Designing Insightful (Network) Visualizations *of Scholarly Activity*

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Information Visualization Laboratory, Director
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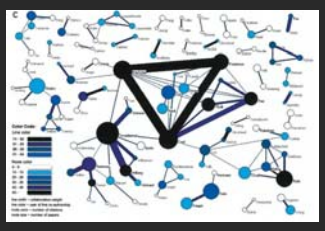
Networks and Network Analysis for the Humanities
Institute for Pure and Applied Mathematics, UCLA, Los Angeles, CA
August 16, 2010



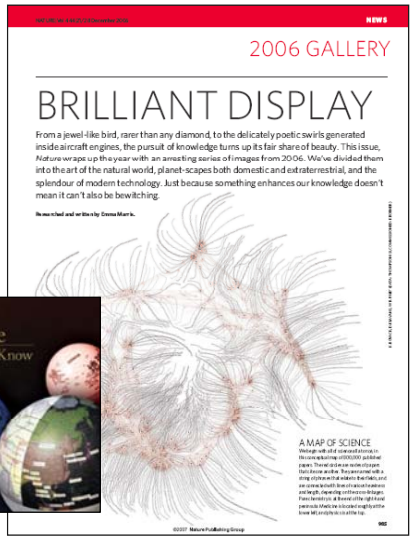
Computational Scientometrics OR Science of Science Studies

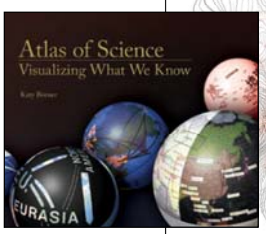
Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains.** In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, Inc./American Society for Information Science and Technology, Volume 37, Chapter 5, pp. 179-255.
http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf

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/

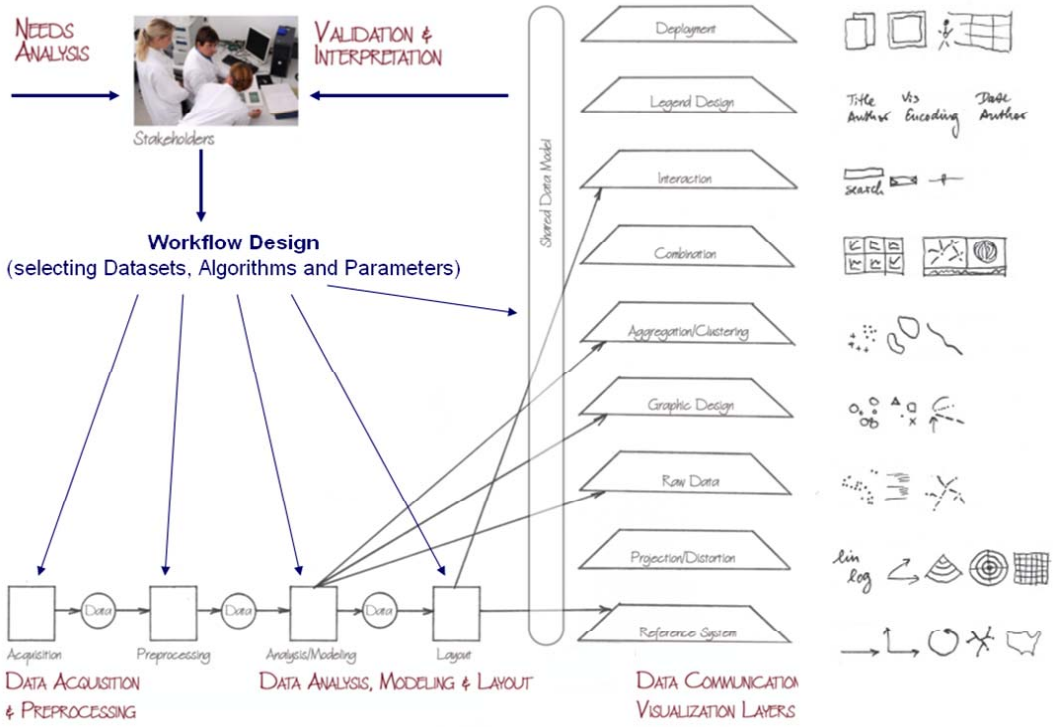
Börner, Katy, Sanyal, Soma and Vespignani, Alessandro (2007). **Network Science.** In Blaise Cronin (Ed.), *ARIST*, Information Today, Inc./American Society for Information Science and Technology, Medford, NJ, Volume 41, Chapter 12, pp. 537-607.
http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf

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





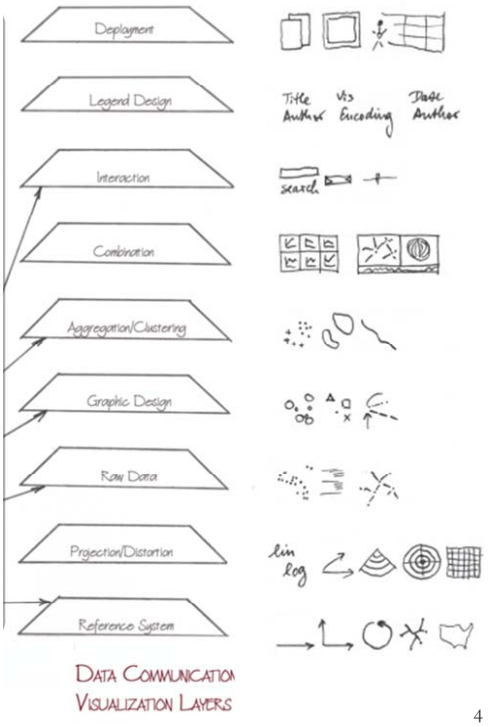
Visualization Design using a modular data acquisition/analysis/modeling/ visualization pipeline as well as modular visualization layers.



Börner, Katy (2010) Atlas of Science. MIT Press.

Visualization Design using a modular data acquisition/analysis/modeling/ visualization pipeline as well as modular visualization layers.

- **Deployment** of results is enabled through paper printouts, online animations, or interactive, three-dimensional, audiovisual environments.
- The **Legend Design** delivers guidance on the purpose, generation, and visual encoding of the data. Mapmakers should proudly sign their visualizations, adding credibility as well as contact information.
- In many cases, it is desirable to **Interact** with the data, that is, to zoom, pan, filter, search, and request details on demand. Selecting a data entity in one view might highlight this entity in other views.
- Sometimes it is beneficial to show multiple simultaneous views of the data, here referred to as **Combination**.
- Frequently, **Aggregation/Clustering** techniques are applied to identify data entities with common attribute values or dense connectivity patterns.
- **Graphic Design** refers to the visual encoding of data attributes using qualities such as size, color, and shape coding of nodes, linkages, or surface areas.
- Placing the **Raw Data** in a reference system reveals spatial patterns.
- **Projections/Distortions** of the reference system help emphasize certain areas or provide focus and context.
- **Reference Systems** organize the space.



