Envisioning Knowledge (and Expertise)

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With special thanks to the members at the Cyberinfrastructure for Network Science Center, Mapping Science exhibit map makers and advisory board members, and the VIVO team.

June 22, 2010

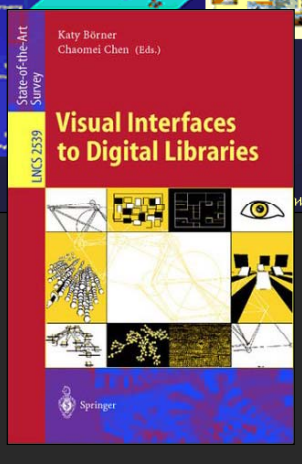
JOINT JCDL/ICADL
INTERNATIONAL DIGITAL LIBRARIES CONFERENCE

JCDL Workshop 2001

Visual Interfaces to Digital Libraries - Its Past, Present, and Future

Workshop Organizers:
K. Borner, Indiana University, US & C. Chen,

Program Committee:
A. Blandford, K. Boyack, M. Dodge, X. Lin, J. Ma



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http://vw.indiana.edu/visual02

TRINITY COLLEGE LIBRARY DUBLIN

REAL GABINETE PORTUGUES DE LEITURA RIO DE JANEIRO

STIFTSBIBLIOTHEK ST. GALLEN

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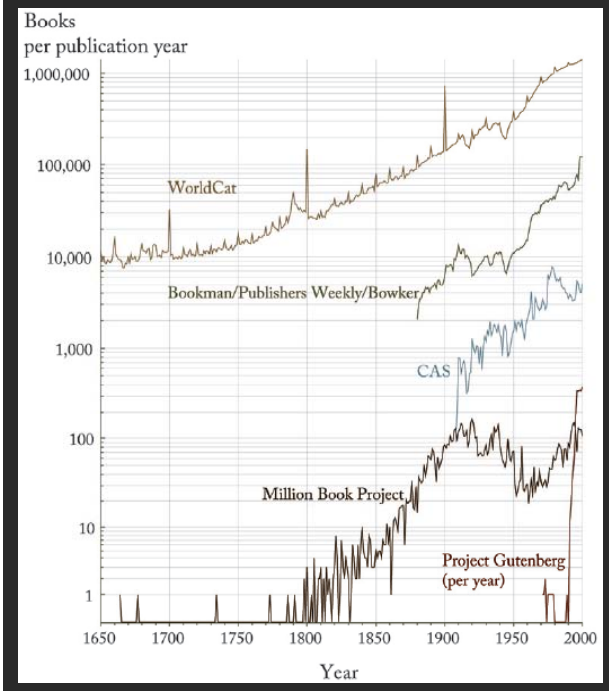
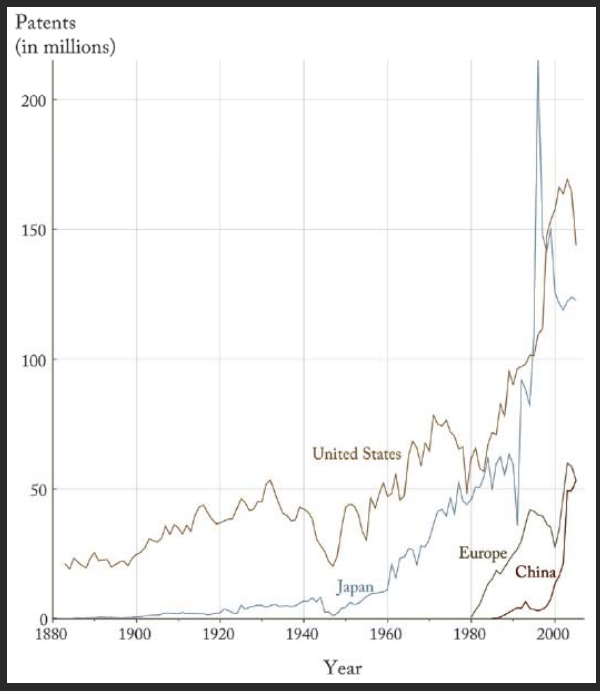
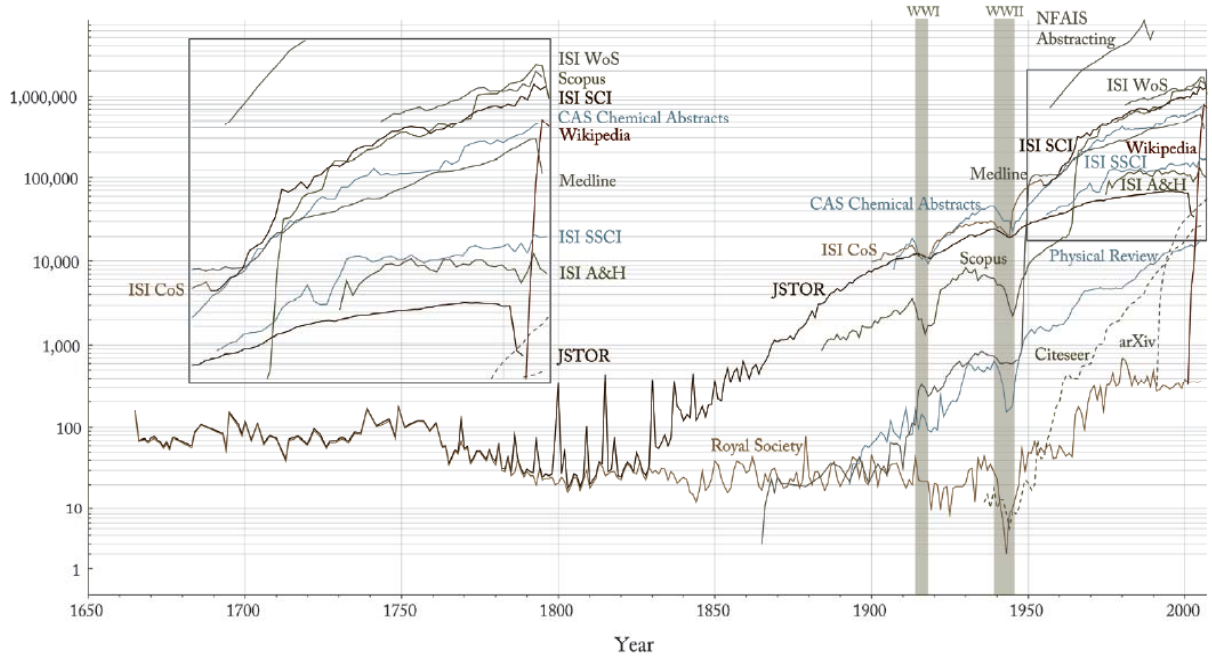




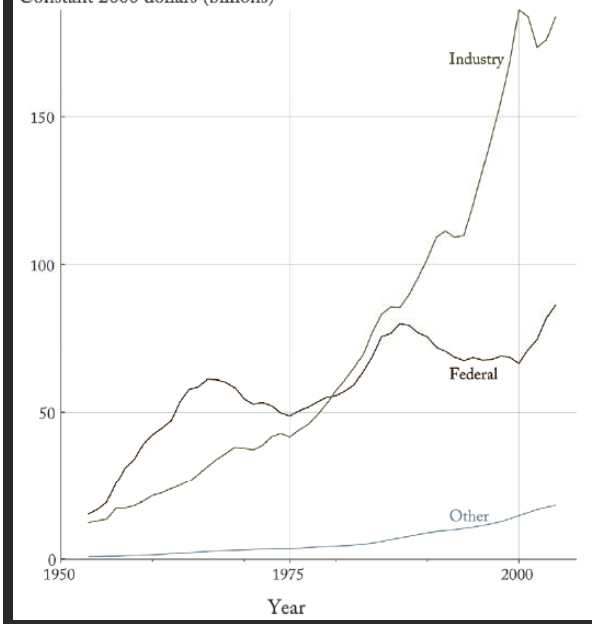
Börner, Katy (2010) Atlas of Science. MIT Press. http://scimaps.org/atlas

Papers & Wikipedia Entries

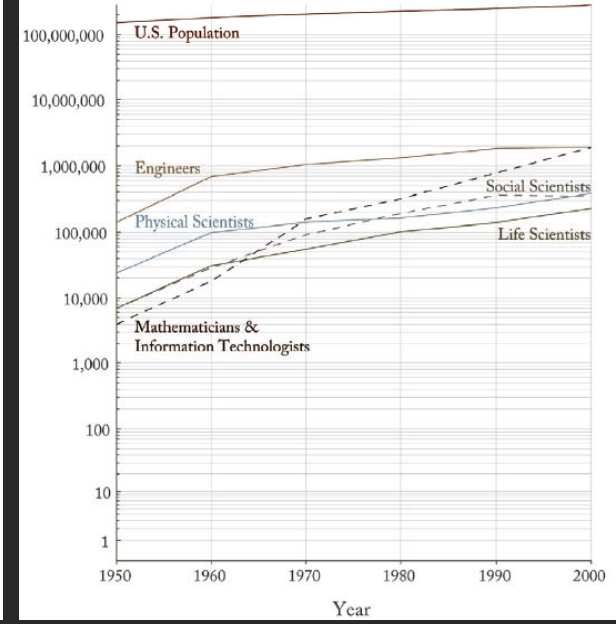


Börner, Katy (2010) Atlas of Science. MIT Press. http://scimaps.org/atlas

U.S. R&D Expenditures
Constant 2000 dollars (billions)



