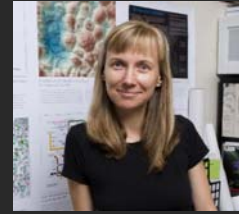


Computational Scientometrics

Studying Science by Scientific Means

Dr. 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



Science of Science Management Meeting
 NIH Office of Portfolio Analysis and Strategic Initiatives (OPASI)
 National Institutes of Health, Bethesda, MD
 October 2 & 3, 2008



“Features that distinguish science from pseudoscience are repeatability, economy, menuration, heuristics, and consilience.”
E. O. Wilson in Consilience: The Unity of Knowledge (1998)

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

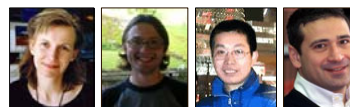
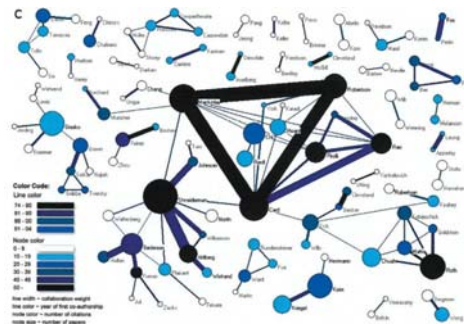
Börner, Dall'Asta, Ke & Vespignani (2005) *Complexity*, 10(4):58-67.

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.



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

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.*

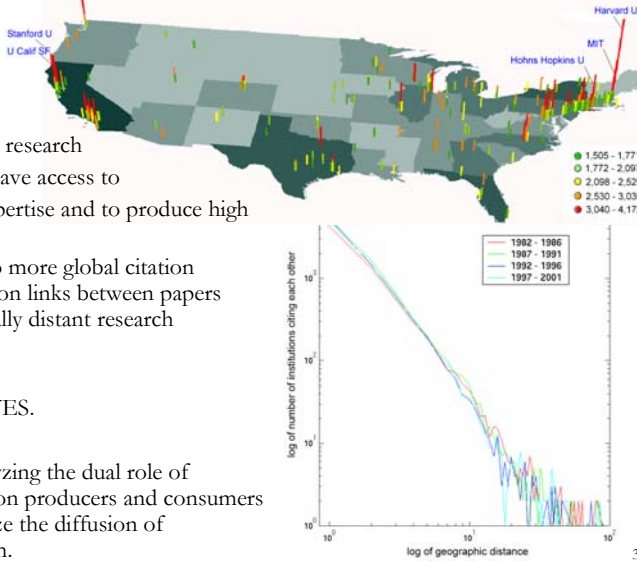


Research questions:

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 institutions?

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.



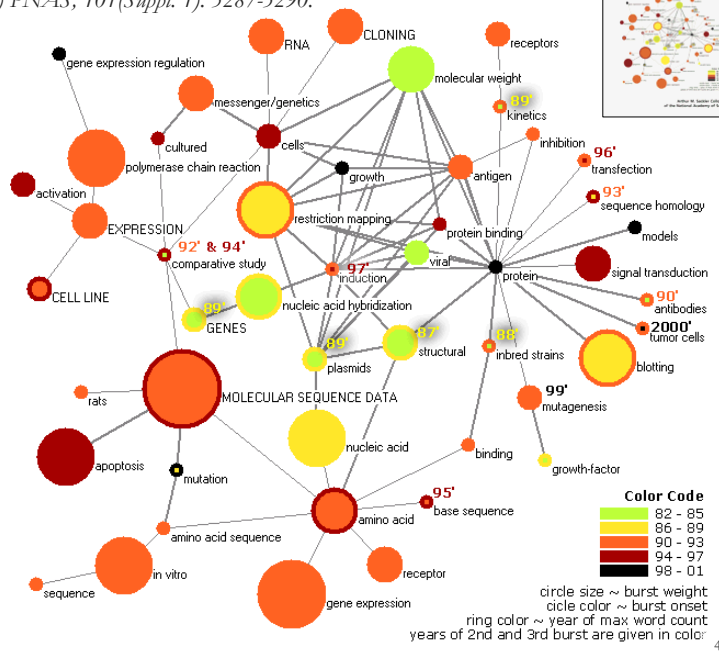
Mapping Topic Bursts

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

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.

Insight gained:

Most bursts occur before words experience wide-spread usage.



Mapping Science Exhibit – 10 Iterations in 10 years

<http://scimaps.org/>



The Power of Maps (2005)



The Power of Reference Systems (2006)



The Power of Forecasts (2007)



Science Maps for Economic Decision Makers (2008)



Science Maps for Science Policy Makers (2009)

Science Maps for Scholars (2010)

Science Maps as Visual Interfaces to Digital Libraries (2011)

Science Maps for Kids (2012)

Science Forecasts (2013)

How to Lie with Science Maps (2014)

Exhibit has been shown in 49 venues on four continents. Also at
 - NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA.
 - National Research Council in Ottawa, Canada, April 3-Aug. 29, 2008.
 - Chinese Academy of Sciences, China, May 17-Nov. 15, 2008.



