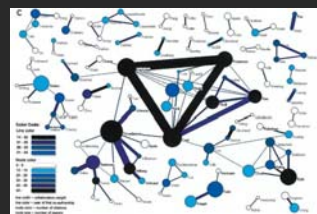


# Types and Levels of Team (Network) Analysis

**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](mailto:katy@indiana.edu)



*Network Perspectives of Teams Panel  
 April 22, 2010*



## Type of Analysis vs. Level of Analysis

	<i>Micro/Individual</i> (1-100 records)	<i>Meso/Local</i> (101-10,000 records)	<i>Macro/Global</i> (10,000 < records)
<i>Statistical Analysis/Profiling</i>	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
<i>Temporal Analysis (When)</i>	Funding portfolio of one individual	Mapping topic bursts in 20-years of PNAS	113 Years of Physics Research
<i>Geospatial Analysis (Where)</i>	Career trajectory of one individual	Mapping a states intellectual landscape	PNAS Publications
<i>Topical Analysis (What)</i>	Base knowledge from which one grant draws.	Knowledge flows in Chemistry research	VxOrd/Topic maps of NIH funding
<i>Network Analysis (With Whom?)</i>	NSF Co-PI network of one individual	Co-author network	NSF's core competency



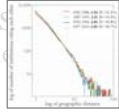
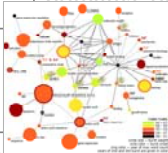








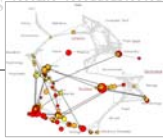
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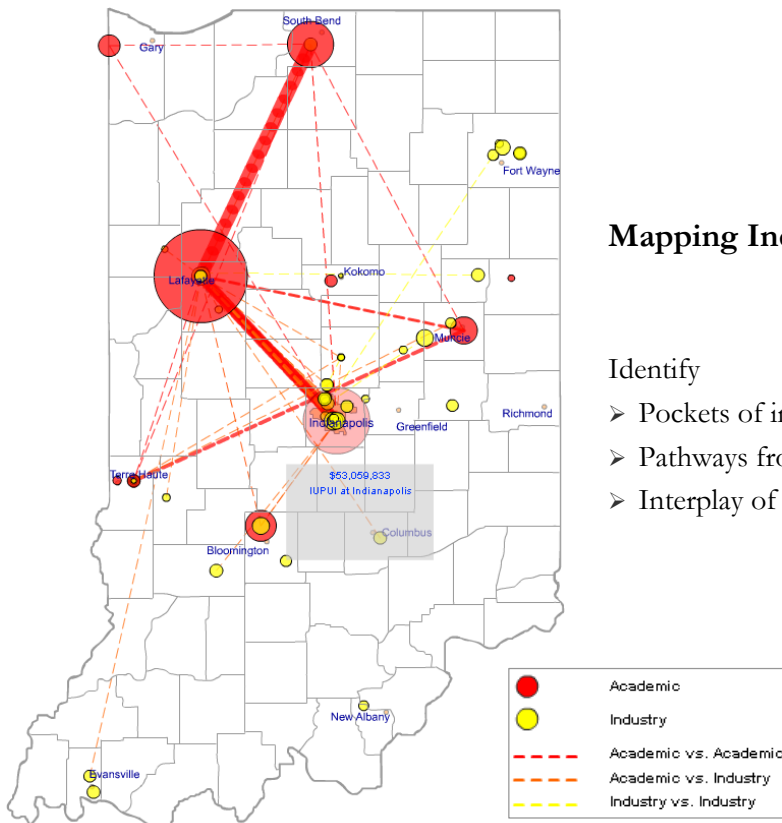
4



## Type of Analysis vs. Level of Analysis

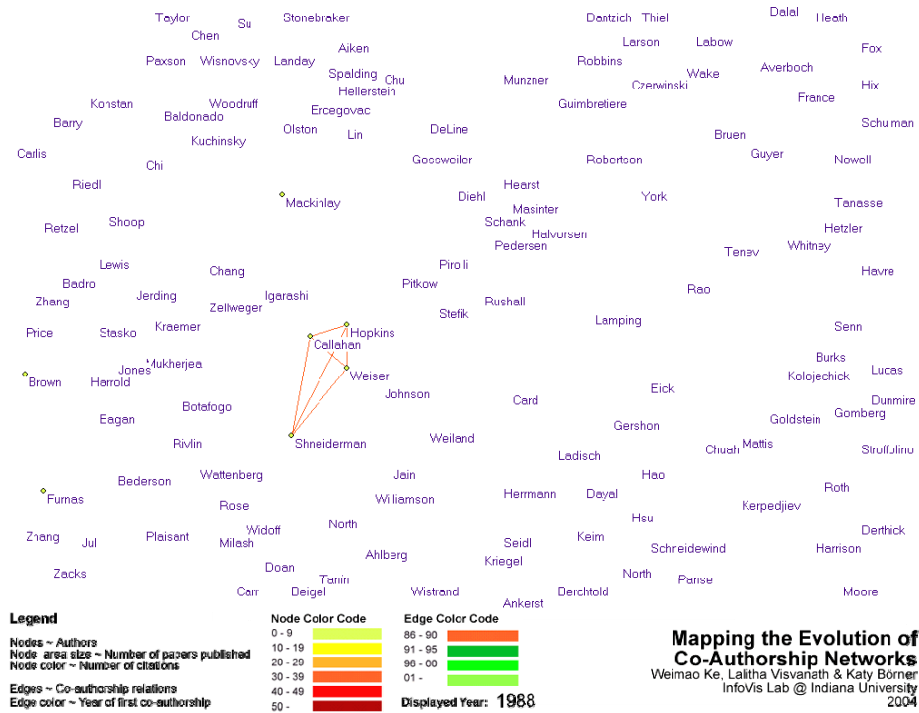
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5