People



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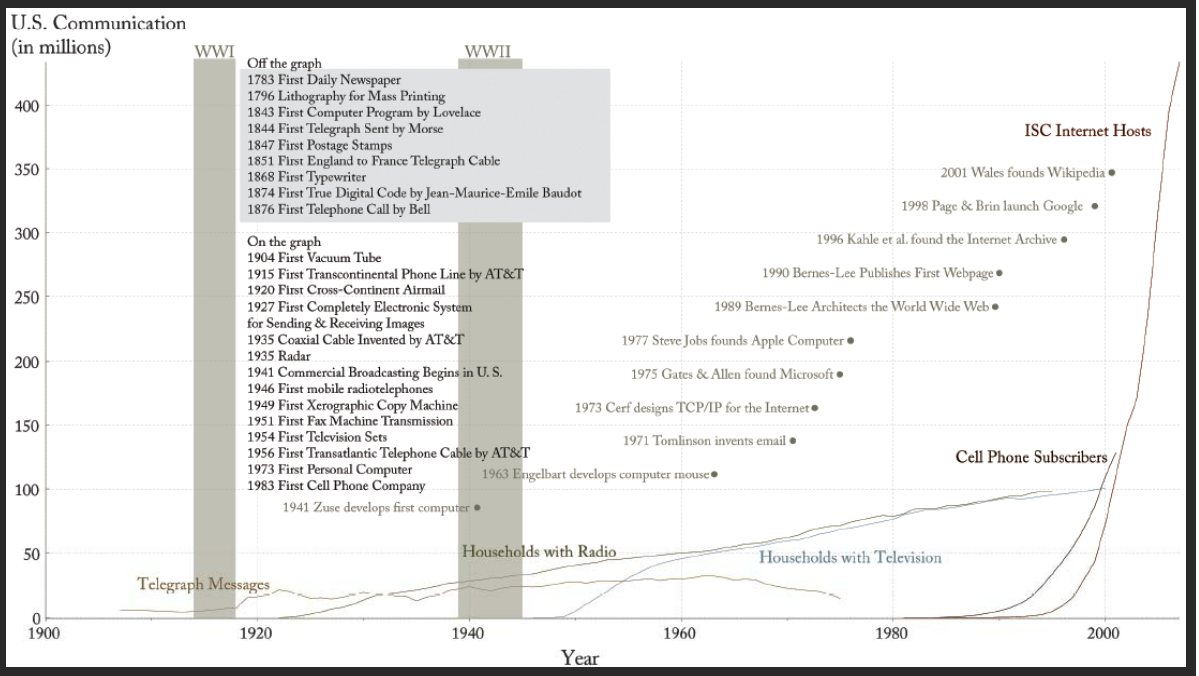
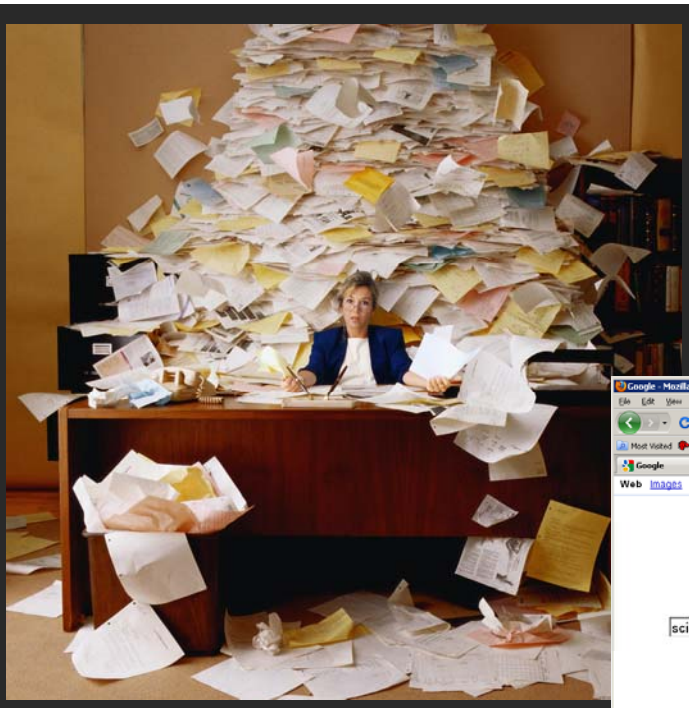
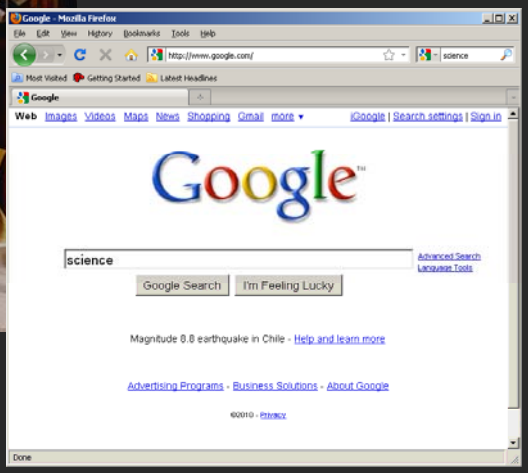
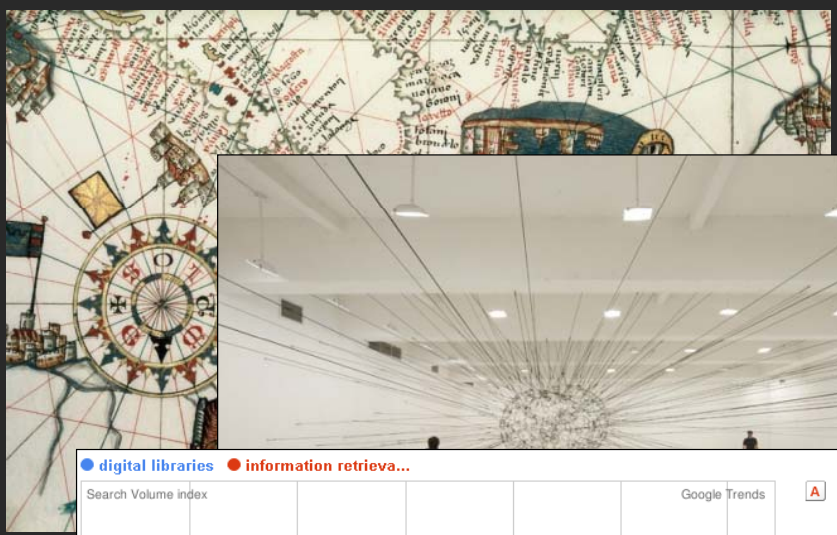


Börner, Katy (2010) Atlas of Science. MIT Press. http://scimaps.org/atlas

By Ludwig Gatzke. Uploaded to Flickr in January 2006
http://www.flickr.com/photos/stabilo-boss/93136022







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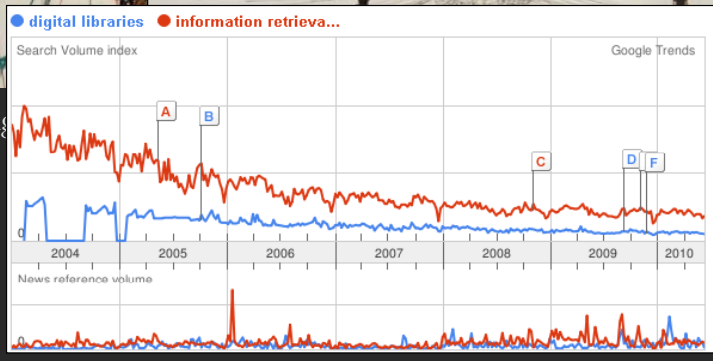


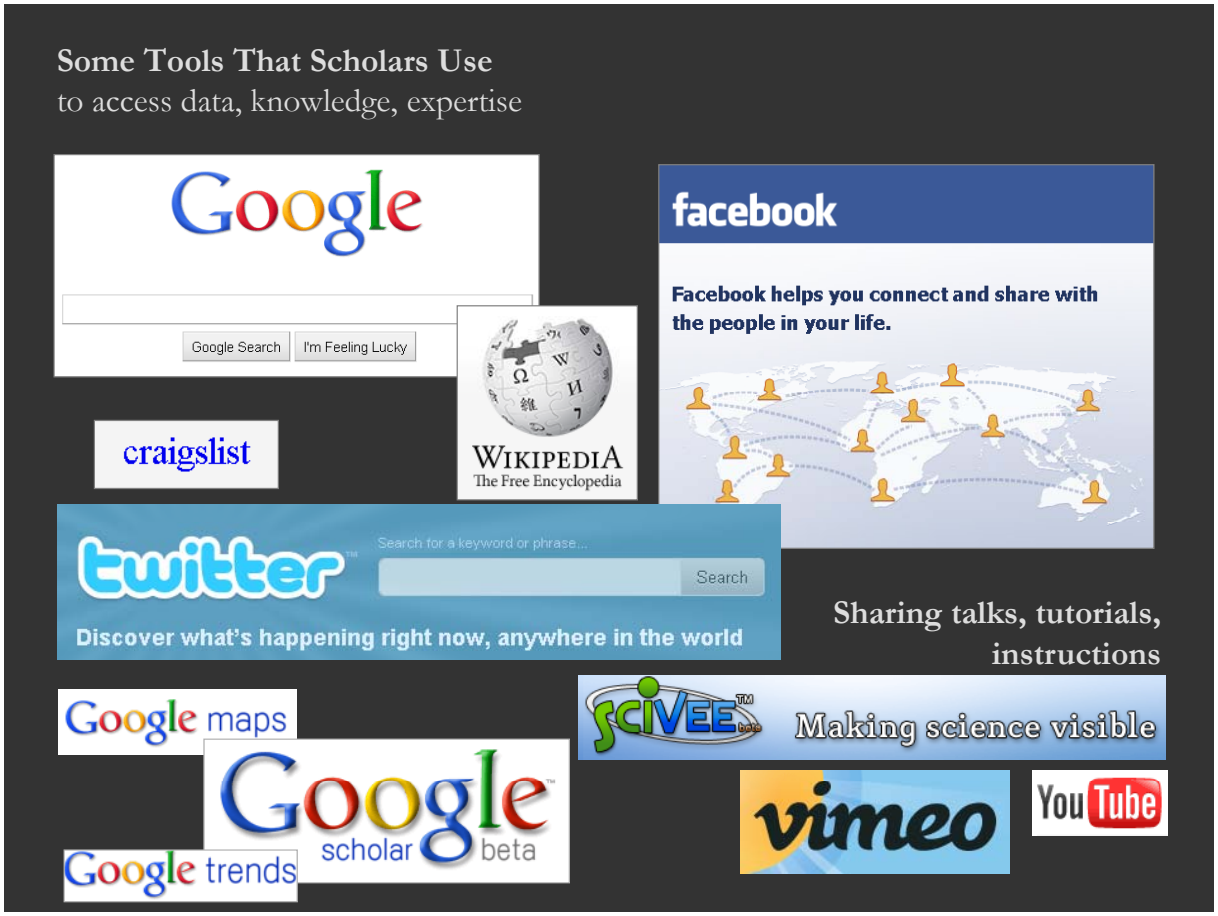
A [A View On Google's Patent: Information Retrieval Based On Historical Data](#)
WebProNews - May 12 2005

B [Details about Europe's i2010 Digital Libraries Program Emerge](#)
Search Engine Watch - Oct 4 2005

C ["Research Meets Practice" Information Retrieval Symposium 2008](#)
MarketWatch - Nov 4 2008

D [Consumer Watchdog Backs Digital Libraries, Opposes Google Books Settlement Deal](#)
Reuters - Sep 10 2009

Identify patterns, trends, outliers



S&T Navigation, Management Tools that Different Stakeholders Want

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.

