extraction: Examples

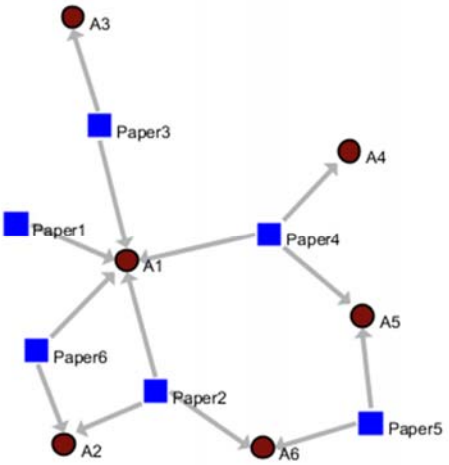
Author co-occurrence network



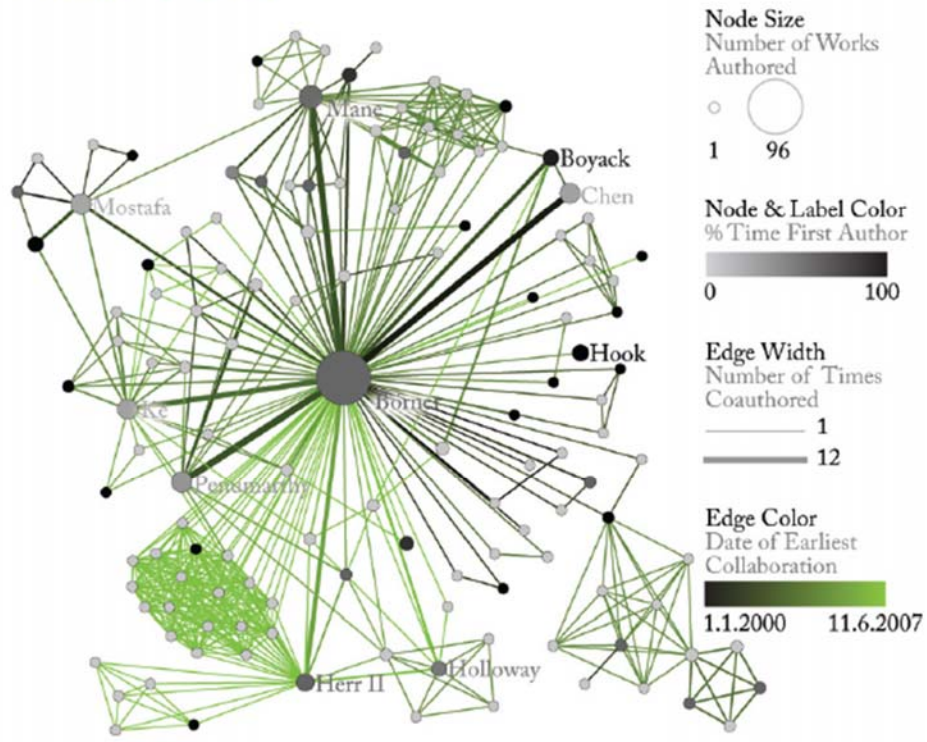
	A	B
1	Publication	Authors
2	Paper1	A1
3	Paper2	A1;A2;A6
4	Paper3	A1;A3
5	Paper4	A1;A4;A5
6	Paper5	A5;A6
7	Paper6	A1;A2