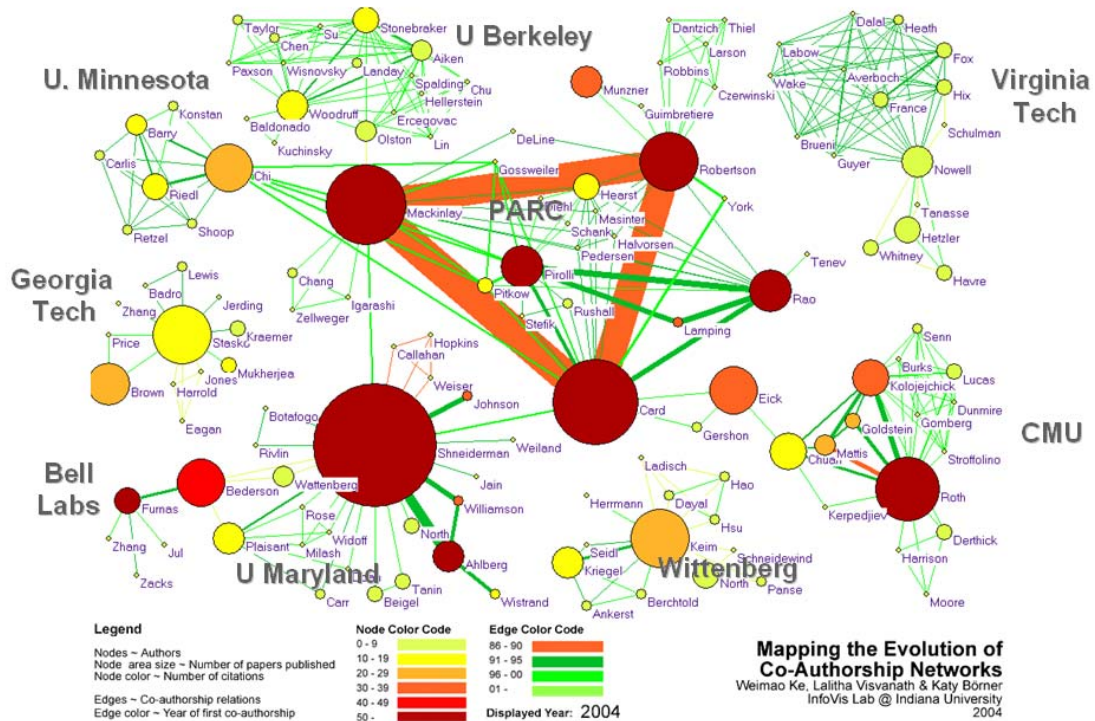
# Mapping the Evolution of Co-Authorship Networks

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



# Mapping the Evolution of Co-Authorship Networks

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



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

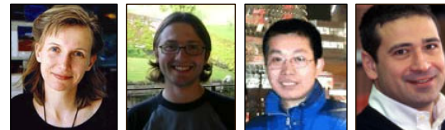
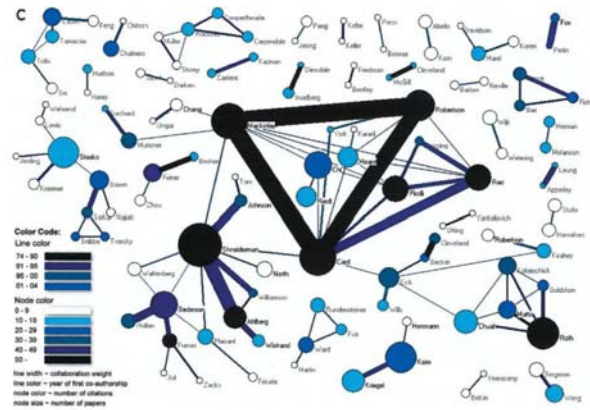
Börner, Dall'Asta, Ke & Vespignani (2005) *Complexity*, 10(4):58-67.