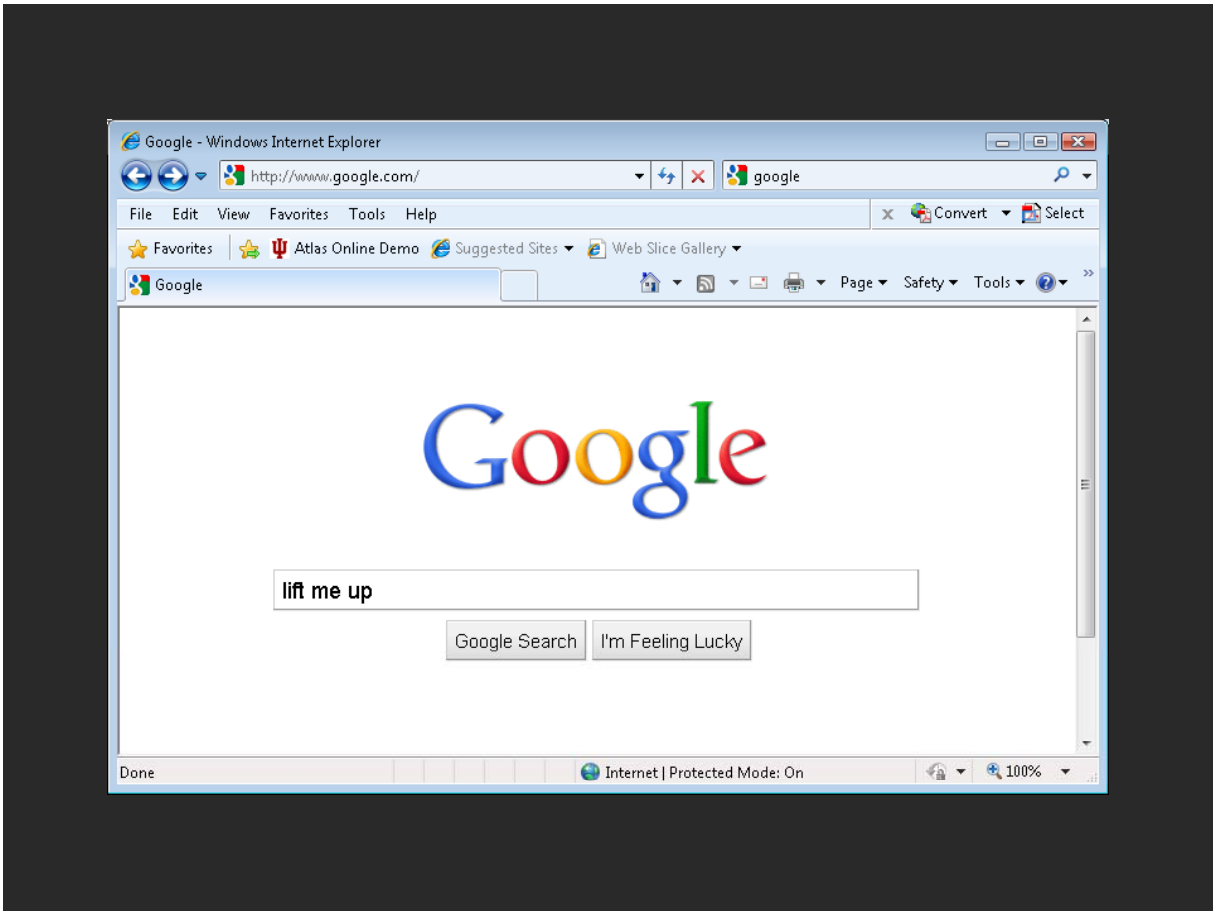
Reviewers—read, critique, and suggest changes to help improve the quality of papers and funding proposals. They need to identify related works that should be cited or complementary skills that authors might consider when selecting project collaborators.

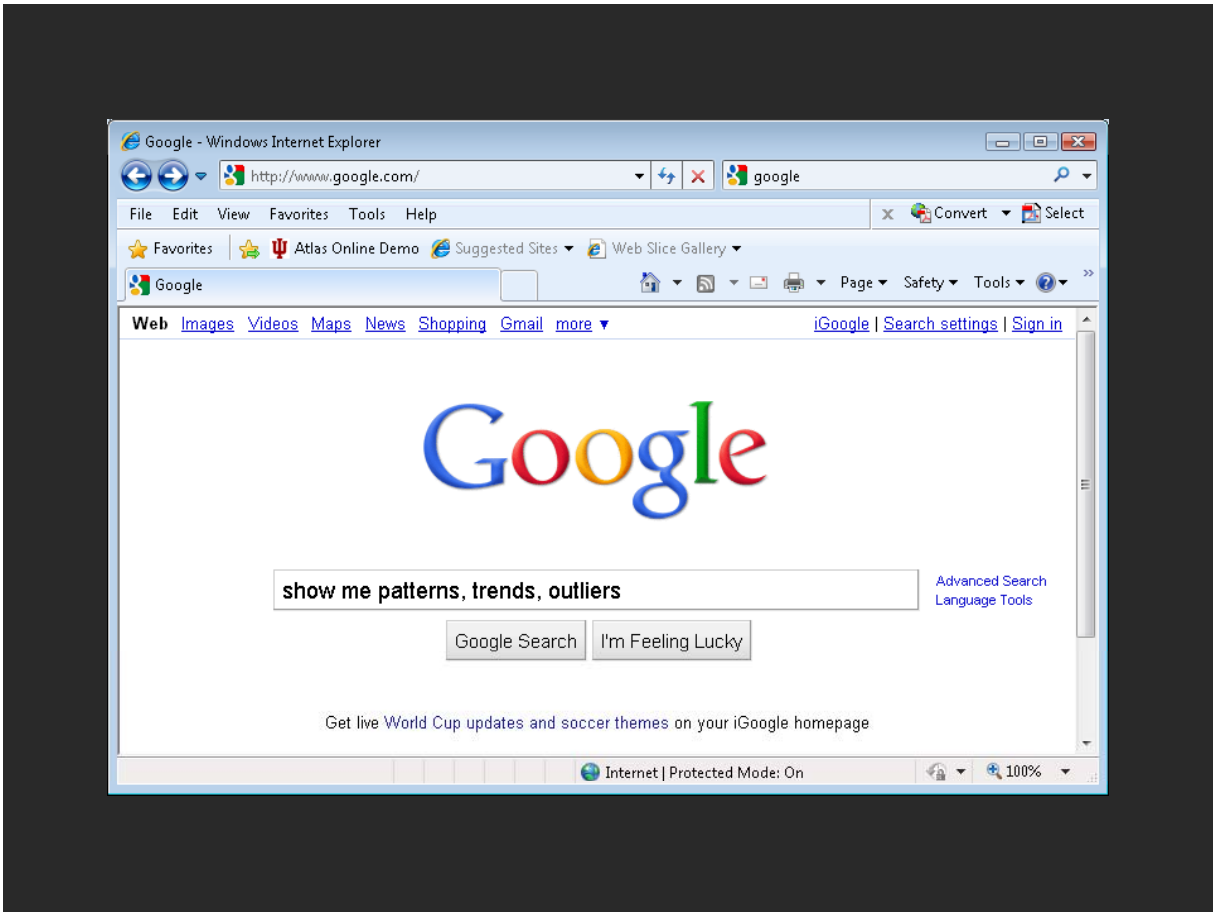
Teachers—teach classes, train doctoral students, and supervise postdoctoral researchers. They need to identify key works, experts, and examples relevant to a topic area and teach them in the context of global science.

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.

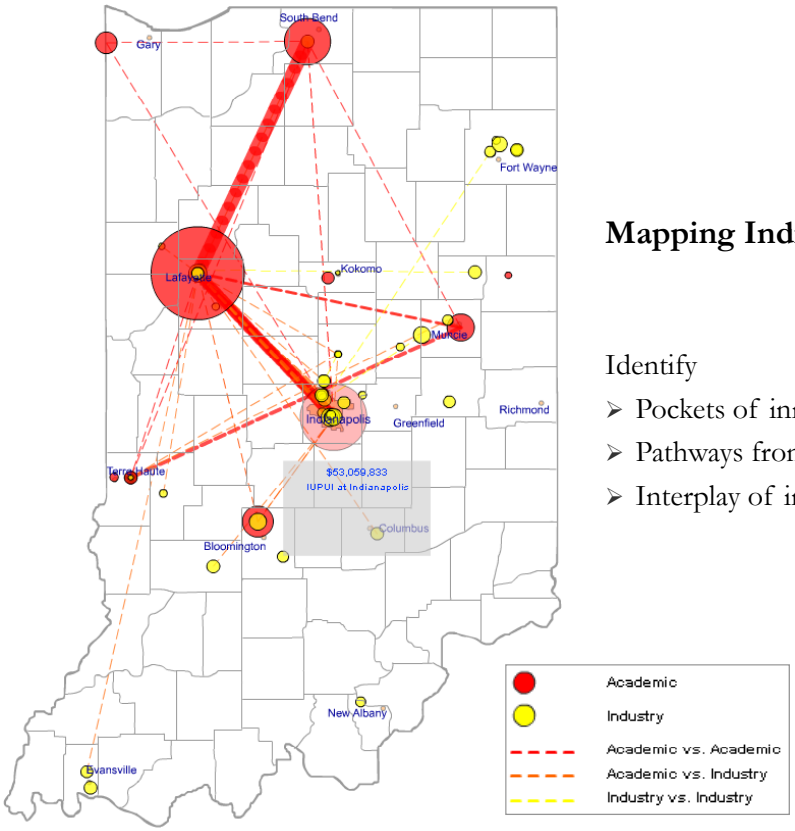
Team Leads and Science Administrators—many scholars direct multiple research projects simultaneously. Some have full-time staff, research scientists, and technicians in their laboratories and centers. Leaders need to evaluate performance and provide references for current or previous members; report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