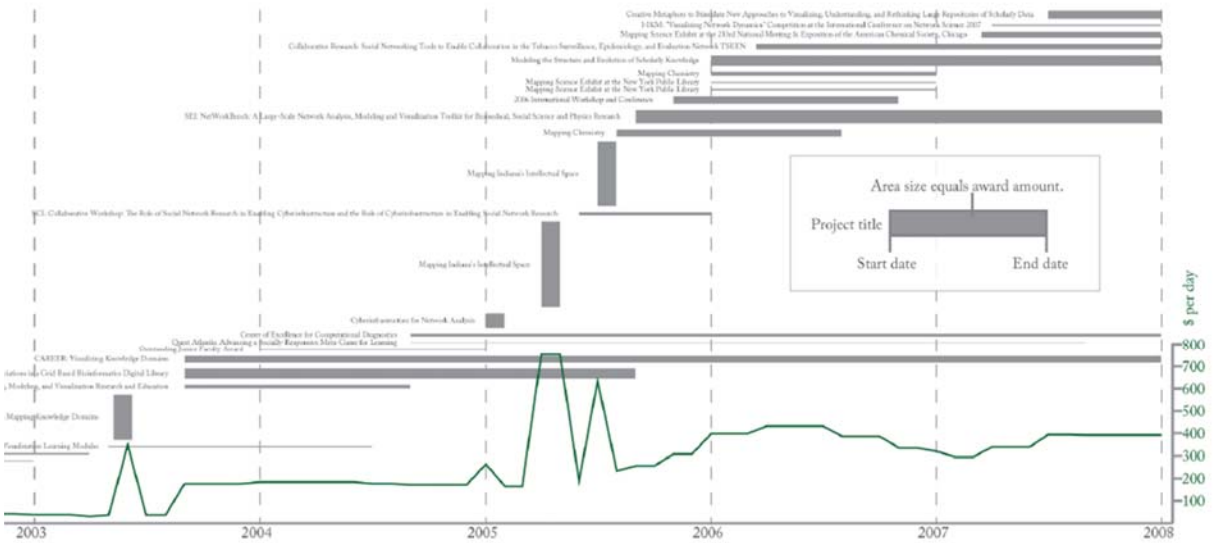
Paper-author 2-mode network

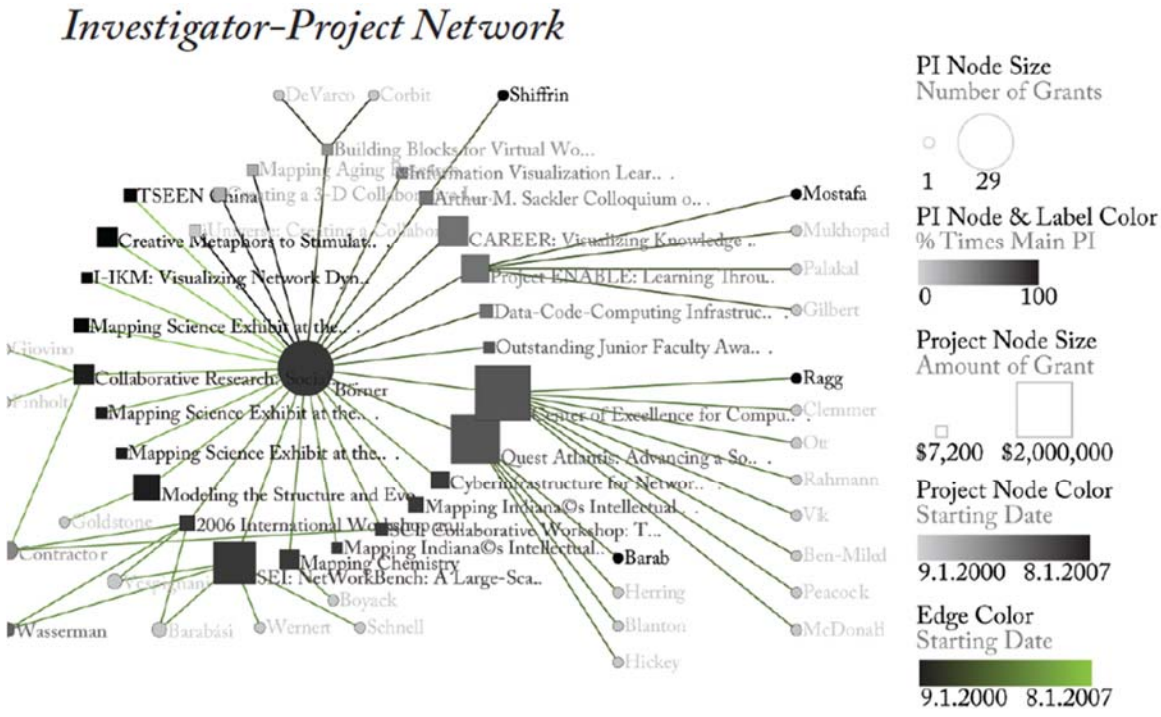


Coauthor Network



Project Timeline





Learn how to run custom VIVO data queries and visualize results

See also Visualization in VIVO Workshop on Aug 24, 2011
http://wiki.cns.iu.edu/display/PRES/VIVO+Presentation

VIVO Presentation

4 Added by Chin Hua Kong, last edited by Chintan Tank on Aug 24, 2011 (view change)

August, 2011 Workshop

Material

- Java 1.5 or higher - A programming language and computing platform for developing cross OS softwares.
- Science of Science tool (Sci2) - An desktop application for information analysis and visualization.
- Gephi - An interactive visualization tool for networks and complex systems, dynamic and hierarchical graphs.
- VIVO August 2011 workshop data.zip - Hands on workshop data package