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 NSF, all of USA, all of science.
Temporal Analysis (When)	Funding portfolio of one individual	Mapping topic bursts in 20-years of PNAS	113 Years of Physics Research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a states intellectual landscape	PNAS Publications
Topical Analysis (What)	Base knowledge from which one grant draws.	Knowledge flows in Chemistry research	Topic maps of NIH funding
Network Analysis (With Whom?)	NSF Co-PI network of one individual	Co-author network	NSF's core competency

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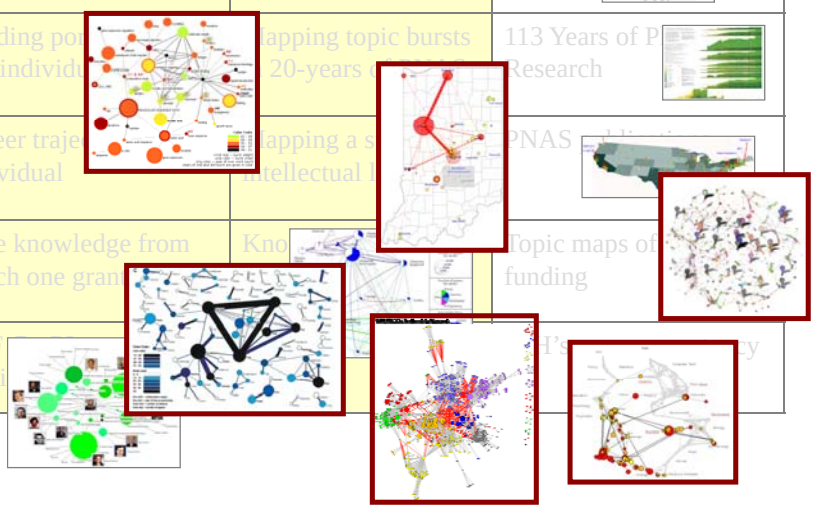
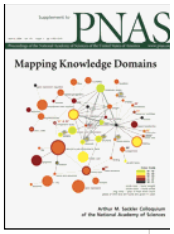
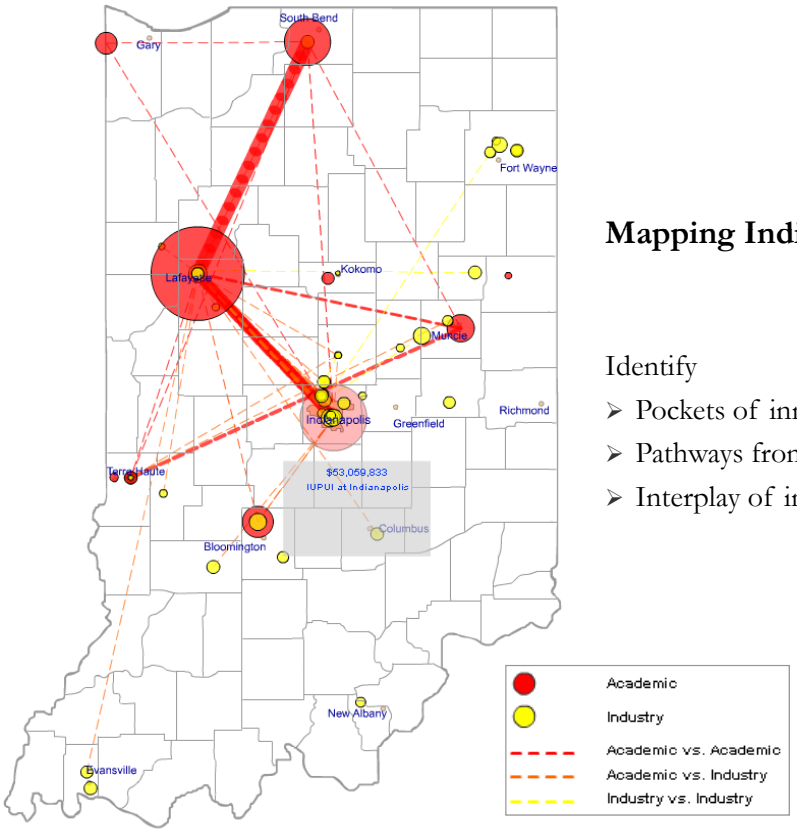


Mapping Topic Bursts

Co-word space of the top 50 highly frequent and bursty words used in the top 10% most highly cited PNAS publications in 1982-2001.

Mane & Börner. (2004) PNAS, 101(Suppl. 1): 5287-5290.





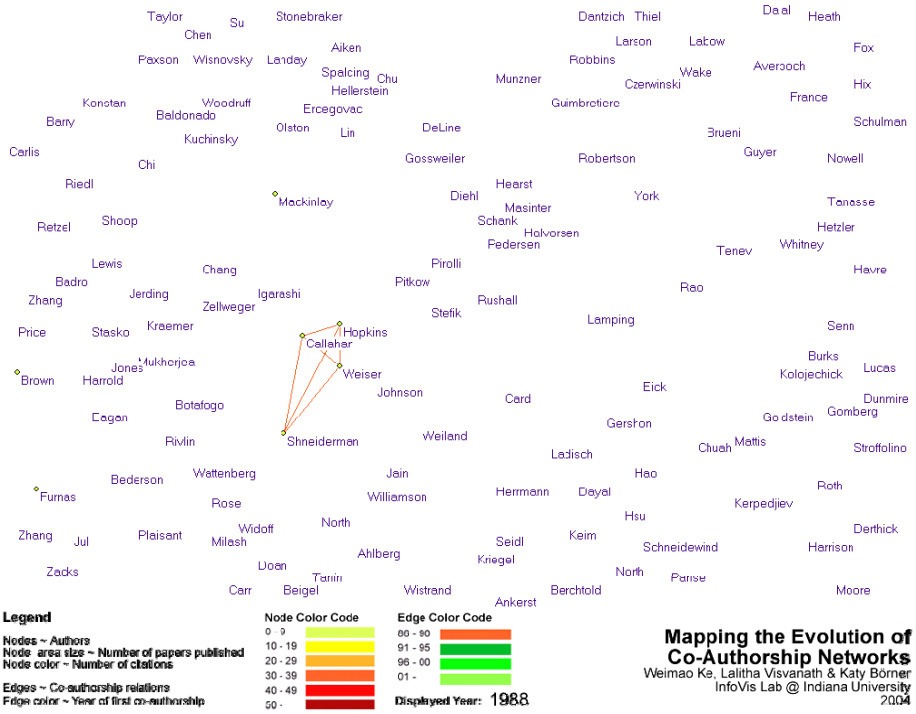
Mapping Indiana's Intellectual Space

Identify

- Pockets of innovation
- Pathways from ideas to products
- Interplay of industry and academia

Mapping the Evolution of Co-Authorship Networks

Ke, Visvanath & Börner, (2004) Won 1st price at the IEEE InfoVis Contest.



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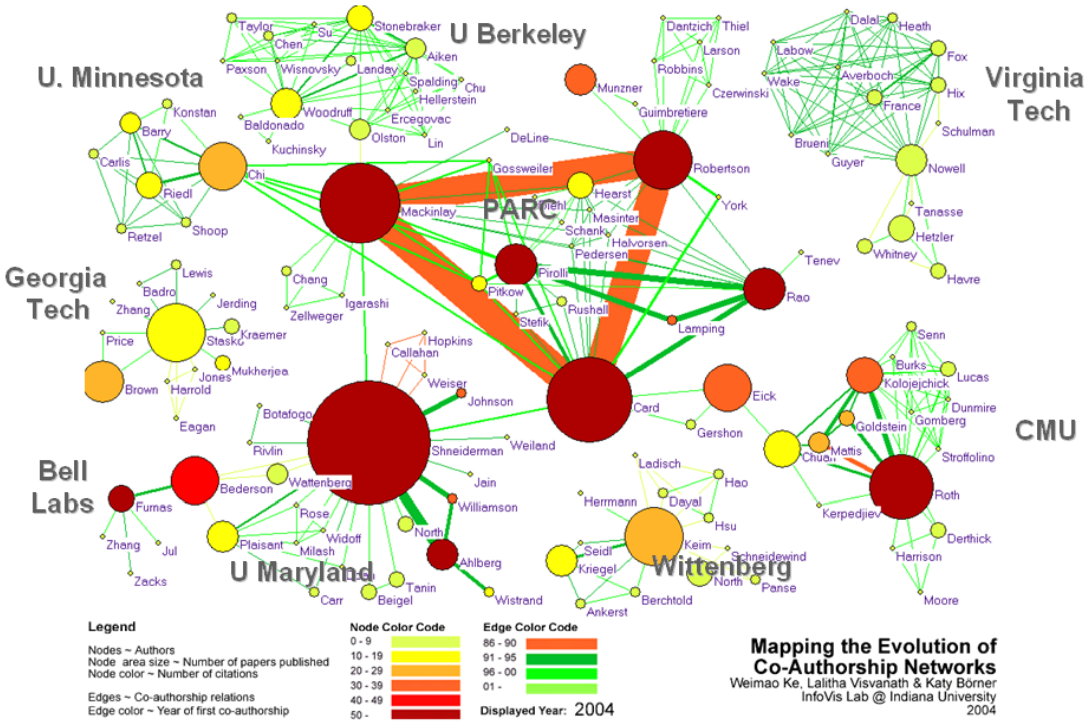