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	pic bursts of PNAS	113 Years of P Research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a sta intellectual la	PNAS
Topical Analysis (What)	s.	e flows in research	VxOrd/Topic n NIH funding
Network Analysis (With Whom?)	NSF work of one	k	NIH's core competency



Mapping Indiana's Intellectual Space

Identify

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

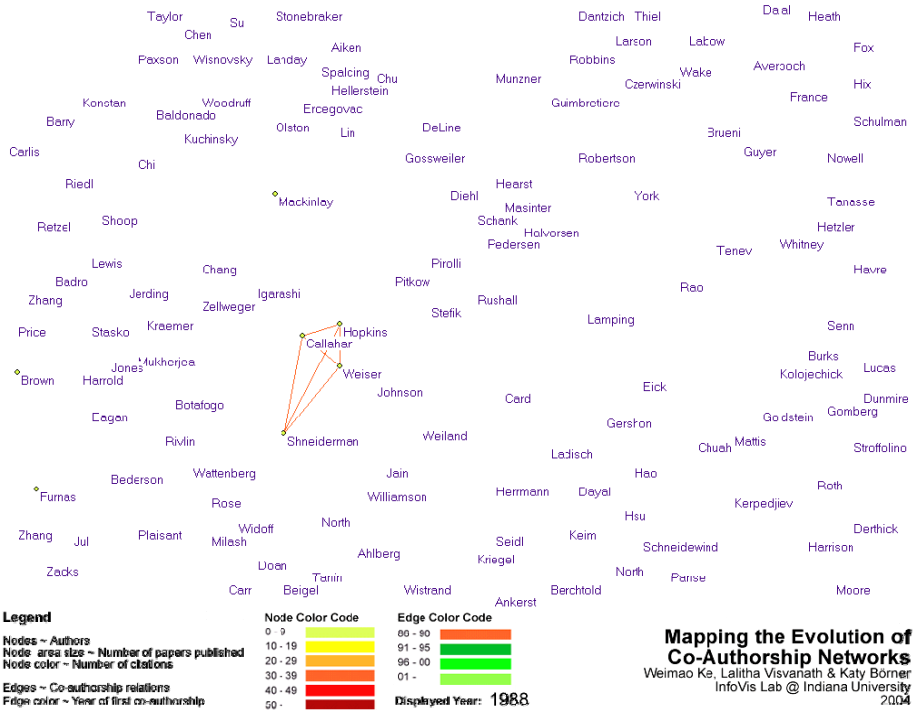
Research Collaborations by the Chinese Academy of Sciences

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

This map highlights the research co-authorship collaborations of the Chinese Academy of Sciences with locations in China and countries around the world. The large geographic map shows the research collaborations of **all CAS institutes**. Each smaller geographic map shows the research collaborations by the CAS researchers in one **province-level administrative division**. Collaborations between CAS researchers are not included in the data. On each map, locations are colored on a logarithmic scale by the number of collaborations from red to yellow. The darkest red is 3,395 collaborations by all of CAS with researchers in Beijing. Also, flow lines are drawn from the location of focus to all locations collaborated with. The width of the flow line is linearly proportional to the number of collaborations with the locations it goes to, with the smallest flow lines representing one collaboration and the largest representing differing amounts on each geographic map.

Mapping the Evolution of Co-Authorship Networks

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



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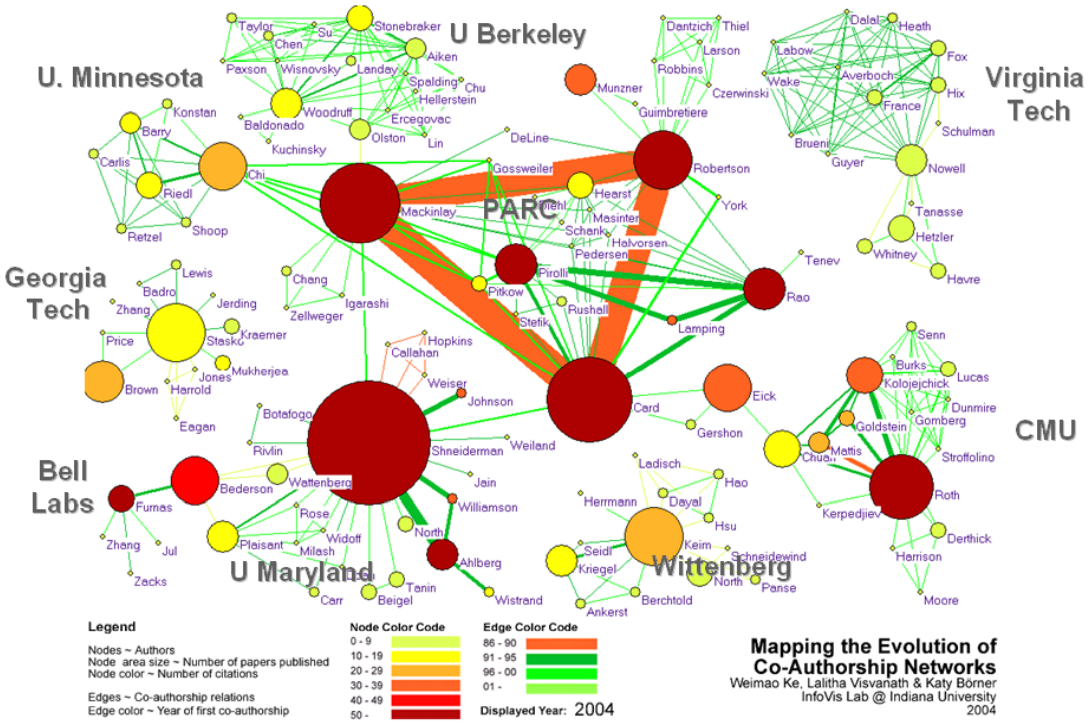


Studying the Emerging Global Brain: Analyzing and Visualizing the Impact of Co-Authorship Teams

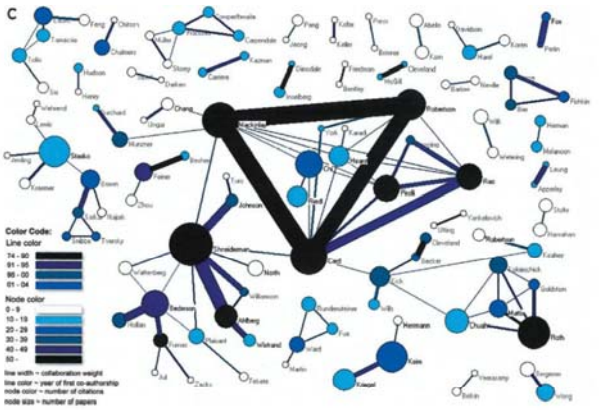
Börner, Dall'Asta, Ke & Vespignani (2005) Complexity, 10(4):58-67.

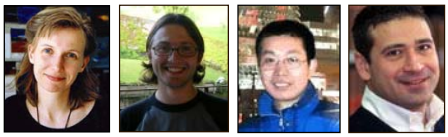
Research question:

- 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.

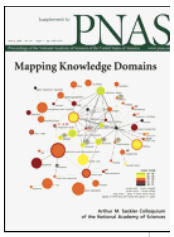




Mapping Topic Bursts

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.

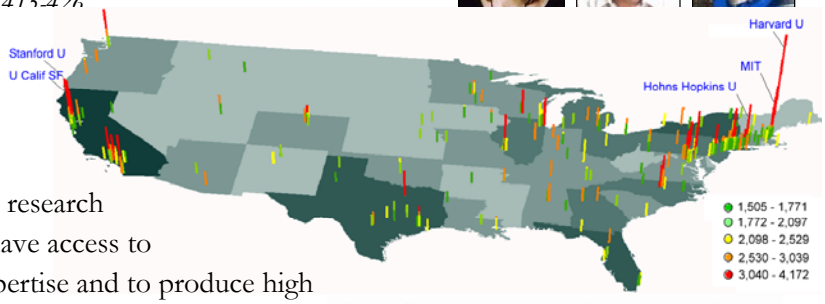


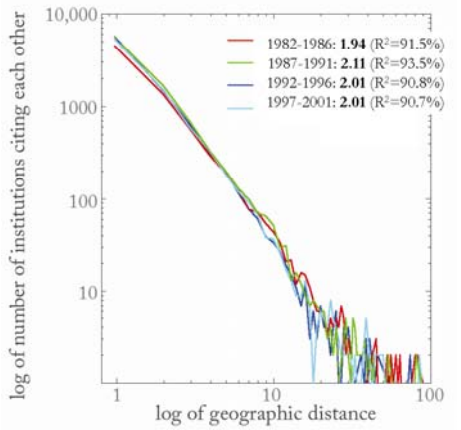
Spatio-Temporal Information Production and Consumption of Major U.S. Research Institutions

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?