Illuminated Diagram Display

W. Bradford Paley, Kevin W. Boyack, Richard Kalvas, and Katy Börner (2007)
Mapping, Illuminating, and Interacting with Science. SIGGRAPH 2007.

Questions:

- Who is doing research on what topic and where?
- What is the 'footprint' of interdisciplinary research fields?
- What impact have scientists?

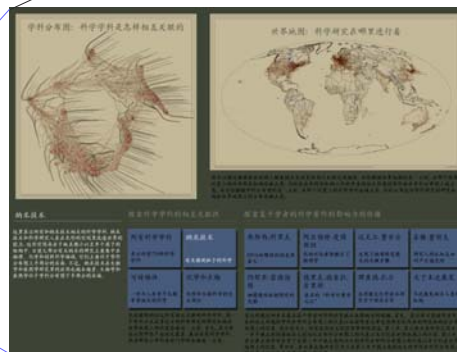
Contributions:

- Interactive, high resolution interface to access and make sense of data about scholarly activity.




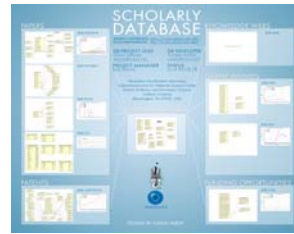
Large-scale, high resolution prints illuminated via projector or screen.

Interactive touch panel.




Cyberinfrastructures for a Science of Science

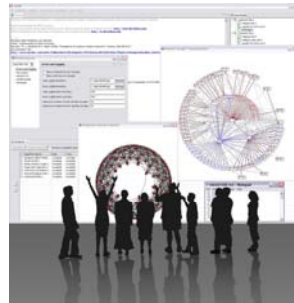
 Scholarly Database of 18 million scholarly records
<https://sdb.slis.indiana.edu>



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

 Network Workbench Tool and Community Wiki
***NEW* Scientometrics plugins**
<http://nwb.slis.indiana.edu>

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



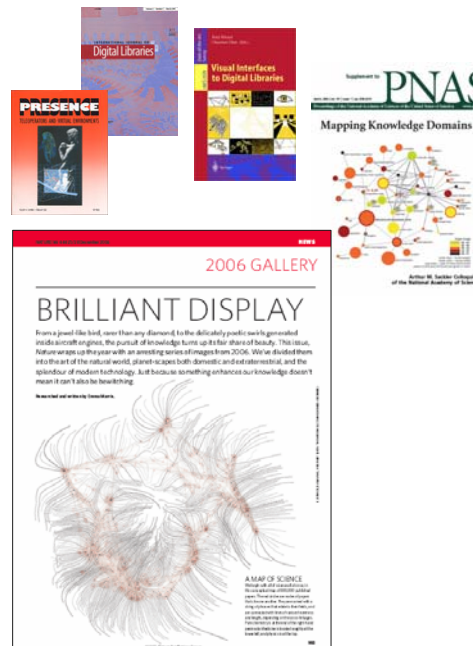
7

Relevant References

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>



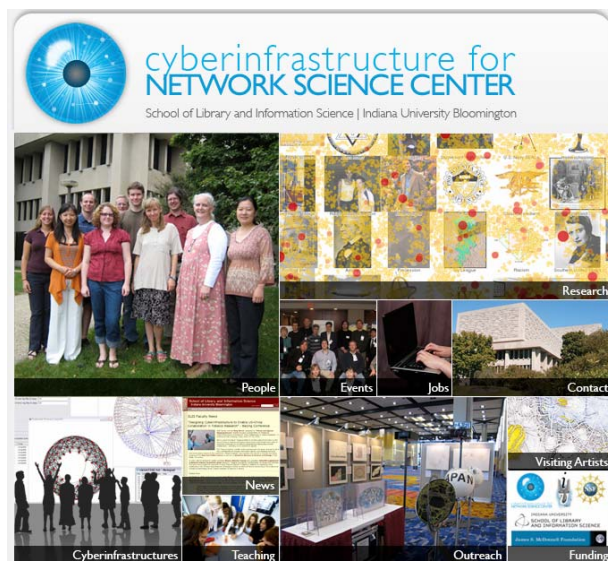
8

Science of Science Studies Challenges

- (Different) user groups and their needs and priorities have to be identified.
- Major terms, e.g., 'impact' or 'interdisciplinary', need to be defined and operationalized.
- (Standard) datasets have to be federated and made available so that science of science studies can be replicated.
- A common science of science cyberinfrastructure is desirable.
- There is a need for well documented case studies and evaluation.
- Major results, good practices, and new datasets/tools have to be communicated widely.

Note that

- Science of science studies can augment but not replace human judgment.
- Incomplete, low coverage data typically leads to low quality results.
- Studies performed using proprietary tools and/or proprietary data are hard to replicate.



Papers, maps, cyberinfrastructures, talks, press are linked from <http://cns.slis.indiana.edu>