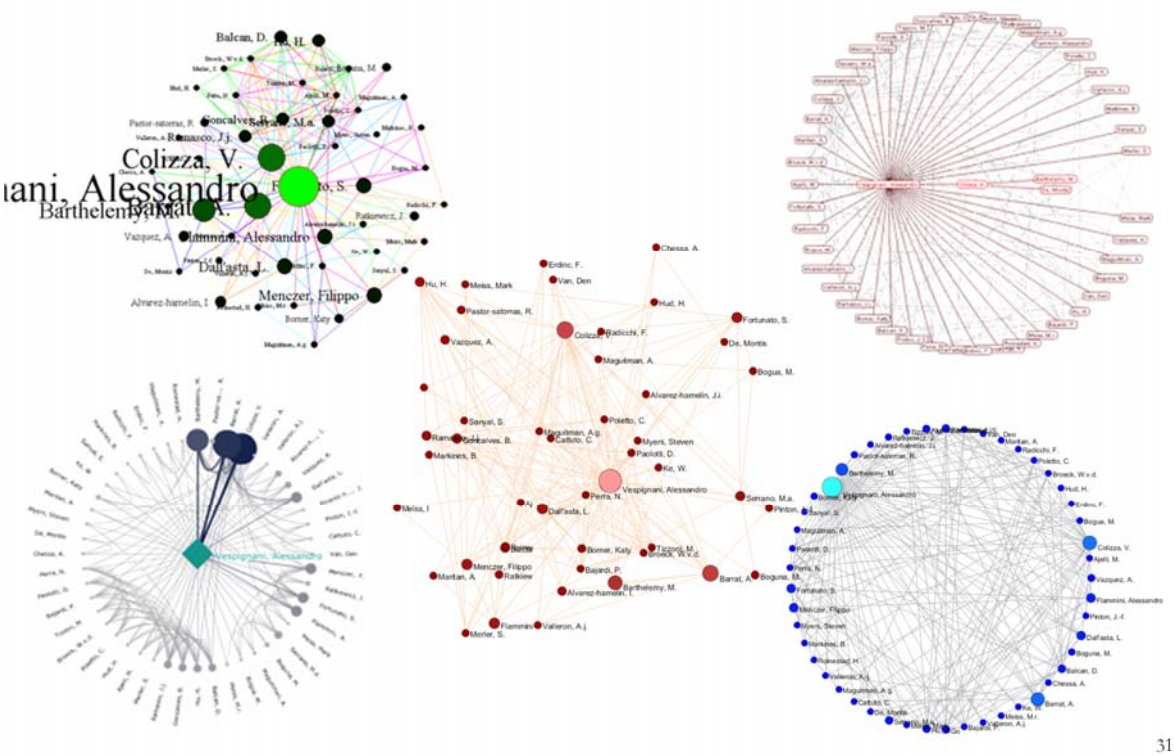
Slides

- Tutorial Slides presented at the VIVO Conference 2011
- Pre-Questionnaire and Post-Questionnaire

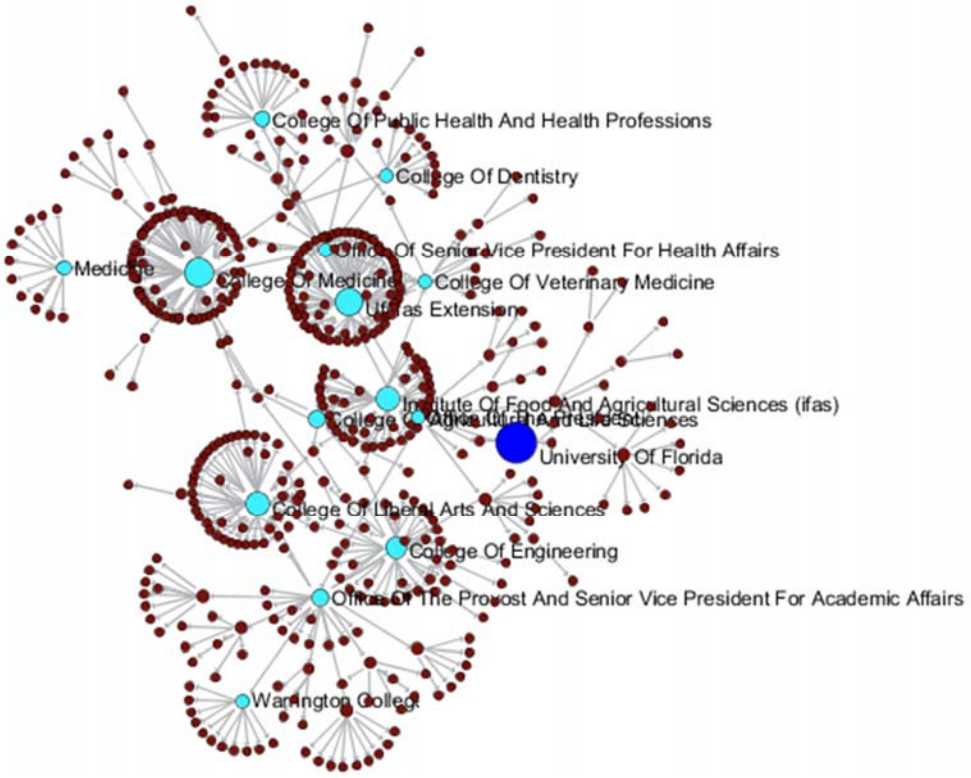
Demo Links

- Map of Science Visualization (dev link)
- Temporal Graph Visualization (dev link)
- National Researcher Networking Visualization
- Word Cloud Visualization dev link