Studying the Emerging Global Brain: Analyzing and Visualizing the Impact of Co-Authorship Teams

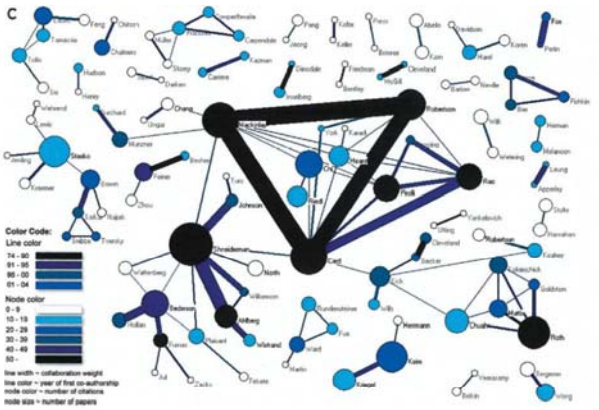
Börner, Dall'Asta, Ke & Vespignani (2005) Complexity, 10(4):58-67.

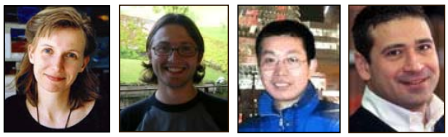
Research question:

- Is science driven by prolific single experts or by high-impact co-authorship teams?

Contributions:

- New approach to allocate citational credit.
- Novel weighted graph representation.
- Visualization of the growth of weighted co-author network.
- Centrality measures to identify author impact.
- Global statistical analysis of paper production and citations in correlation with co-authorship team size over time.
- Local, author-centered entropy measure.

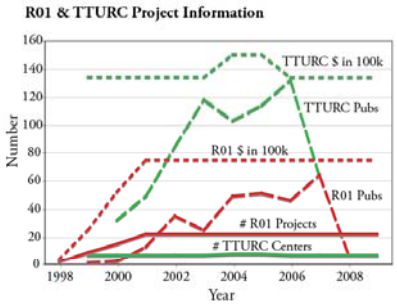


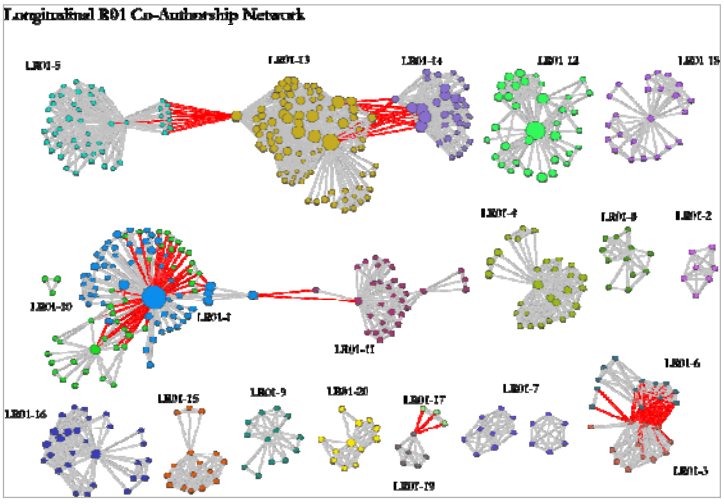


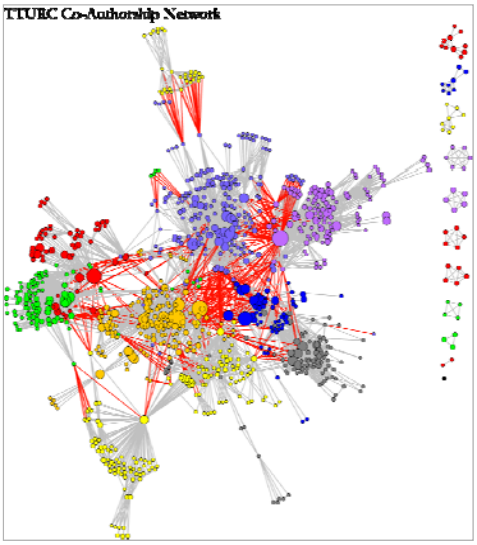
Mapping Transdisciplinary Tobacco Use Research Centers Publications

Compare R01 investigator based funding with TTURC Center awards in terms of number of publications and evolving co-author networks.

Zoss & Börner, forthcoming.







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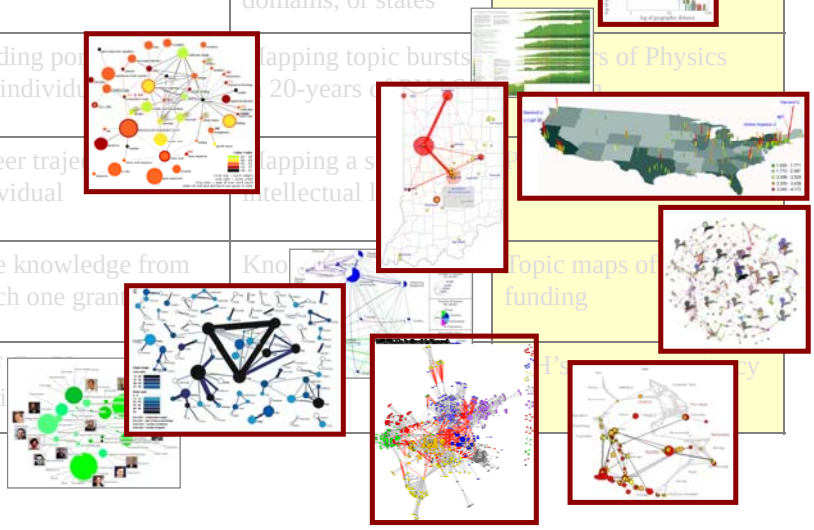

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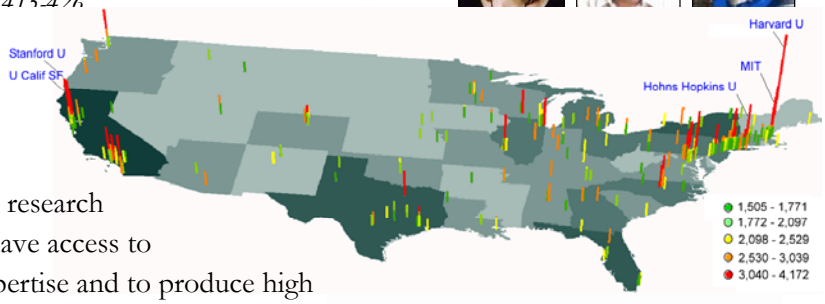
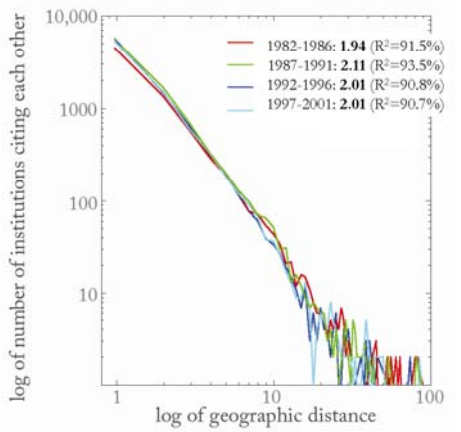
Spatio-Temporal Information Production and Consumption of Major U.S. Research Institutions

Börner, Katy, Penumarthy, Shashikant, Meiss, Mark and Ke, Weimao. (2006) Mapping the Diffusion of Scholarly Knowledge Among Major U.S. Research Institutions. Scientometrics. 68(3), pp. 415-426.