## 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.

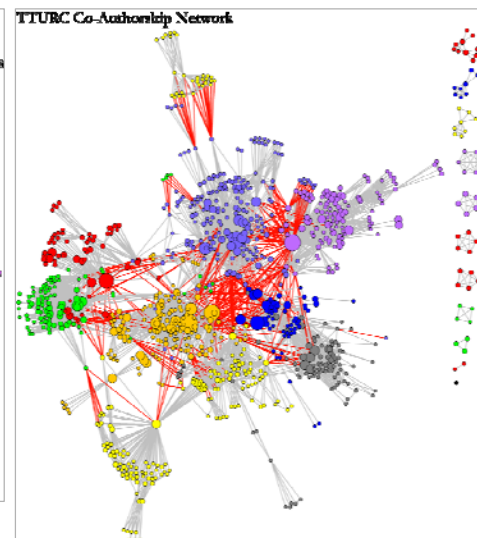
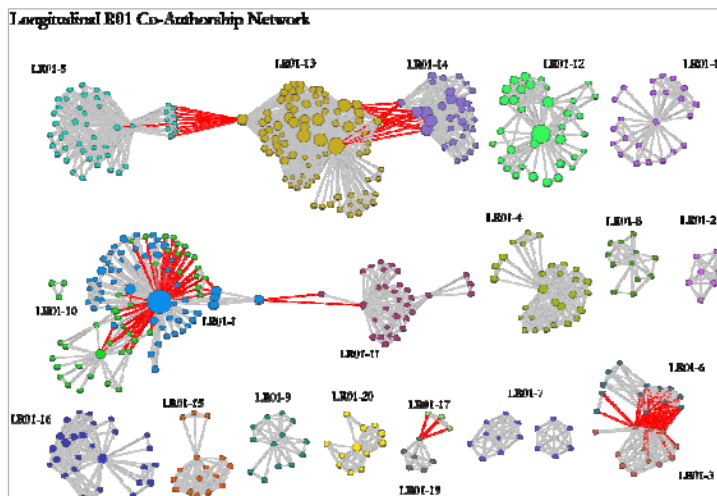
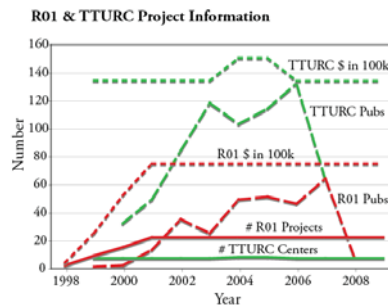


9

# Mapping Transdisciplinary Tobacco Use Research Centers Publications

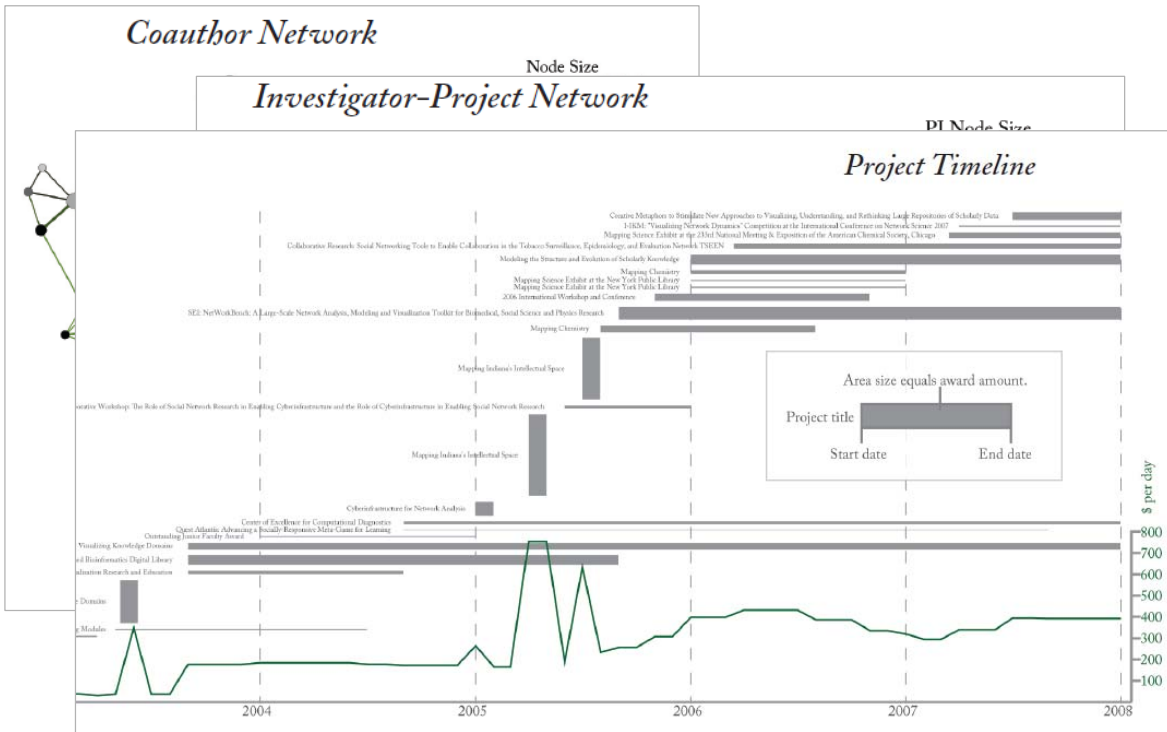
Compare R01 investigator based funding with TTURC Center awards in terms of number of publications and evolving co-author networks.

Zoss & Börner, *forthcoming*.



# Representing, Analyzing, and Visualizing Scholarly Data in Support of Research Management (<http://ivl.slis.indiana.edu>)

Thomas Neiryck and Katy Börner (2007)



## Type of Analysis vs. Level of Analysis

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# MAPS OF SCIENCE

A visualization of 7.2 million scholarly documents

**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.

**Forecasting Large Trends in Science**

Calculations were performed using the large subject groupings of disciplines. Statistics to determine if any of these were likely to show large-scale change in the placement of science over time. Correlation coefficients between fields were calculated for each individual year, 2001–2005. A linear regression analysis was conducted for each year to determine if there were significant changes in these correlation coefficients from year to year.

If the structure of science shifted before or during overall stability, we would expect some features between one grouping back to several, and connections between Richard Feynman to describe the world the opposite, suggesting that the underlying structure is unstable and likely to change dramatically over the next decade.

Key clusters representing how the structure is likely to change are provided below. Maps with white nodes represent categories of research that are not likely to be in the center of science in the next decade. The fields that have many of science will show changes in their connections to these categories. Nodes will become lighter while the physical sciences will lighten and move closer to the middle field.