Create different visualizations of the same data



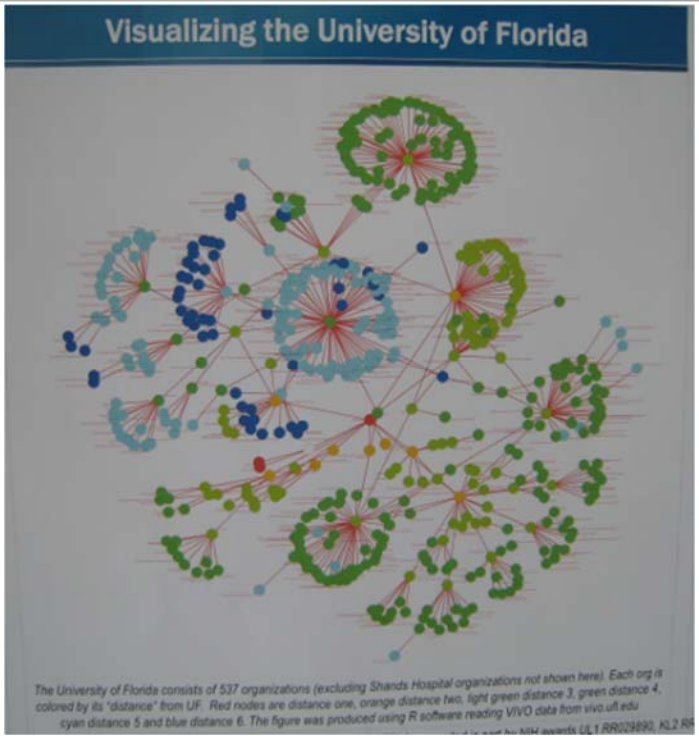
Visualization of VIVO Organizational Hierarchy



Attributes to Org Charts: Using R and VIVO for Visualization of Research Activity

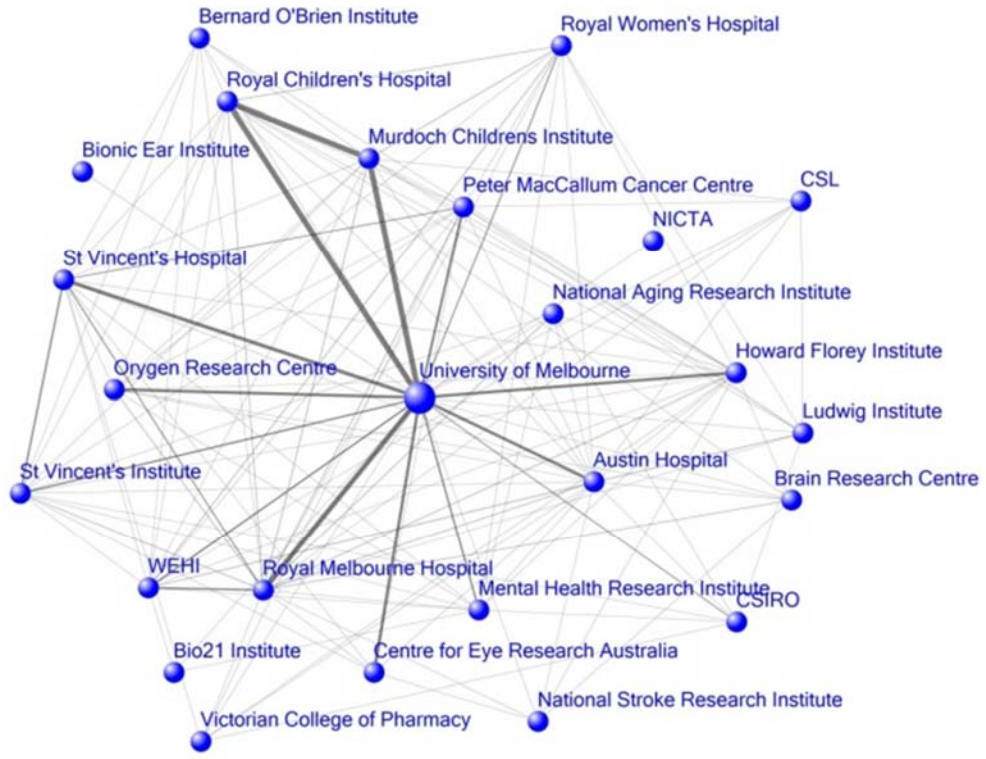
Mike Conlon, UF Clinical and Translational Science Institute, Gainesville, Florida