Research questions:

1. Does space still matter in the Internet age?
2. Does one still have to study and work at major research institutions in order to have access to high quality data and expertise and to produce high quality research?
3. Does the Internet lead to more global citation patterns, i.e., more citation links between papers produced at geographically distant research instructions?



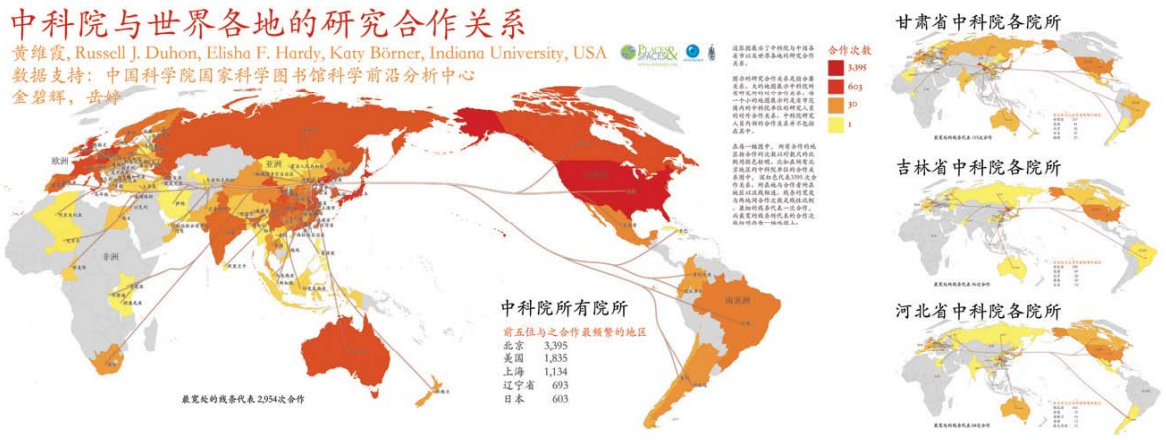


Contributions:

- Answer to Qs 1 + 2 is YES.
- Answer to Qs 3 is NO.
- Novel approach to analyzing the dual role of institutions as information producers and consumers and to study and visualize the diffusion of information among them.

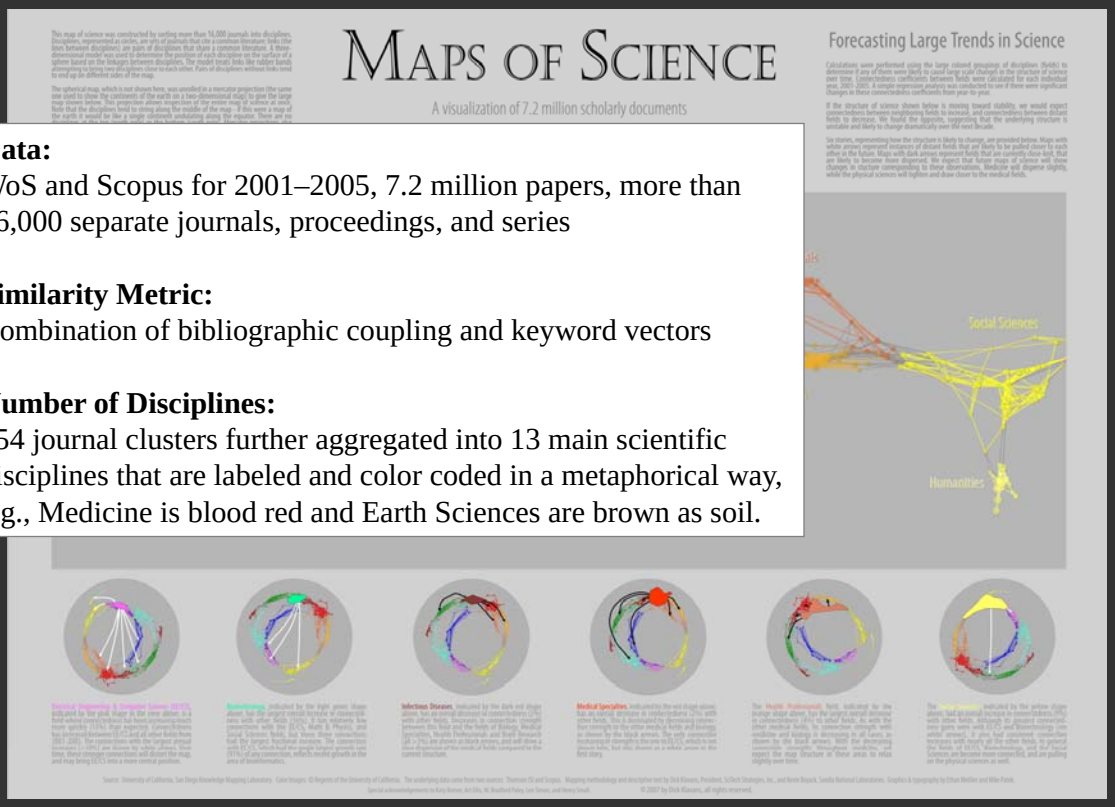
Research Collaborations by the Chinese Academy of Sciences

By Weixia (Bonnie) Huang, Russell J. Duhon, Elisha F. Hardy, Katy Börner, Indiana University, USA



Co-authorship collaborations of the Beijing branch of the Chinese Academy of Sciences (left) and six regional branches (3 shown on right) with countries around the world.

Collaborating countries are colored on a logarithmic scale by the number of collaborations from red to yellow. The darkest red denotes 3,395 collaborations by all CAS researchers in Beijing. Flow lines are drawn from the location of focus to all locations collaborated with. Line width is linearly proportional to the number of joint papers.

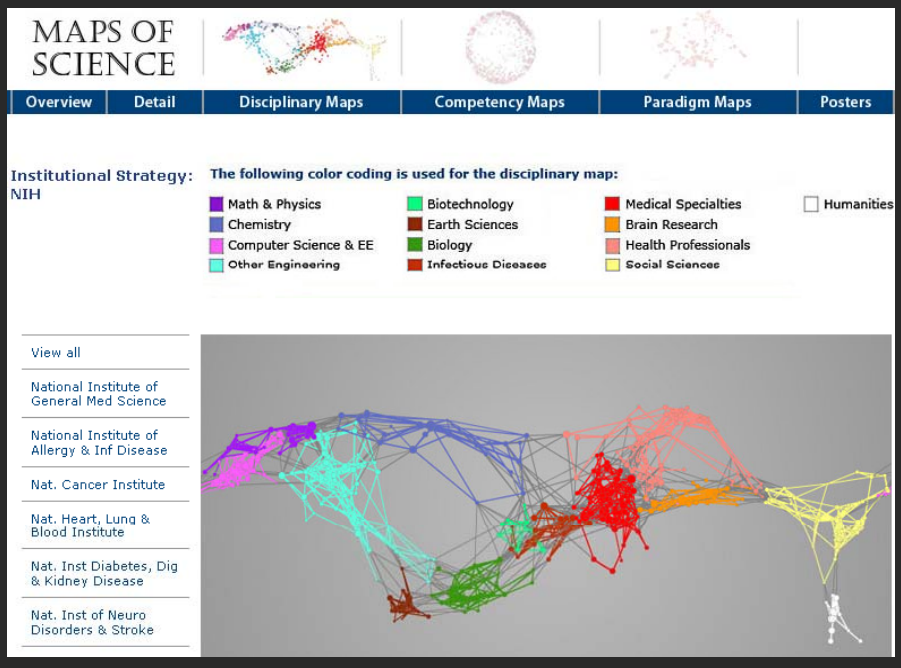


Data:
WoS and Scopus for 2001–2005, 7.2 million papers, more than 16,000 separate journals, proceedings, and series

Similarity Metric:
Combination of bibliographic coupling and keyword vectors

Number of Disciplines:
554 journal clusters further aggregated into 13 main scientific disciplines that are labeled and color coded in a metaphorical way, e.g., Medicine is blood red and Earth Sciences are brown as soil.