Richard Klavans and Kevin Boyack. 2007. Maps of Science: Forecasting 13

## MAPS OF SCIENCE

Overview
Detail
Disciplinary Maps
Competency Maps
Paradigm Maps
Posters

**Institutional Strategy:**  
NIH

**View all**

- National Institute of General Med Science
- National Institute of Allergy & Inf Disease
- Nat. Cancer Institute
- Nat. Heart, Lung & Blood Institute
- Nat. Inst Diabetes, Dig & Kidney Disease
- Nat. Inst of Neuro Disorders & Stroke

**The following color coding is used for the disciplinary map:**

<span style="color: purple;">■</span> Math & Physics	<span style="color: green;">■</span> Biotechnology	<span style="color: red;">■</span> Medical Specialties	<input type="checkbox"/> Humanities
<span style="color: blue;">■</span> Chemistry	<span style="color: brown;">■</span> Earth Sciences	<span style="color: orange;">■</span> Brain Research	
<span style="color: magenta;">■</span> Computer Science & EE	<span style="color: darkgreen;">■</span> Biology	<span style="color: pink;">■</span> Health Professionals	
<span style="color: cyan;">■</span> Other Engineering	<span style="color: darkred;">■</span> Infectious Diseases	<span style="color: yellow;">■</span> Social Sciences	

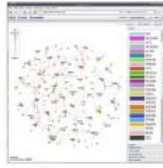
<http://mapofscience.com>

# A Topic Map of NIH Grants 2007

ChalkLabs UCI IRVINE

Bruce W. Herr II (ChalkLabs & IU), Gully Burns (ISU), David Newman (UCI), Edmund Talley (NIH)

The National Institutes of Health (NIH) is organized as a multitude of institutes and Centers whose missions are primarily focused on distinct diseases. However, disease etiologies and therapies flout scientific boundaries, and thus there is tremendous overlap in the kinds of research funded by each Institute. This creates a daunting landscape for decisions on research directions, funding allocations, and policy formulations. Shown here is developed an interactive topic map for navigating this landscape, online at [www.scimaps.org](http://www.scimaps.org). Institute abbreviations can be found at [www.nih.gov/niht](http://www.nih.gov/niht).



Topic modeling, a statistical technique that automatically learns semantic categories, was applied to assess projects in terms used by researchers to describe their work, without the biases of keywords or subject headings. Grant similarities were derived from their topic mixtures, and grants were then clustered on a two-dimensional map using a force-directed simulated annealing algorithm. This analysis creates an interactive environment for assessing grant relevance to research categories and to NIH Institutes in which grants are localized.



## National Cancer Institute (NCI)

### TOP 10 TOPICS

- 1. Drug-Target Interactions
- 2. Cancer Treatment
- 3. Cancer Therapy
- 4. Carcinogenesis
- 5. Risk Factor Analysis
- 6. Cancer Chemoprevention
- 7. Metastasis
- 8. Inhibitors
- 9. Predictive Progression
- 10. Cancer Chemoprevention

## National Institute of General Medical Sciences (NIGMS)

### TOP 10 TOPICS

- 1. Bioactive Organic Synthesis
- 2. Enzyme Cofactor Synthesis
- 3. Protein PPM
- 4. Computational Models
- 5. Host Biology
- 6. Metaproteomics
- 7. Proteomic Workflows
- 8. Protein Complexes
- 9. Microbiology/Debris/Genetics
- 10. Cell Division

## National Heart, Lung, and Blood Institute (NHLBI)

### TOP 10 TOPICS

- 1. Cardiac Failure
- 2. Arteriosclerosis
- 3. Genetic Linkage Analysis
- 4. Cardiovascular Disease
- 5. Atherosclerosis
- 6. Hypertension
- 7. Blood Pressure
- 8. Arteriosclerosis/Artery Disease
- 9. Gene Association
- 10. Angiogenesis