VIVO
Enabling a National Network of Scientists

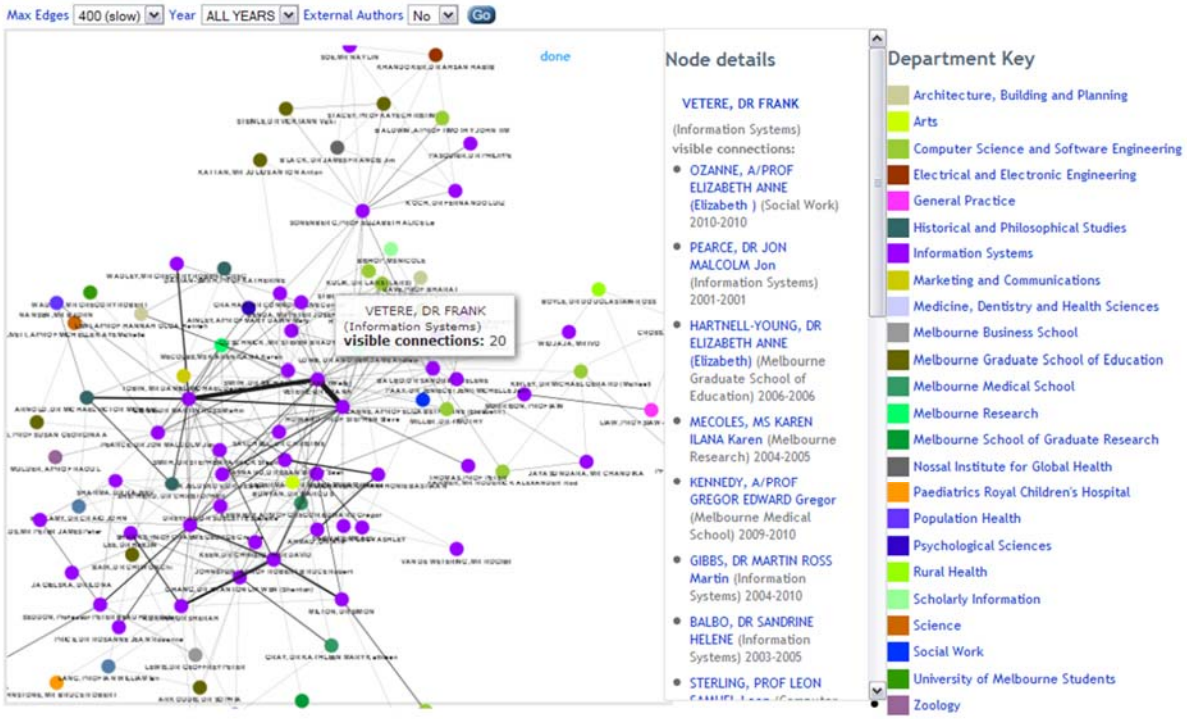


VIVO
Enabling a National Network of Scientists

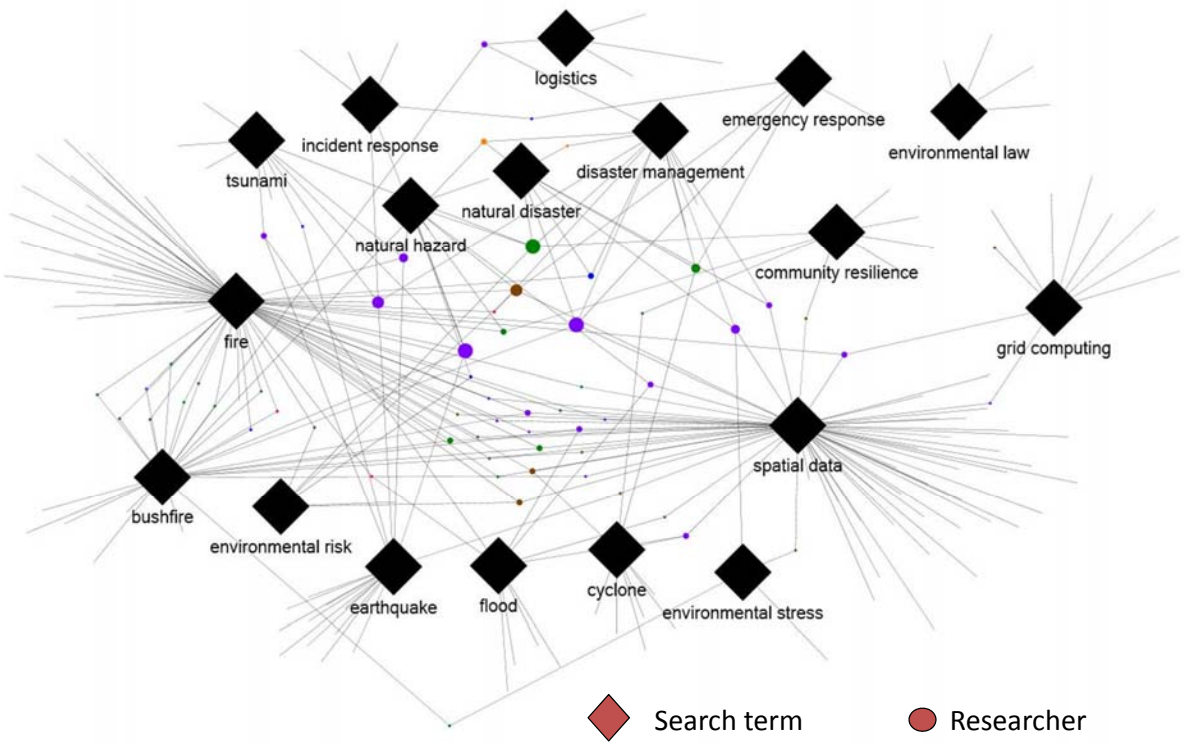
Custom NRN Visualizations



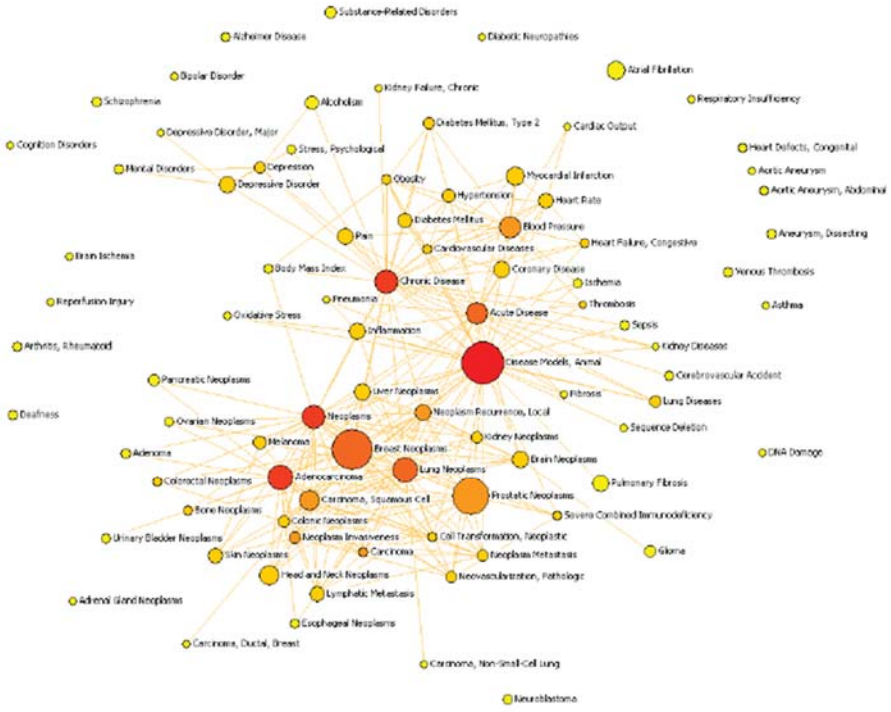
2008 collaboration patterns for medical institutions located close to Melbourne University