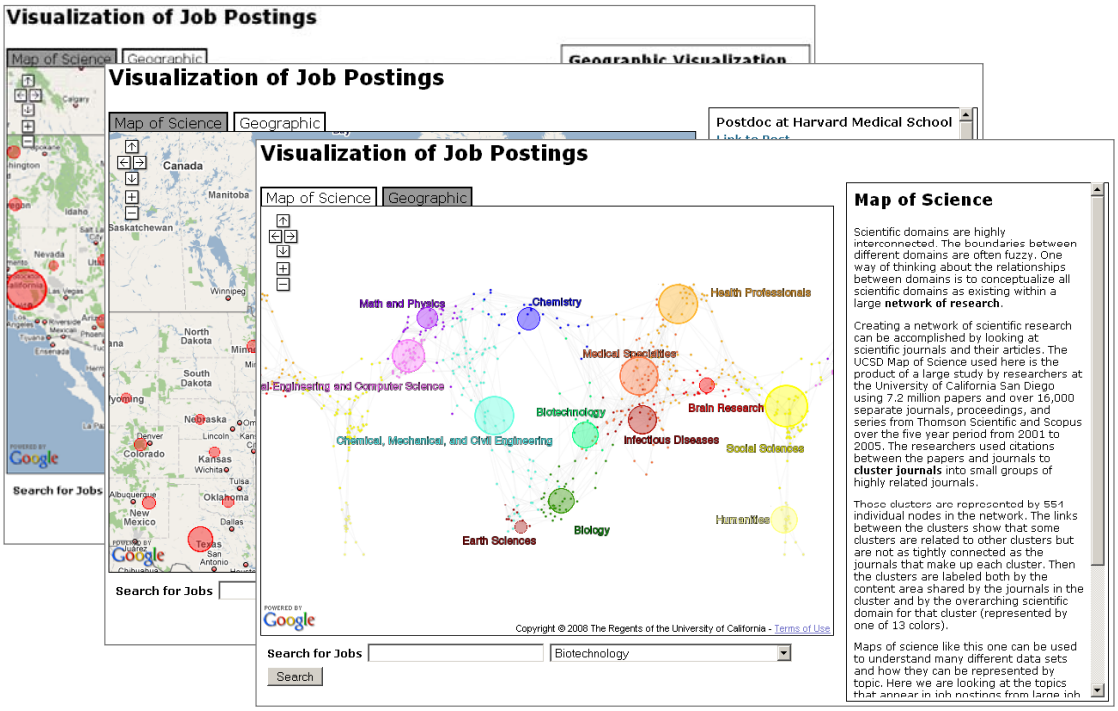
Richard Klavans and Kevin Boyack. 2007. Maps of Science: Forecasting Large Trends in Science.



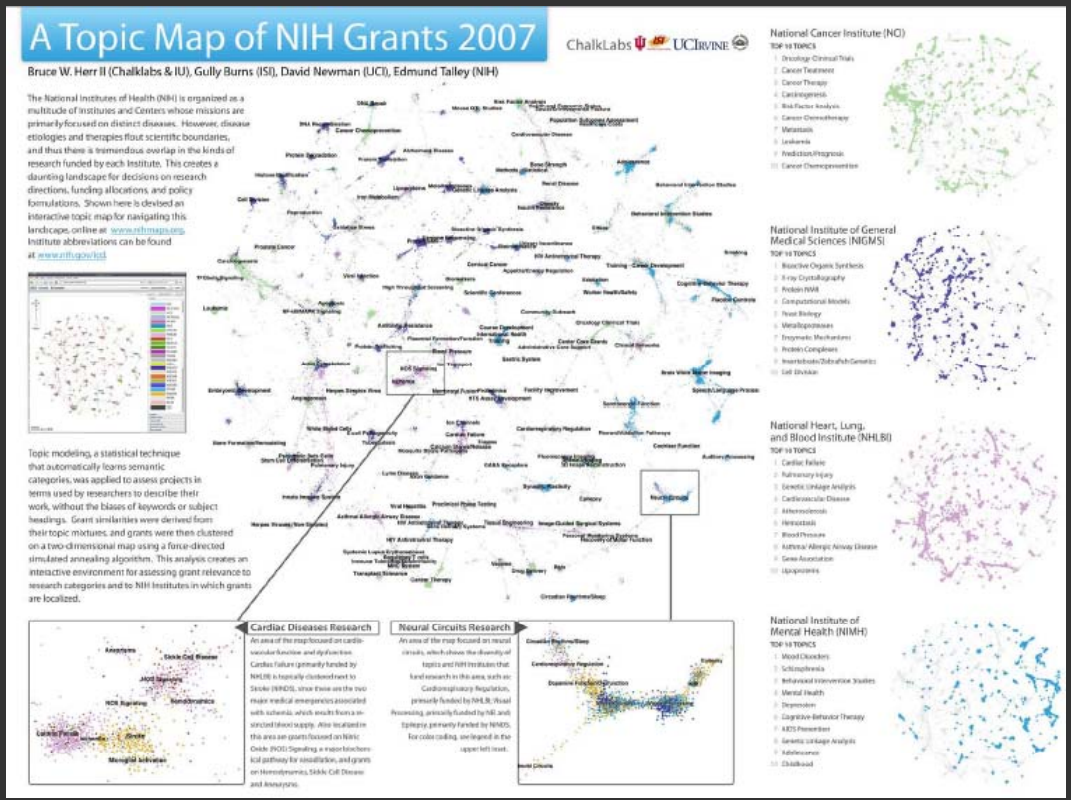
http://mapofscience.com

Where Are the Academic Jobs? Interactive Exploration of Job Advertisements in Geospatial and Topical Space

Angela Zoss, Michael Connover, Katy Börner (2010)



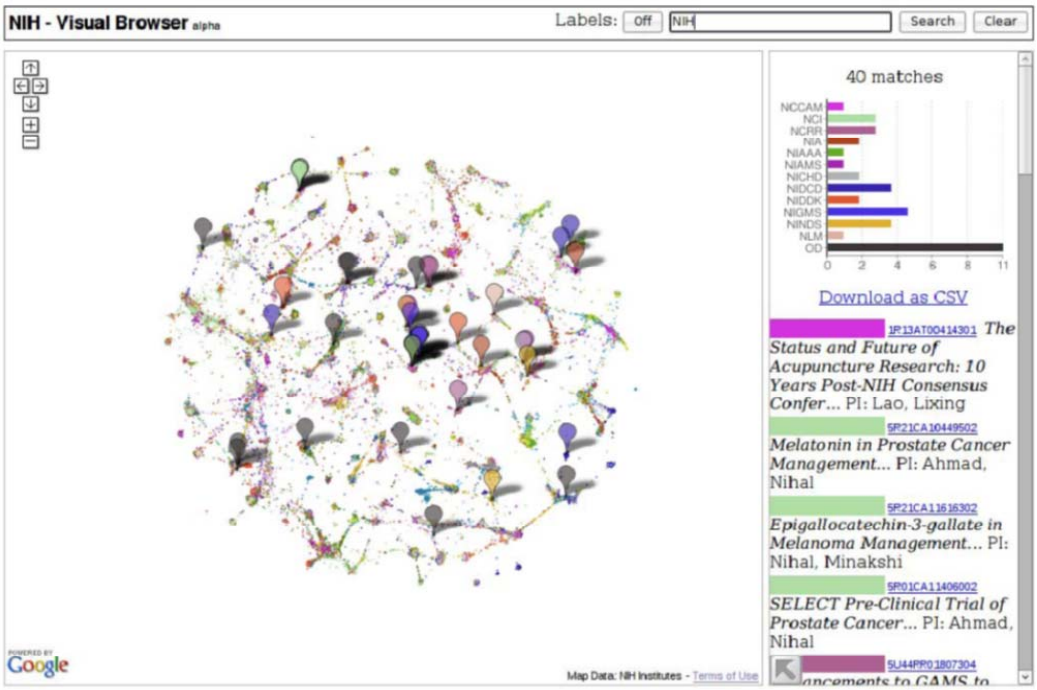
http://cns-nd3.slis.indiana.edu/mapjobs/geo