## National Institute of Mental Health (NIMH)

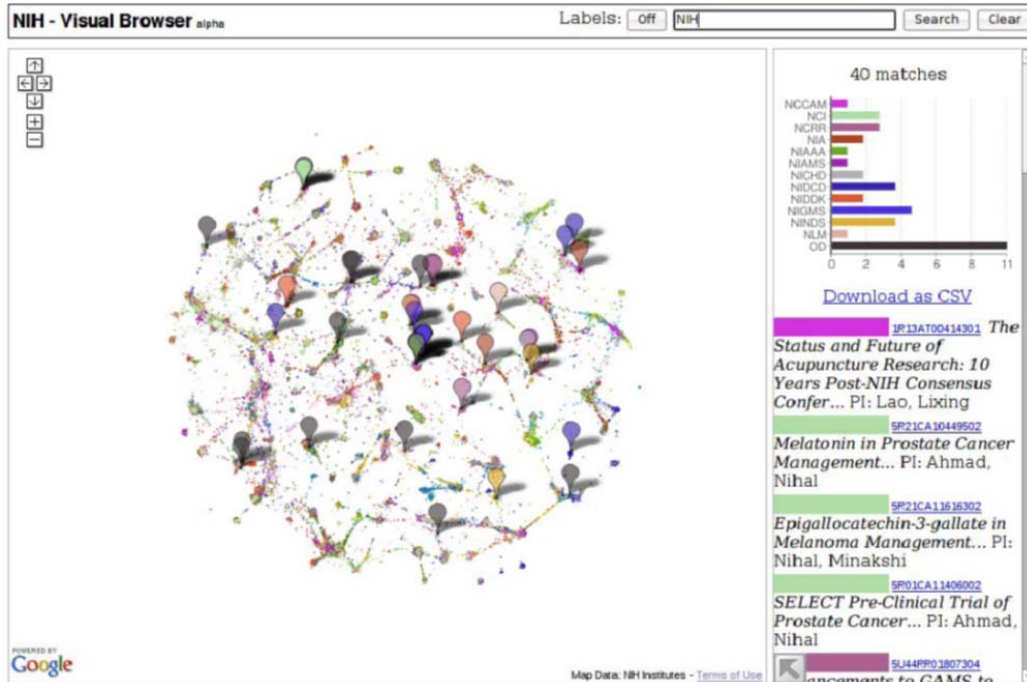
### TOP 10 TOPICS

- 1. Mood Disorders
- 2. Schizophrenia
- 3. Behavioral Neuroscience Studies
- 4. Mental Health
- 5. Depression
- 6. Cognitive Behavioral Therapy
- 7. PTSD/Posttrauma
- 8. Genetic Linkage Analysis
- 9. Addictions
- 10. Childhood

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).