Source: Web of Science co authorship information. Compiled by Simon Porter



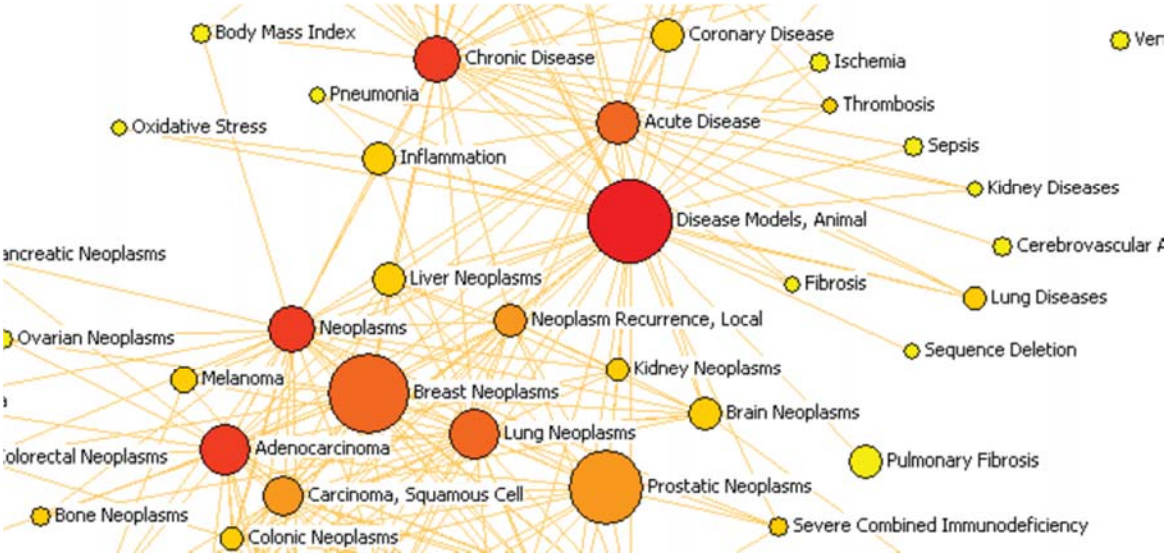
Co-authorship network for the department of Information Systems
Source: Melbourne Research Windows. Contact Simon Porter simon.porter@unimelb.edu.au