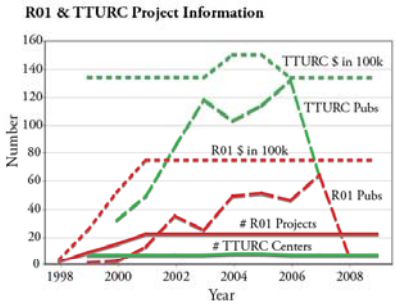
Contributions:

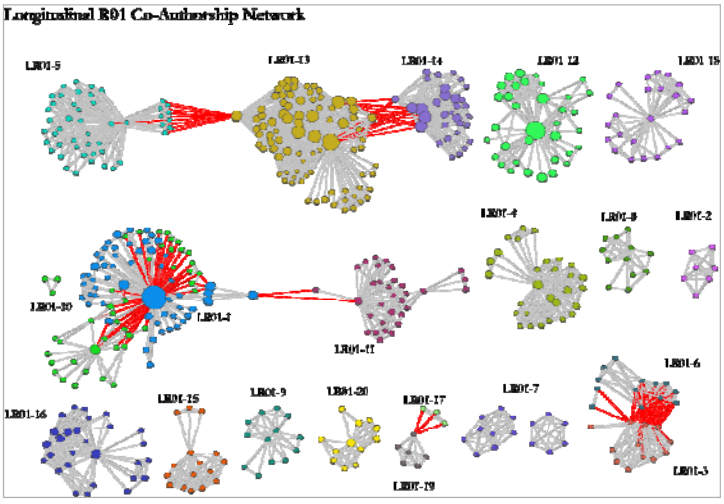
- Answer to Qs 1 + 2 is YES.
- Answer to Qs 3 is NO.
- Novel approach to analyzing the dual role of institutions as information producers and consumers and to study and visualize the diffusion of information among them.

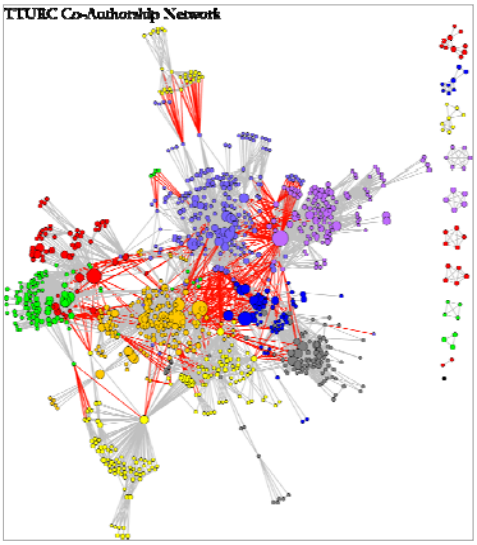
Mapping Transdisciplinary Tobacco Use Research Centers Publications

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

Zoss & Börner, forthcoming.



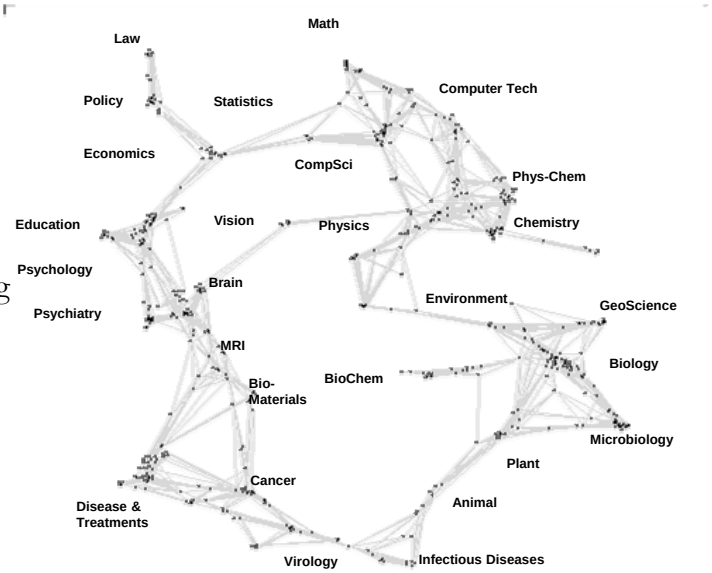




2002 Base Map of Science

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.

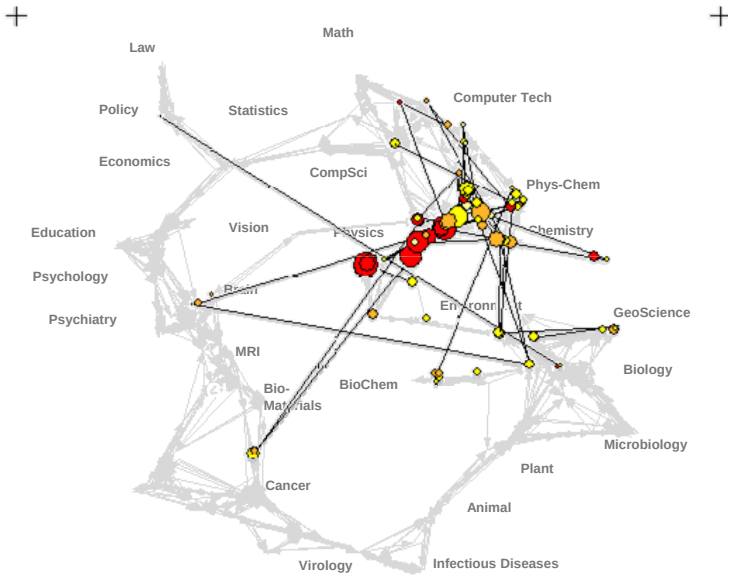
- Uses combined SCI/SSCI from 2002
  - 1.07M papers, 24.5M references, 7,300 journals
  - Bibliographic coupling of papers, aggregated to journals
- Initial ordination and clustering of journals gave 671 clusters
- Coupling counts were reaggregated at the journal cluster level to calculate the
  - (x,y) 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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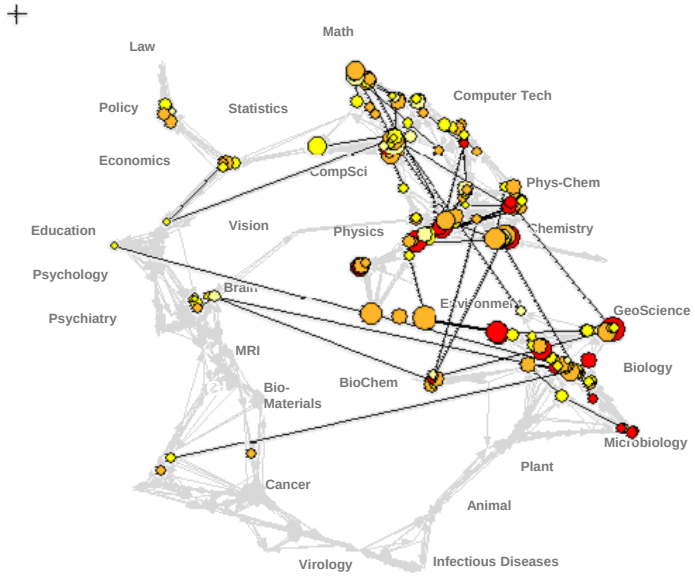
Funding Patterns of the National Science Foundation (NSF)



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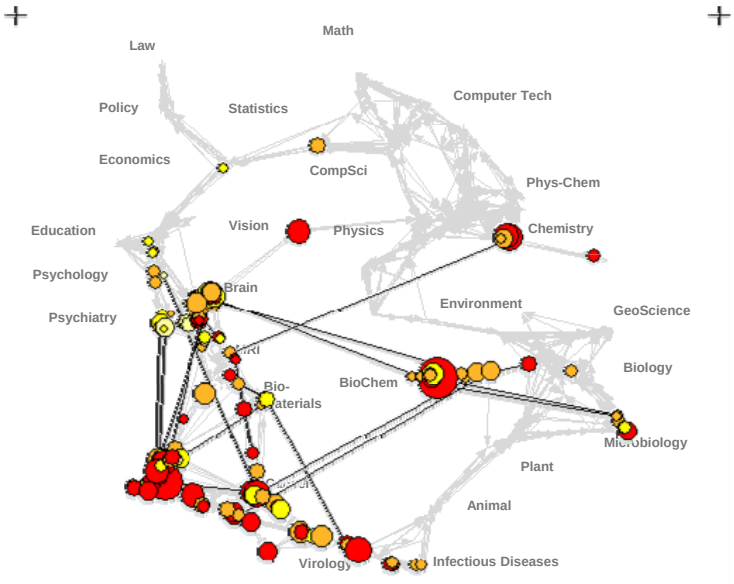