Herr II, Bruce W., Gully Burns, David Newman, Edmund Talley. 2007. A Topic Map of NIH Grants 2007.

Interactive Science Map of NIH Funding

Herr II, Bruce W., Talley, Edmund M, Burns, Gully APC, Newman, David & La Rowe, Gavin. (2009).



http://scimaps.org/maps/nih/2007

Interactive Maps of Science – NIH Funding

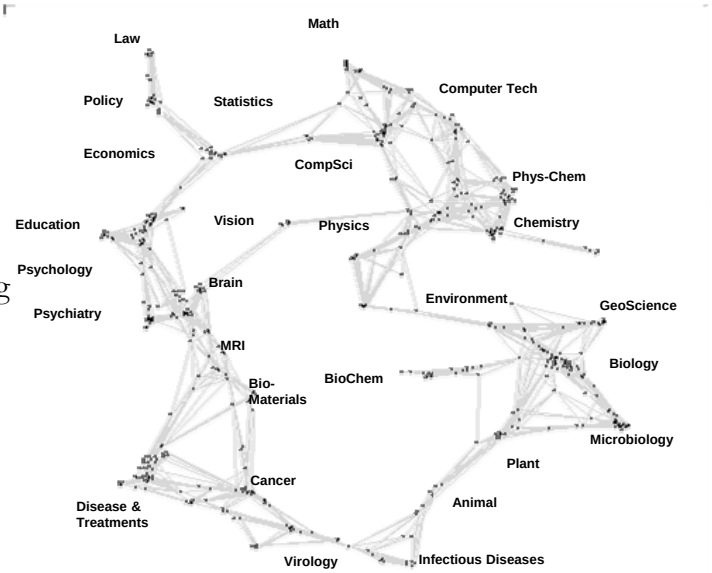
Google maps with charts and tables

http://scimaps.org/maps/nih/2007

2002 Base Map of Science

Kevin W. Boyack, Katy Börner, & Richard Klavans (2007). Mapping the Structure and Evolution of Chemistry Research. 11th International Conference on Scientometrics and Informetrics. pp. 112-123.

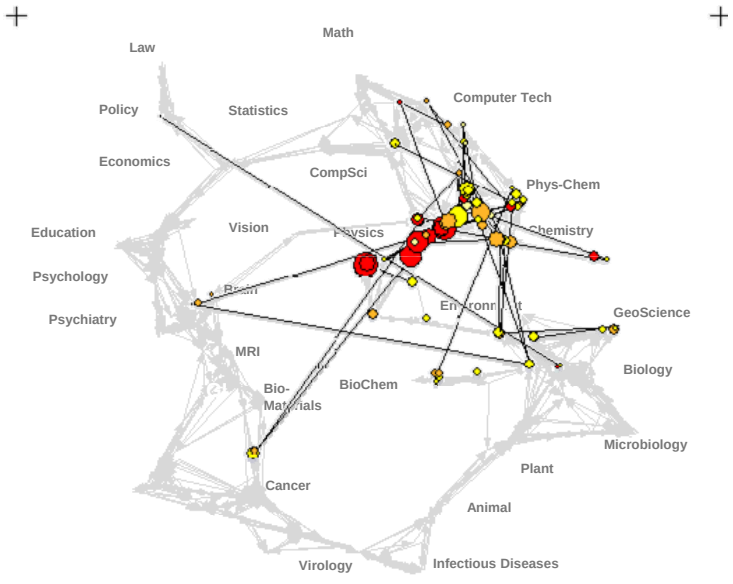
- Uses combined SCI/SSCI from 2002
  - 1.07M papers, 24.5M references, 7,300 journals
  - Bibliographic coupling of papers, aggregated to journals
- Initial ordination and clustering of journals gave 671 clusters
- Coupling counts were reaggregated at the journal cluster level to calculate the
  - (x,y) positions for each journal cluster
  - by association, (x,y) positions for each journal



Science map applications: Identifying core competency

Kevin W. Boyack, Katy Börner, & Richard Klavans (2007).

Funding patterns of the US Department of Energy (DOE)



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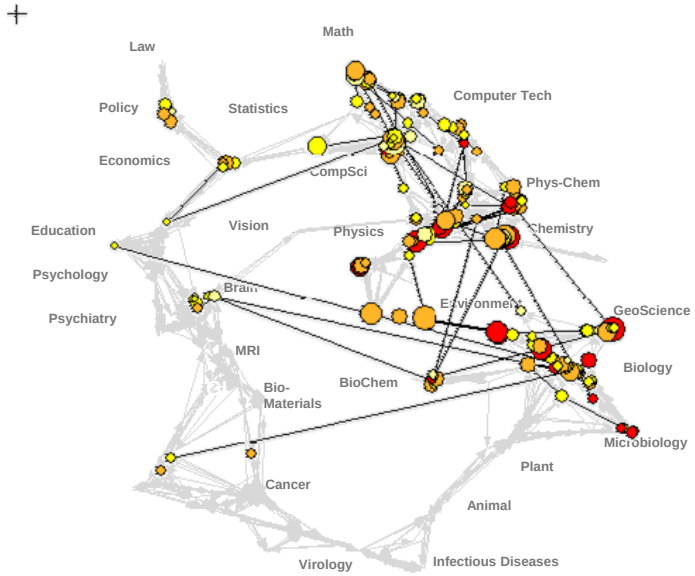

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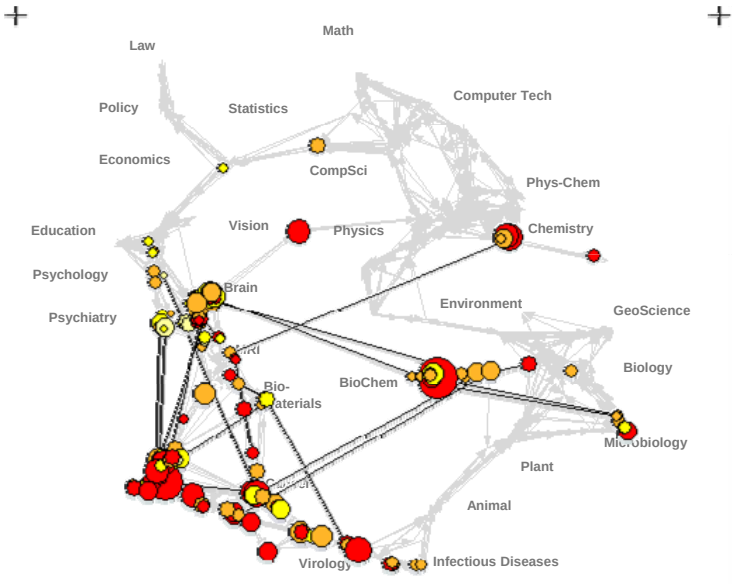