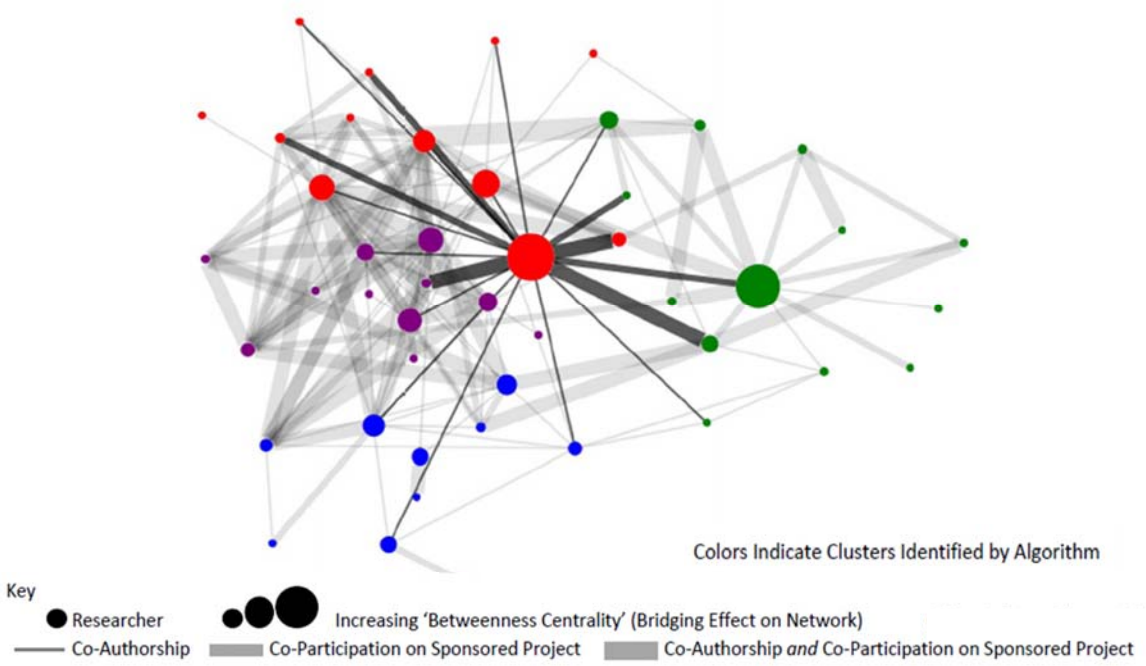
Bimodal network of search terms and researchers extracted from research profile search results to show the **University's capability in Disaster Management** to the Government
Contact: simon.porter@unimelb.edu.au



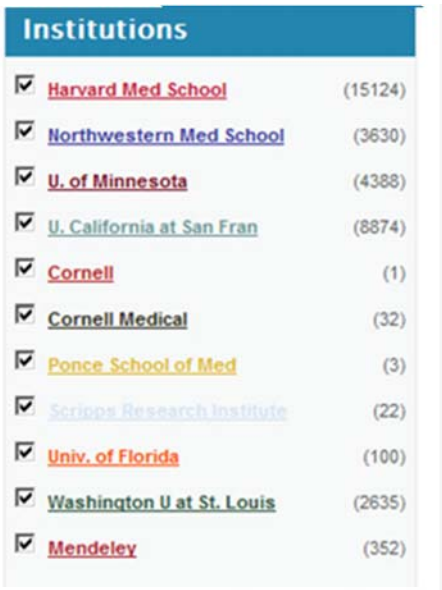
Top MeSH Disease Concepts Appearing in PubMed Publications by the University of Michigan Medical School. Links connect concepts where 100+ authors published about both concepts within the span of their careers.
Contact: Jeffrey Horon, J.Horon@elsevier.com

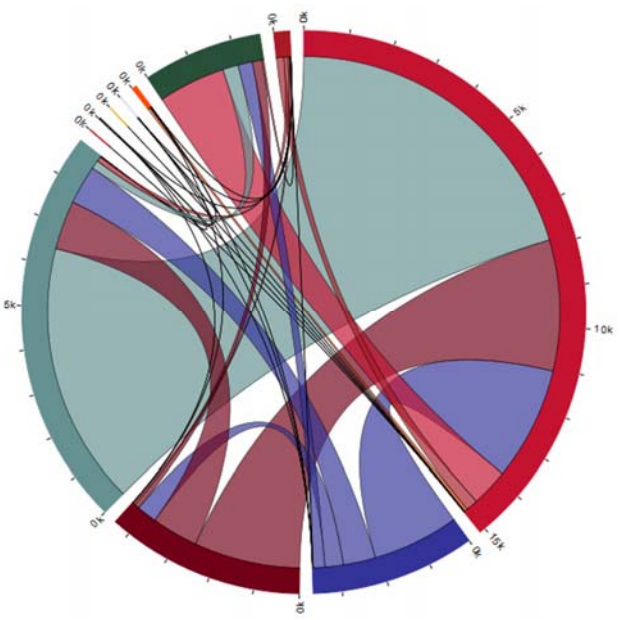


Top MeSH Disease Concepts Appearing in PubMed Publications by the University of Michigan Medical School. Links connect concepts where 100+ authors published about both concepts within the span of their careers.
This visualization revealed that animal disease models were central to disease research at U-M whiich encouraged additional thought and attention to animal husbandry, animal expenses, and core/shared services overall.
Contact: Jeffrey Horon, J.Horon@elsevier.com