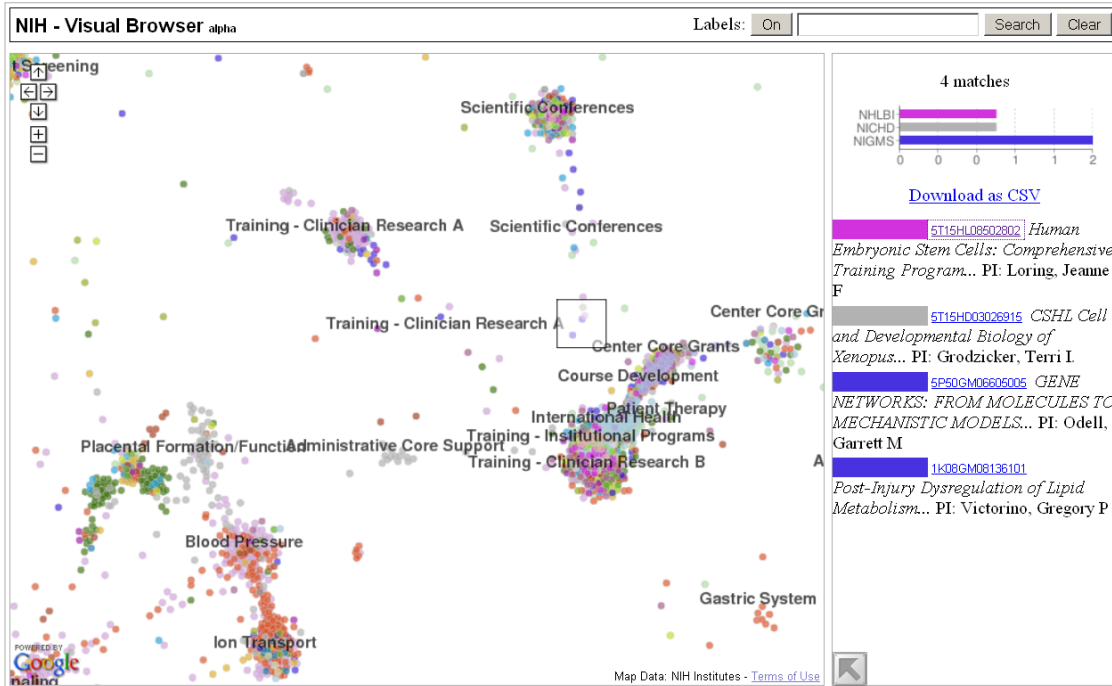


<http://scimaps.org/maps/nih/2007>



## Interactive Maps of Science – NIH Funding

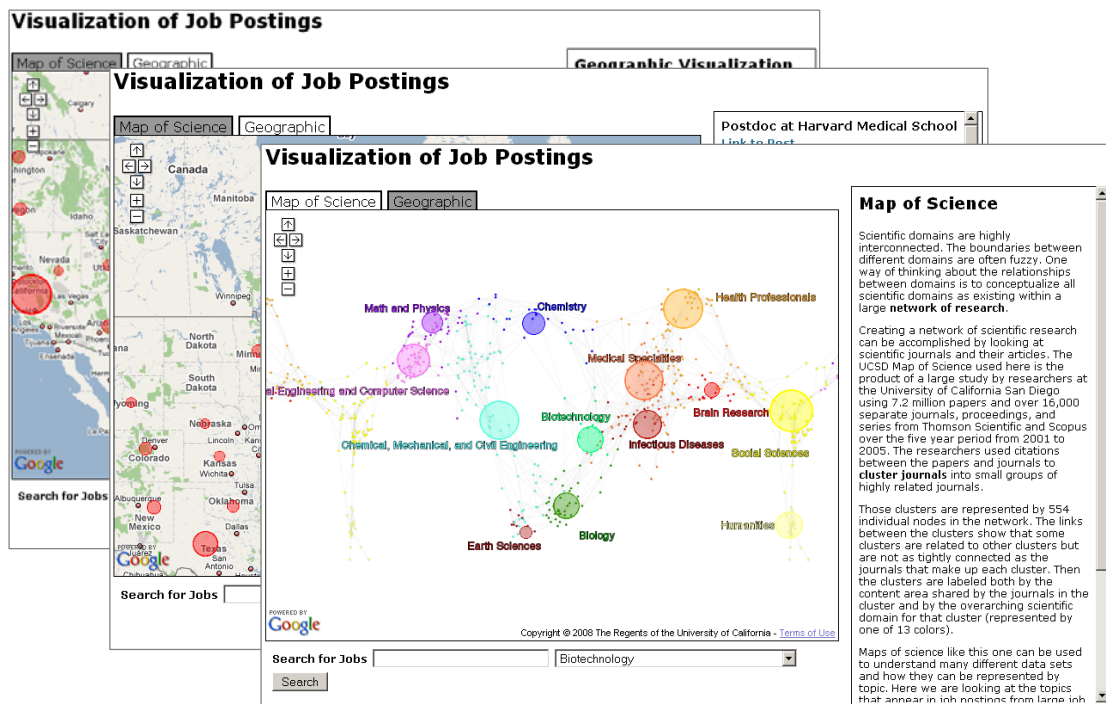
Google maps with charts and tables



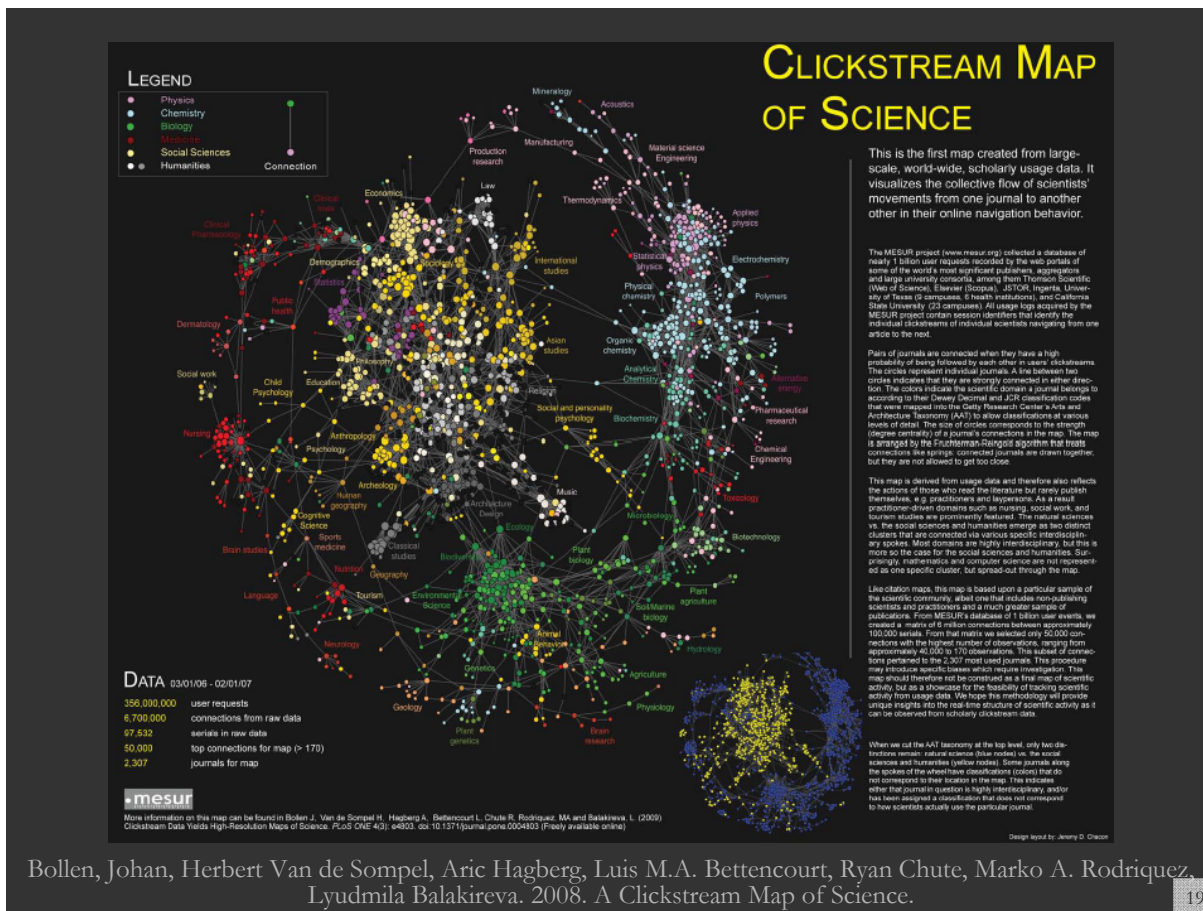
<http://scimaps.org/maps/nih/2007>

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

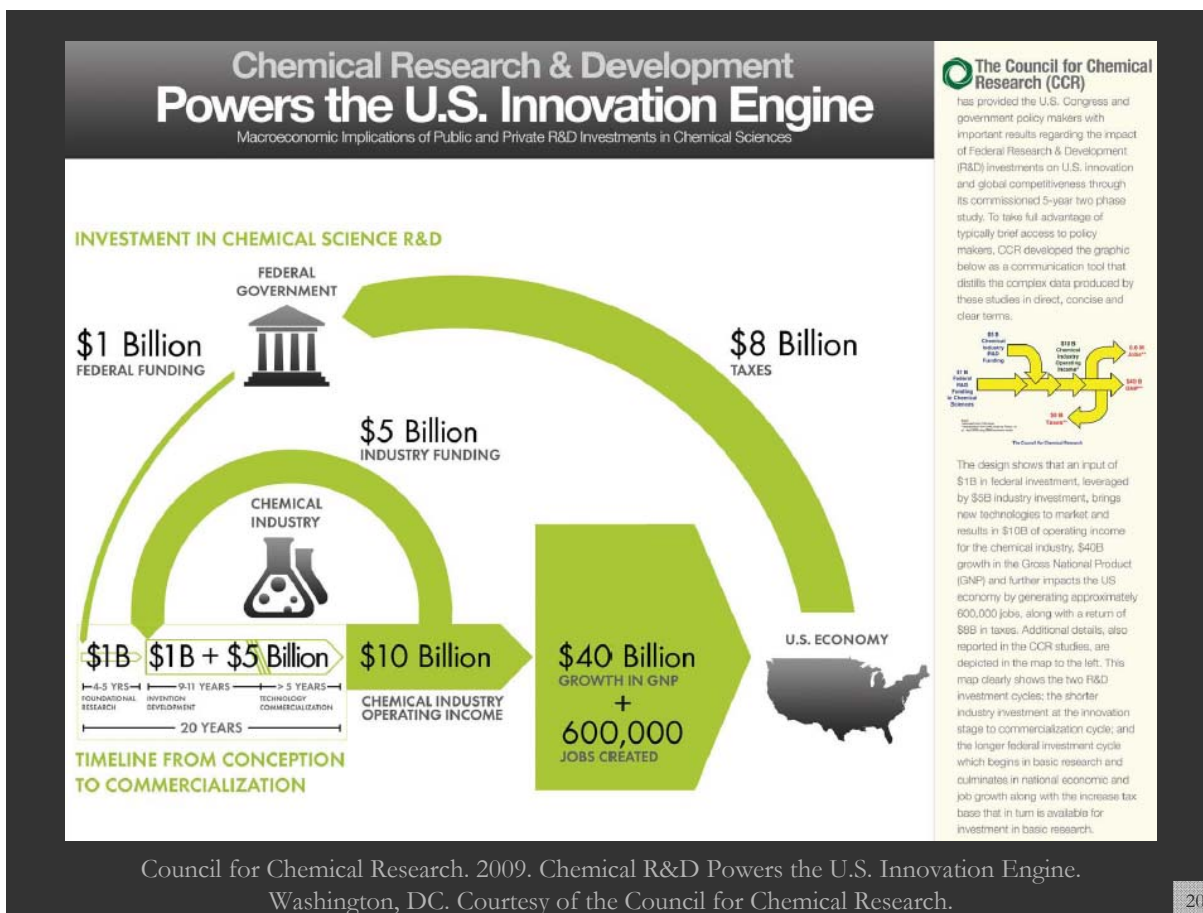
Angela Zoss, Michael Conover, Katy Börner (2010)



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



Bollen, Johan, Herbert Van de Sompel, Aric Hagberg, Luis M.A. Bettencourt, Ryan Chute, Marko A. Rodriguez, Lyudmila Balakireva. 2008. A Clickstream Map of Science. 19

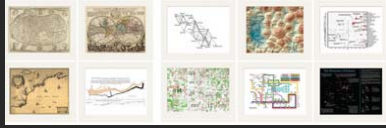


Council for Chemical Research. 2009. Chemical R&D Powers the U.S. Innovation Engine. Washington, DC. Courtesy of the Council for Chemical Research. 20

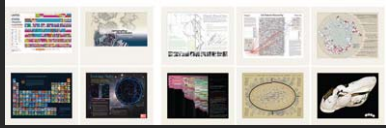