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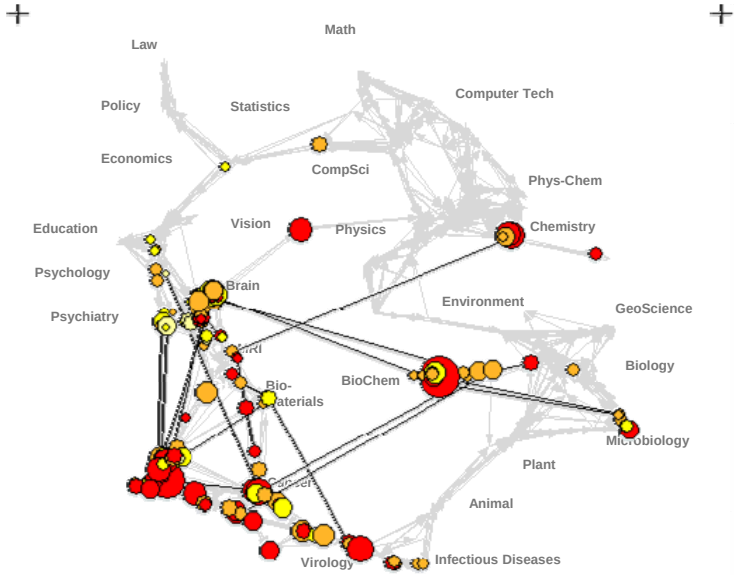
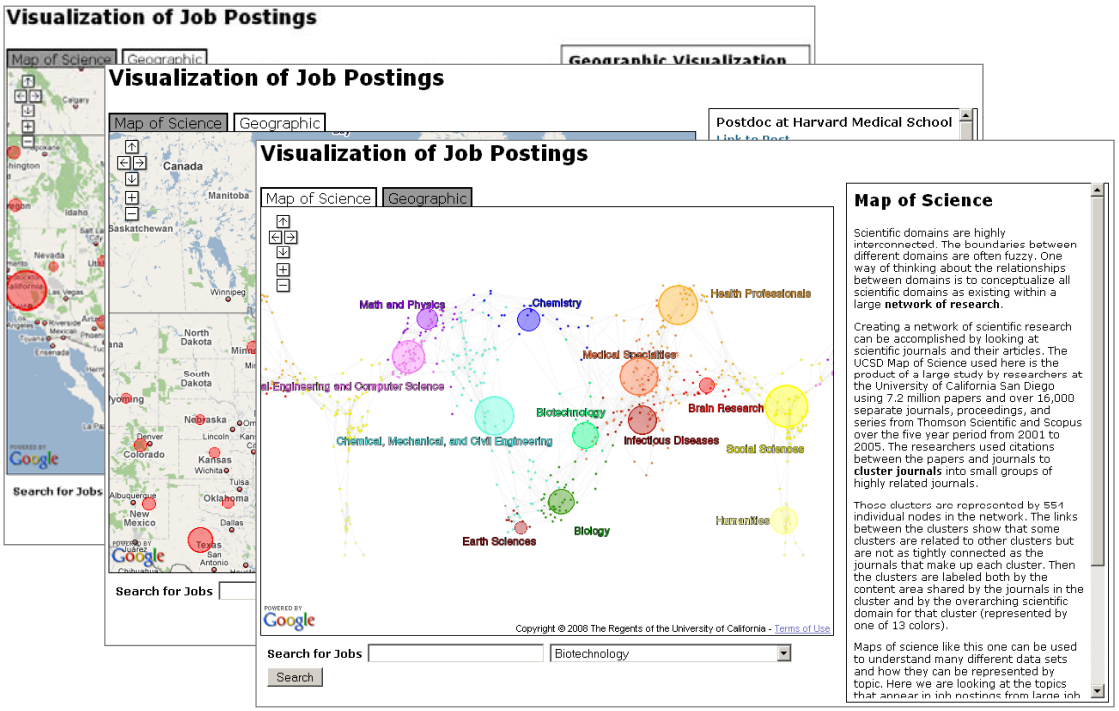
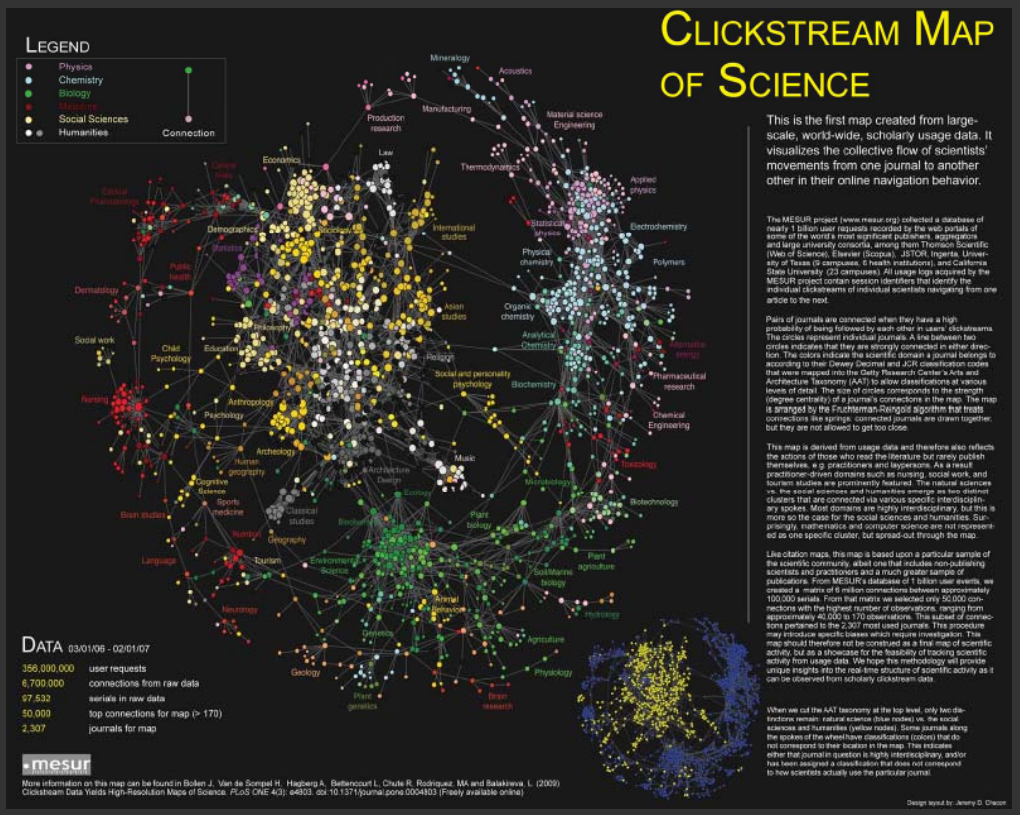


Where Are the Academic Jobs? Interactive Exploration of Job Advertisements in Geospatial and Topical Space

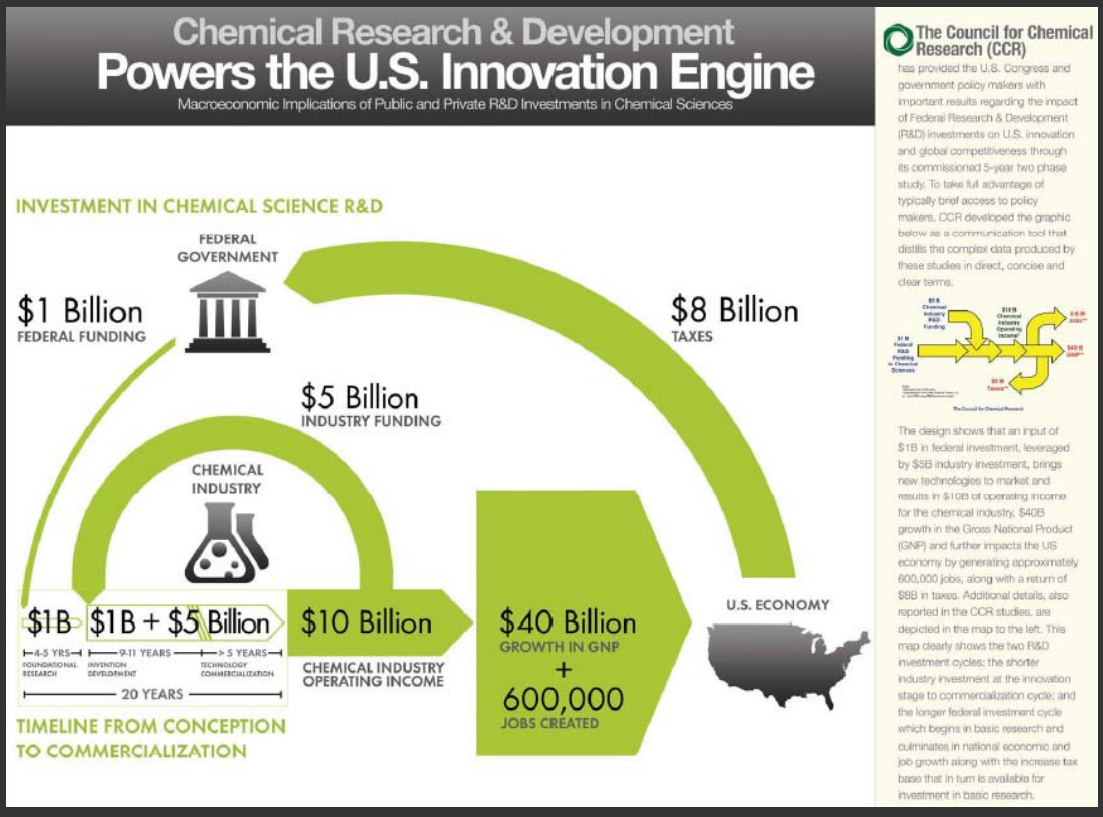
Angela Zoss, Michael Connover, Katy Börner (2010)



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



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

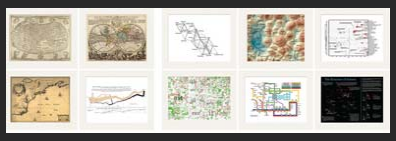


Council for Chemical Research. 2009. Chemical R&D Powers the U.S. Innovation Engine. Washington, DC. Courtesy of the Council for Chemical Research.

Mapping Science Exhibit – 10 Iterations in 10 years

http://scimaps.org

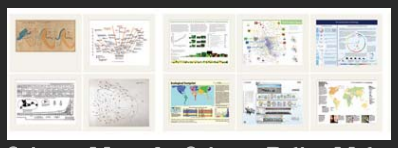
The Power of Maps (2005)



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)

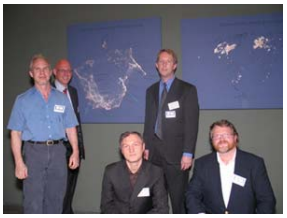
Exhibit has been shown in 72 venues on four continents. Currently at
- NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA
- Marston Science Library, University of Florida, Gainesville, FL
- Center of Advanced European Studies and Research, Bonn, Germany
- Science Train, Germany.