P30 Member Collaborations – Sponsored Project Co-Participation and Co-Authorship Network. Used in **successful! P30** funding application. Shows the PI's relationships with various P30 members, conveying that the PI was not only the formal center of the group but also the informal center and the person who exhibited the highest betweenness centrality. *Contact: Jeffrey Horon, J.Horon@elsevier.com*





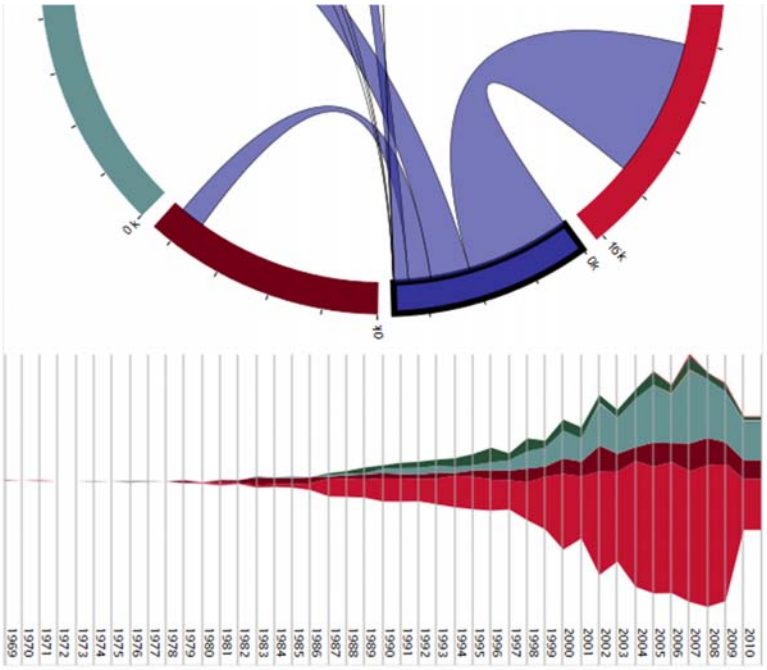
Inter-Institutional Collaboration Explorer

This visualization shows information about “collaborative publications” found at 2 or more Researcher Networking websites.

The idea that institutions don't work together and that biomedical research is conducted in silos is not true. Researchers, even when separated by great distances, are in fact willing to work together, and this visualization demonstrates that they often do.

Contact: Nick Benik (nbenik@gmail.com), Harvard Medical School, Boston, MA.

URL: http://xcite.hackerceo.org/VIVOviz



Inter-Institutional Collaboration Explorer

The outer solid colored arcs represent the 11 institutions. The size of the arc is proportional to the number of collaborative publications found on the site. The inner colored bands represent the number of collaborative publications found between the two institutions that each band connects. Clicking an institution's arc will hide any bands not connected to that institution and will display a timeline of when that institution's collaborative publications were written.

References

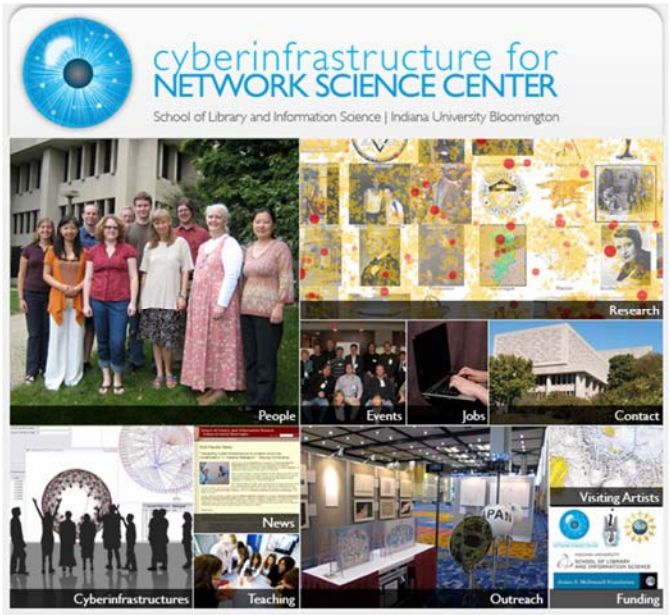
Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains.** In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, Volume 37, Chapter 5, pp. 179-255.
http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf

Shiffrin, Richard M. and Börner, Katy (Eds.) (2004). **Mapping Knowledge Domains**. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl_1).
http://www.pnas.org/content/vol101/suppl_1/

Börner, Katy, Sanyal, Soma and Vespignani, Alessandro (2007). **Network Science.** In Blaise Cronin (Ed.), *ARIST*, Information Today, Inc., Volume 41, Chapter 12, pp. 537-607.
http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf

Börner, Katy (2010) **Atlas of Science**. MIT Press.
http://scimaps.org/atlas

Scharnhorst, Andrea, Börner, Katy, van den Besselaar, Peter (2011) **Models of Science Dynamics**. Springer Verlag.



All papers, maps, tools, talks, press are linked from http://cns.iu.edu

CNS Facebook: http://www.facebook.com/cnscenter
Mapping Science Exhibit Facebook: http://www.facebook.com/mappingscience