# Mapping Science Exhibit – 10 Iterations in 10 years

<http://scimaps.org/>

## The Power of Maps (2005)



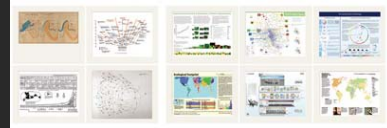
## The Power of Reference Systems (2006)



## 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 72 venues on four continents. Currently at  
 - NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA  
 - Marston Science Library, University of Florida, Gainesville, FL  
 - Center of Advanced European Studies and Research, Bonn, Germany  
 - Science Train, Germany.

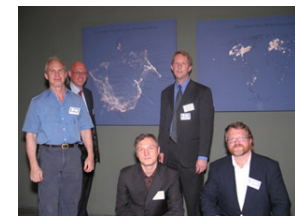


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## Illuminated Diagram Display

W. Bradford Paley, Kevin W. Boyack, Richard Kalvans, 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?

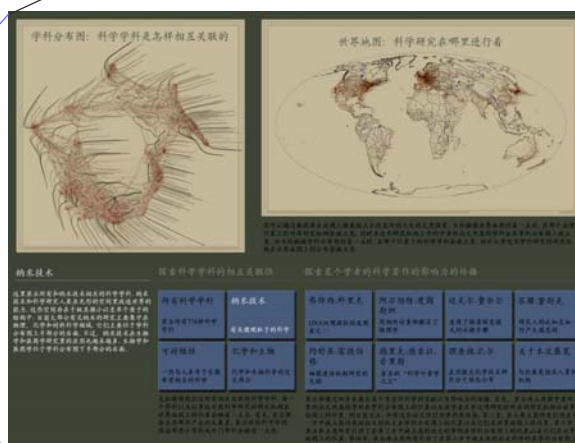


Large-scale, high resolution prints illuminated via projector or screen.