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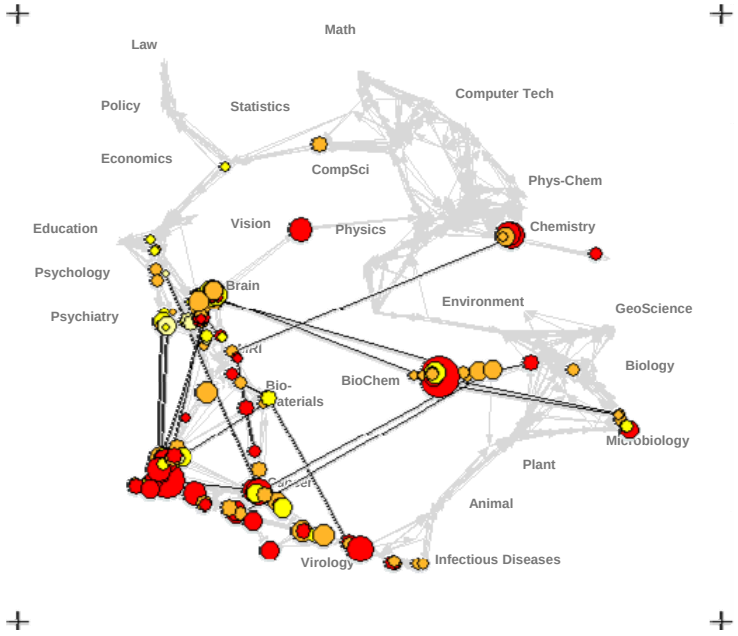
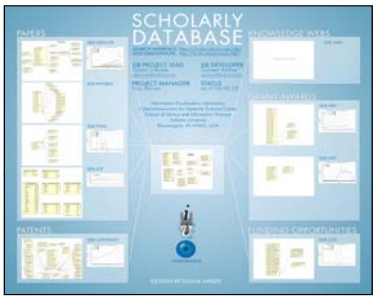


Computational Scientometrics Cyberinfrastructures



Scholarly Database: 23 million scholarly records
http://sdb.slis.indiana.edu

James S. McDonnell Foundation

VIVO Research Networking
http://vivoweb.org

Information Visualization Cyberinfrastructure
http://iv.slis.indiana.edu

Network Workbench Tool & Community Wiki
http://nwb.slis.indiana.edu

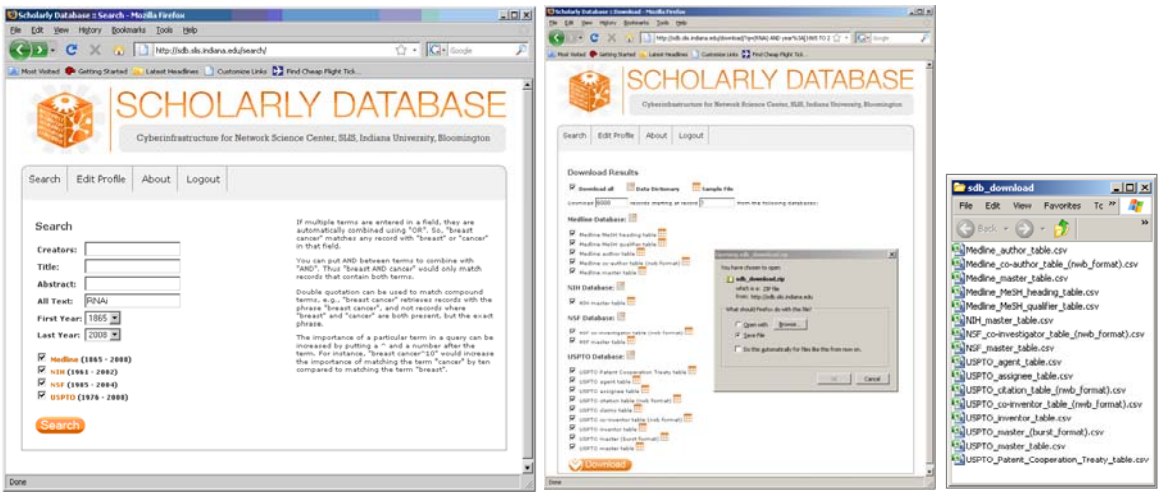
Science of Science (Sci^2) Tool and CI Portal
http://sci.slis.indiana.edu

Epidemics Cyberinfrastructure
http://epic.slis.indiana.edu/

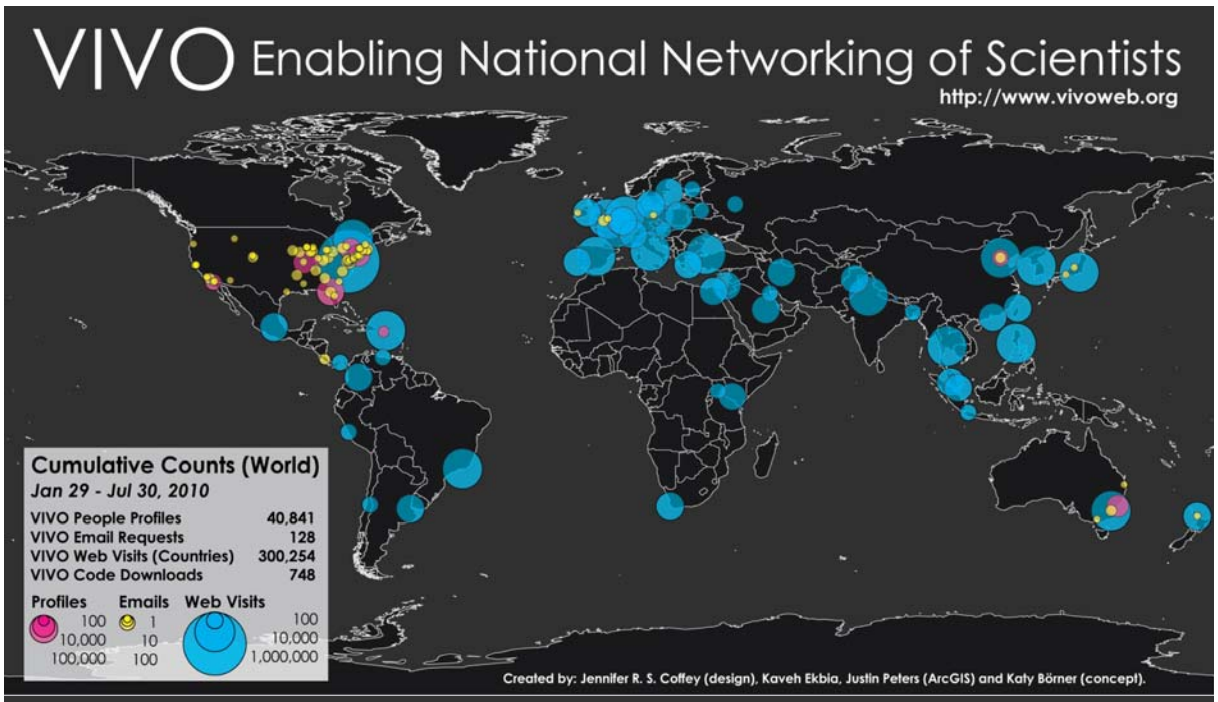
OSGi Alliance

CIShell
cyberinfrastructure shell

Scholarly Database
(http://sdb.slis.indiana.edu)



The **Scholarly Database** at Indiana University provides free access to 23,000,000 papers, patents, and grants. Since March 2009, users can also download networks, e .g., co-author, co-investigator, co-inventor, patent citation, and tables for burst analysis.