ORDER MAPS

Debut of 5th 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

Illuminated Diagram Display

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



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

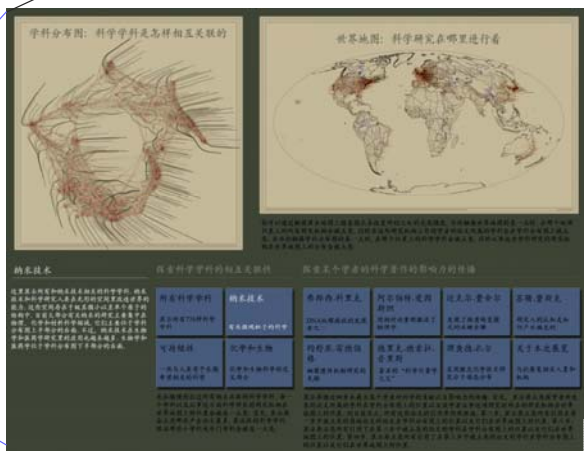
Questions:

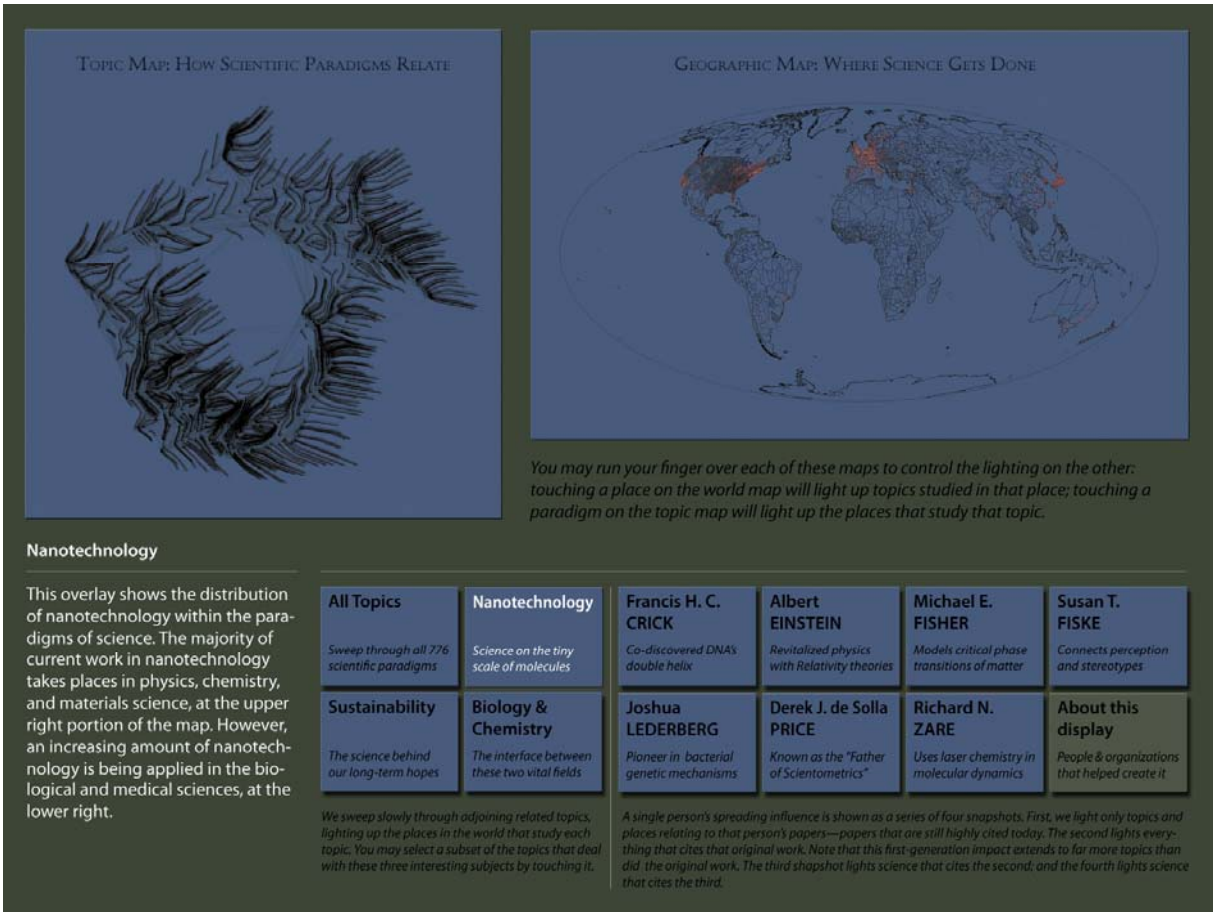
- Who is doing research on what topic and where?
- What is the 'footprint' of interdisciplinary research fields?
- What impact have scientists?

Interactive touch panel.

Contributions:

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





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

Computational Scientometrics References

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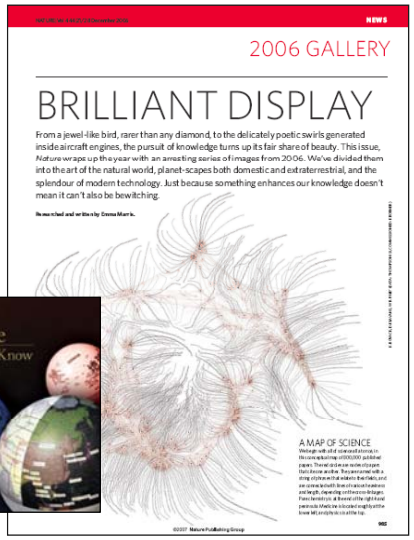
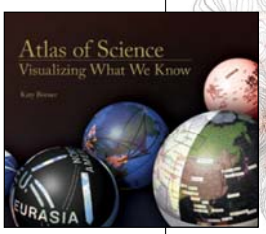
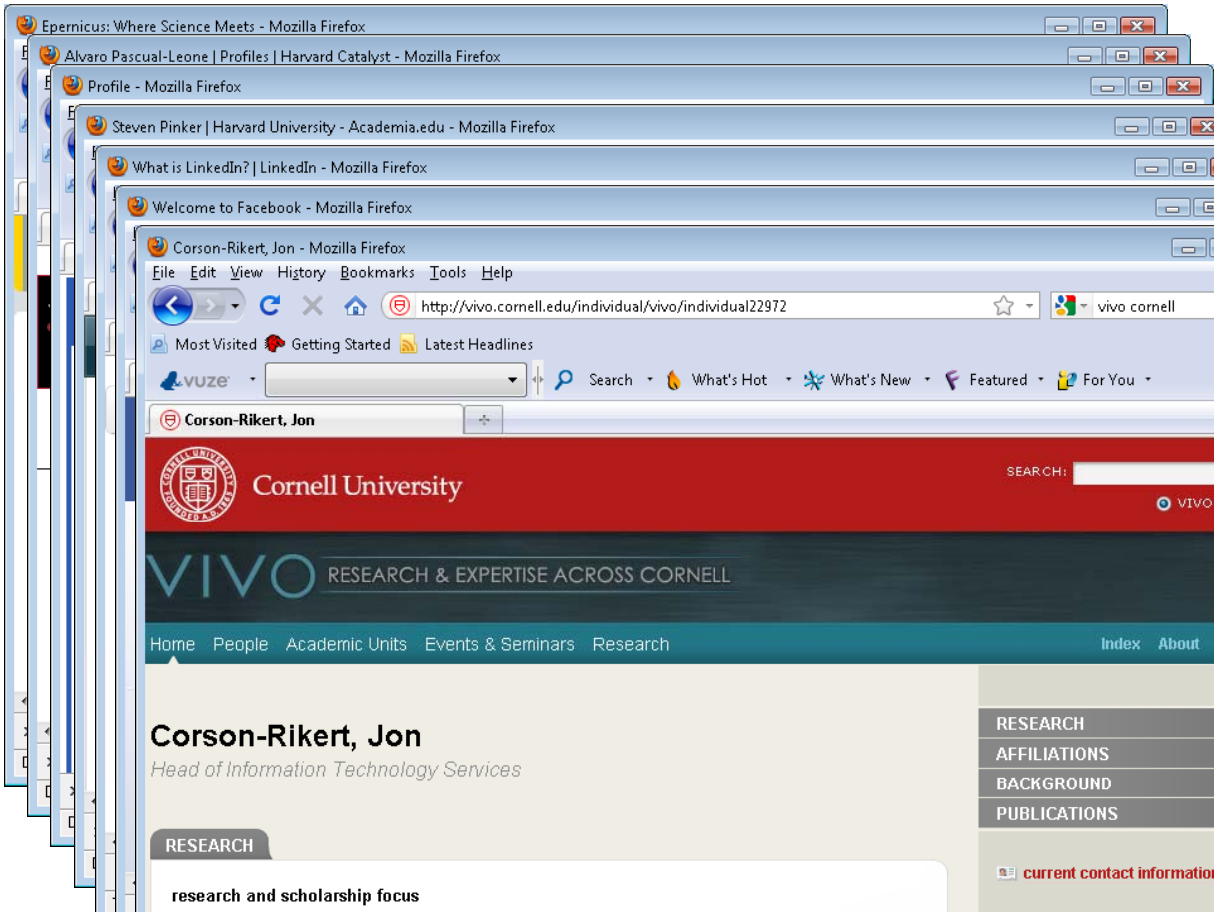






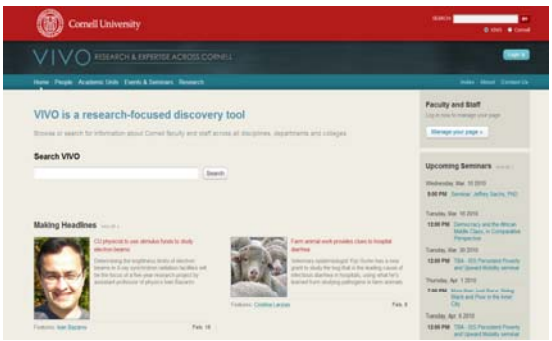
VIVO: A Semantic Approach to Creating a National Network of Researchers (http://vivoweb.org)