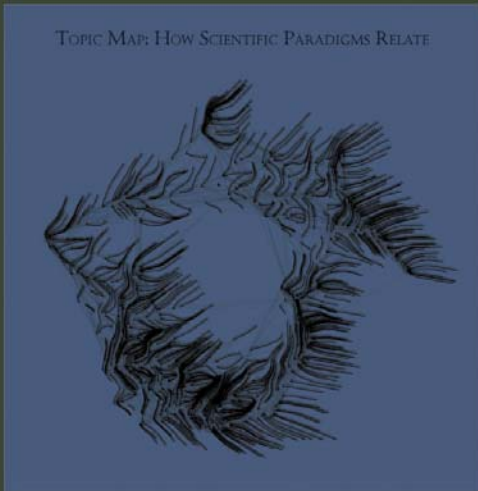
Interactive touch panel.

### Contributions:

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



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You may run your finger over each of these maps to control the lighting on the other: touching a place on the world map will light up topics studied in that place; touching a paradigm on the topic map will light up the places that study that topic.

### Nanotechnology

This overlay shows the distribution of nanotechnology within the paradigms of science. The majority of current work in nanotechnology takes place in physics, chemistry, and materials science, at the upper right portion of the map. However, an increasing amount of nanotechnology is being applied in the biological and medical sciences, at the lower right.

<b>All Topics</b> <i>Sweep through all 776 scientific paradigms</i>	<b>Nanotechnology</b> <i>Science on the tiny scale of molecules</i>	<b>Francis H. C. CRICK</b> <i>Co-discovered DNA's double helix</i>	<b>Albert EINSTEIN</b> <i>Revitalized physics with Relativity theories</i>	<b>Michael E. FISHER</b> <i>Models critical phase transitions of matter</i>	<b>Susan T. FISKE</b> <i>Connects perception and stereotypes</i>
<b>Sustainability</b> <i>The science behind our long-term hopes</i>	<b>Biology &amp; Chemistry</b> <i>The interface between these two vital fields</i>	<b>Joshua LEDERBERG</b> <i>Pioneer in bacterial genetic mechanisms</i>	<b>Derek J. de Solla PRICE</b> <i>Known as the "Father of Scientometrics"</i>	<b>Richard N. ZARE</b> <i>Uses laser chemistry in molecular dynamics</i>	<b>About this display</b> <i>People &amp; organizations that helped create it</i>

We sweep slowly through adjoining related topics, lighting up the places in the world that study each topic. You may select a subset of the topics that deal with these three interesting subjects by touching it.

A single person's spreading influence is shown as a series of four snapshots. First, we light only topics and places relating to that person's papers—papers that are still highly cited today. The second lights everything that cites that original work. Note that this first-generation impact extends to far more topics than did the original work. The third snapshot lights science that cites the second; and the fourth lights science that cites the third.



Debut of 5<sup>th</sup> Iteration of Mapping Science Exhibit at MEDIA X was on May 18, 2009 at Wallenberg Hall, Stanford University, <http://mediax.stanford.edu>, <http://scaleindependentthought.typepad.com/photos/scimaps>



Science Maps in "Expedition Zukunft" science train visiting 62 cities in 7 months  
12 coaches, 300 m long  
Opening was on April 23<sup>rd</sup>, 2009 by German Chancellor Merkel  
<http://www.expedition-zukunft.de>



This is the only mockup in this slide show.

Everything else is available today.



## CI for a Science of Science Studies



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



VIVO Research Networking  
<http://vivoweb.org>



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



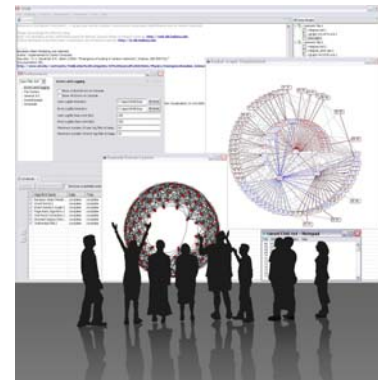
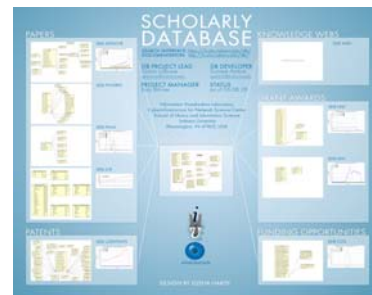
Network Workbench Tool + Community Wiki  
<http://nwb.slis.indiana.edu>



Sci<sup>2</sup> Tool and Science of Science CI Portal  
<http://sci.slis.indiana.edu>



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



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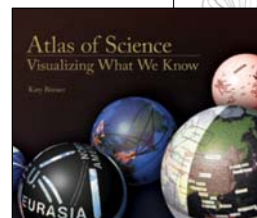
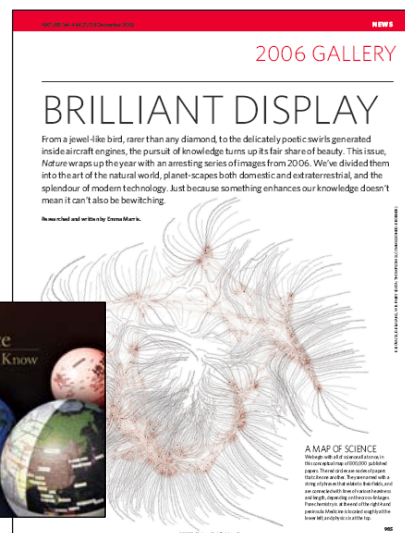
## Computational Scientometrics References

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/](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>



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