VIVO is a 2-year, $12 Million dollar project funded by NIH.
VIVO 1.0 source code was released on April 14, 2010.
The more institutions adopt VIVO, the more high quality data will be available to understand, navigate, manage, utilize, and communicate progress in science and technology.

Network Workbench Tool
(http://nwb.slis.indiana.edu)

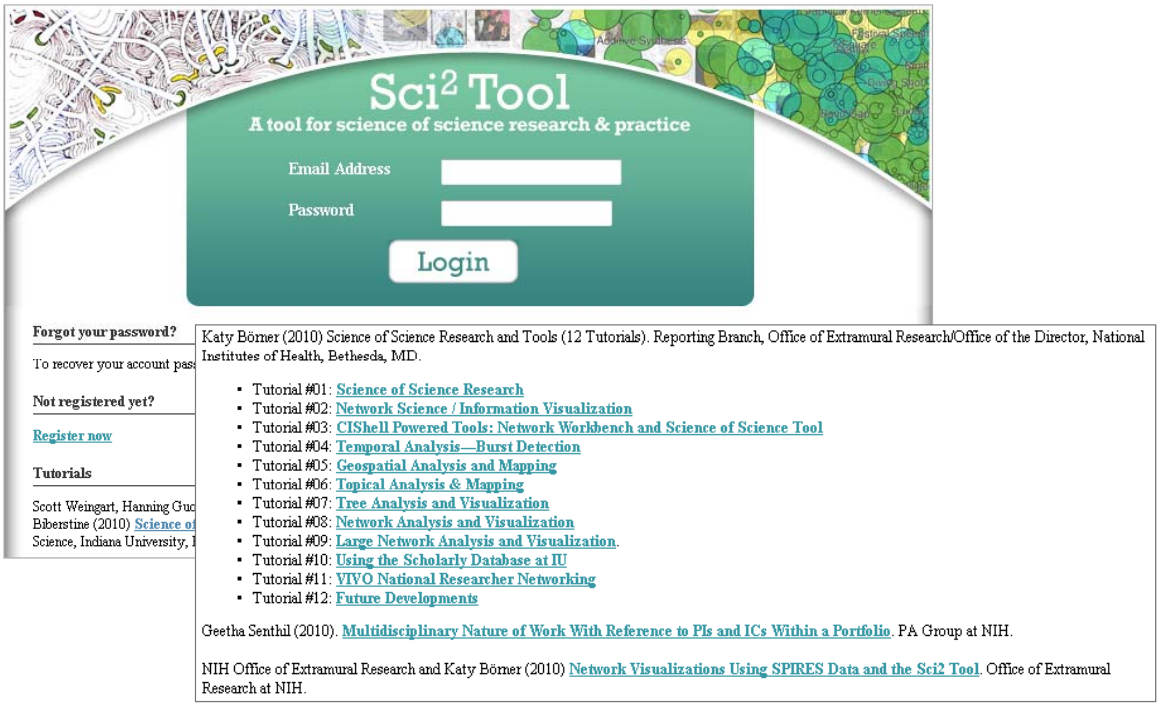
The Network Workbench (NWB) tool supports researchers, educators, and practitioners interested in the study of biomedical, social and behavioral science, physics, and other networks.

In Aug. 2009, the tool provides more 160 plugins that support the preprocessing, analysis, modeling, and visualization of networks.

It has been downloaded more than 60,000 times since October 2006.

Herr II, Bruce W., Huang, Weixia (Bonnie), Penumarthy, Shashikant & Börner, Katy. (2007). Designing Highly Flexible and Usable Cyberinfrastructures for Convergence. In Bainbridge, William S. & Roco, Mihail C. (Eds.), Progress in Convergence - Technologies for Human Wellbeing (Vol. 1093, pp. 161-179), Annals of the New York Academy of Sciences, Boston, MA.

Sci² Tool for Science of Science Research and Practice (http://sci.slis.indiana.edu/sci2)



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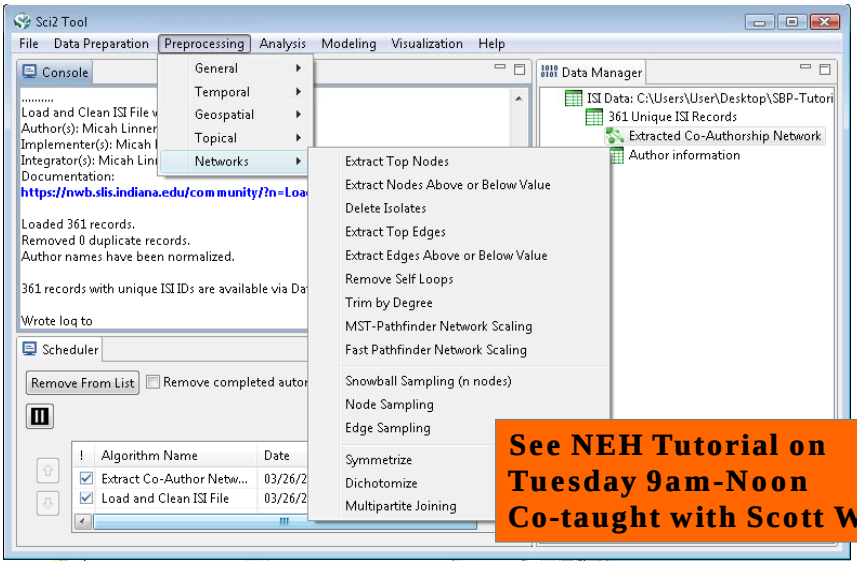

See NEH Tutorial on Tuesday 9am-Noon Co-taught with Scott Weingart

Acknowledgments

This work is supported in part by the Cyberinfrastructure for Network Science center and the School of Library and Information Science at Indiana University, the National Science Foundation under Grant No. SBE-0738111 and IIS-0513650, and the James S. McDonnell Foundation.

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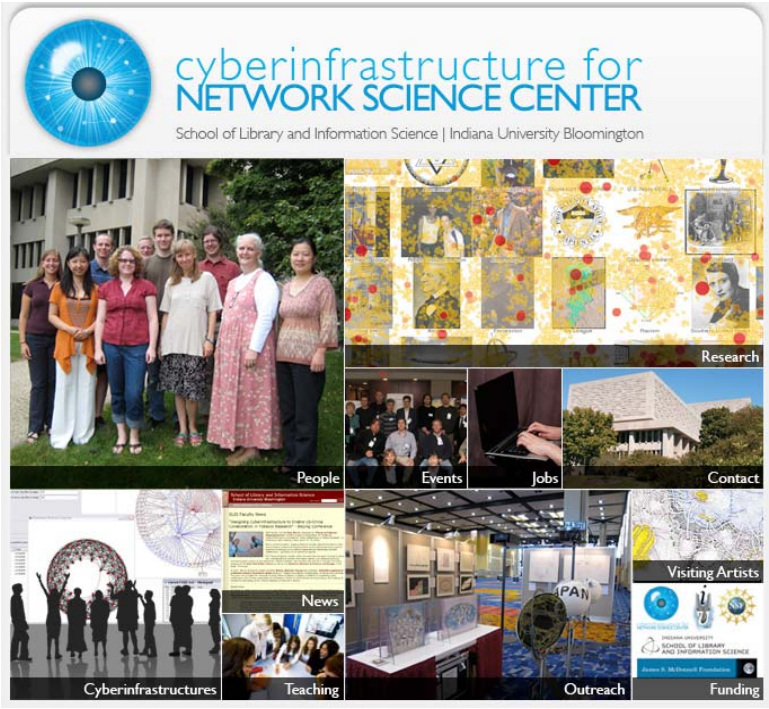

All papers, maps, cyberinfrastructures, talks, press are linked from http://cns.slis.indiana.edu