VIVO
Enabling a National Network of Scientists

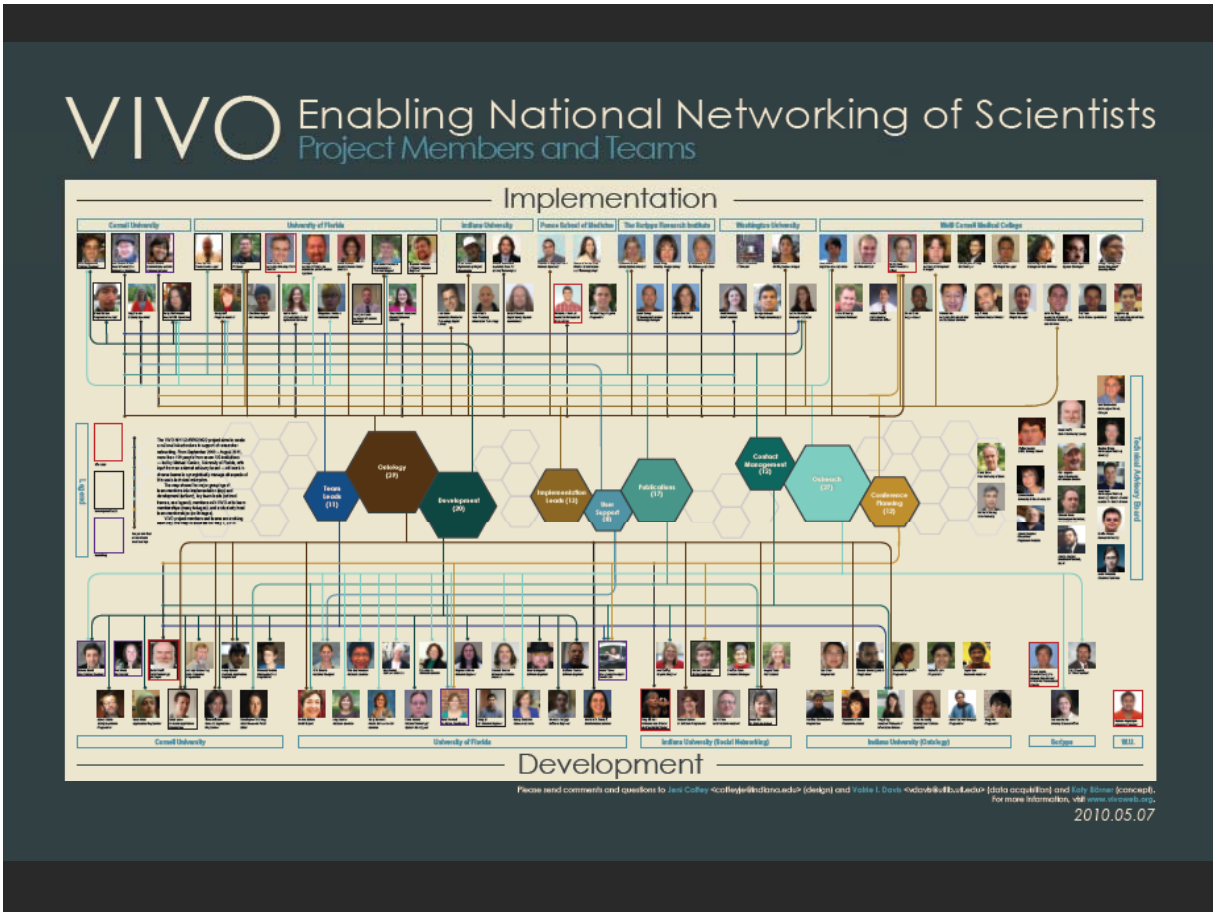
- Semantic web application and ontology editor originally developed at Cornell U.
- Integrates research and scholarship info from systems of record across institution(s).
- Facilitates research discovery and cross-disciplinary collaboration.

Soon:

- Simplify reporting tasks, e.g., generate biosketch, department report.



Cornell University: Dean Krafft (Cornell PI), Manolo Bevia, Jim Blake, Nick Cappadona, Brian Caruso, Jon Corson-Rikert, Elly Cramer, Medha Devare, John Fereira, Brian Lowe, Stella Mitchell, Holly Mistlebauer, Anup Sawant, Christopher Westling, Rebecca Younes. **University of Florida:** Mike Conlon (VIVO and UF PI), Cecilia Botero, Kerry Britt, Erin Brooks, Amy Buhler, Ellie Bushhousen, Chris Case, Valrie Davis, Nita Ferree, Chris Haines, Rae Jesano, Margeaux Johnson, Sara Kreinest, Yang Li, Paula Markes, Sara Russell Gonzalez, Alexander Rockwell, Nancy Schaefer, Michele R. Tennant, George Hack, Chris Barnes, Narayan Raum, Brenda Stevens, Alicia Turner, Stephen Williams. **Indiana University:** Katy Borner (IU PI), William Barnett, Shanshan Chen, Ying Ding, Russell Duhon, Jon Dunn, Micah Linnemeier, Nianli Ma, Robert McDonald, Barbara Ann O'Leary, Mark Price, Yuyin Sun, Alan Walsh, Brian Wheeler, Angela Zoss. **Ponce School of Medicine:** Richard Noel (Ponce PI), Ricardo Espada, Damaris Torres. **The Scripps Research Institute:** Gerald Joyce (Scripps PI), Greg Dunlap, Catherine Dunn, Brant Kelley, Paula King, Angela Murrell, Barbara Noble, Cary Thomas, Michaeleen Trimarchi. **Washington University, St. Louis:** Rakesh Nagarajan (WUSTL PI), Kristi L. Holmes, Sunita B. Koul, Leslie D. McIntosh. **Weill Cornell Medical College:** Curtis Cole (Weill PI), Paul Albert, Victor Brodsky, Adam Cheriff, Oscar Cruz, Dan Dickinson, Chris Huang, Itay Klaz, Peter Michelini, Grace Migliorisi, John Ruffing, Jason Specland, Tru Tran, Jesse Turner, Vinay Varughese.

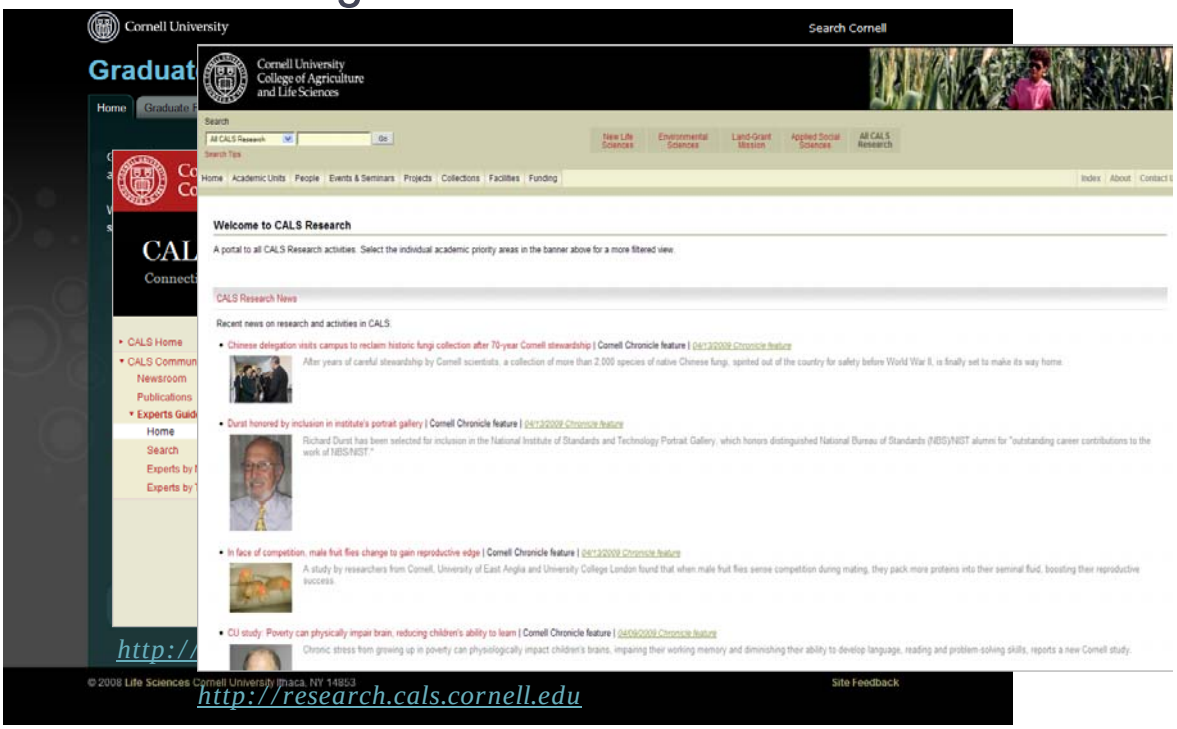


VIVO
Enabling a National Network of Scientists

VIVO Users and Needs

- Faculty/Researchers
  - Customize profile created via feeds; find potential collaborators, "people like me"; discovery via high search rankings; info on activity of colleagues…
- Students
  - Create profiles; easily find mentors + collaborators; locate facilities, events, funding opportunities…
- Administrators
  - Quickly find cross-disciplinary expertise (research area; geography); centralize public data from diverse sources; easily repurpose information for consumers; improve faculty collaboration within or across departments and institutions…
- Funding, donor, legislative agencies
  - Discover projects, grants, expertise (e.g. for review panels; targets for funding)…
- General public
  - Find expertise, learn about research in a region/institution…

VIVO Web Pages



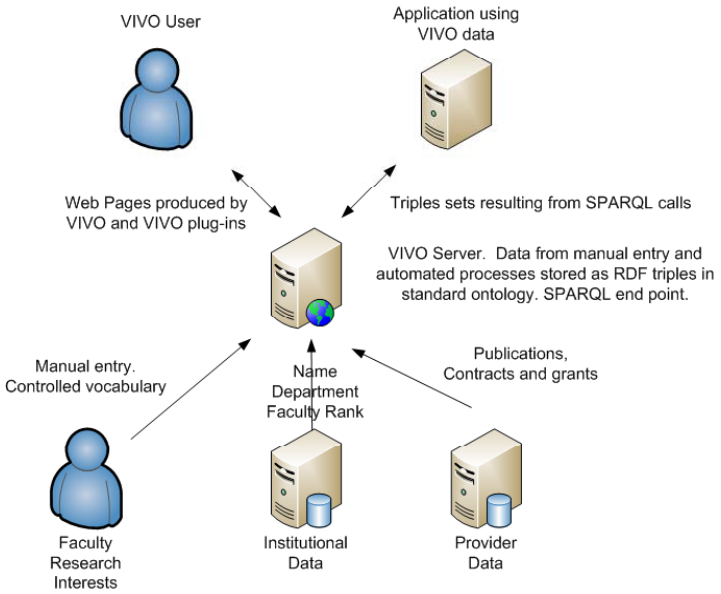
http://gradeducation.lifesciences.cornell.edu

VIVO Data Providers & Users

- Eagle-i ("enabling resource discovery" U24 award)
- Federal agencies – NIH (NIH RePORTER), NSF, USDA, …
- Search Providers – Google, Bing, Yahoo, …
- Professional Societies – AAAS, …
- Publishers/vendors – PubMed, Elsevier, Collexis, ISI…
- Semantic Web community – DERI, …
- Consortia of schools – SURA, CTSA…
- Producers, consumers of semantic web-compliant data

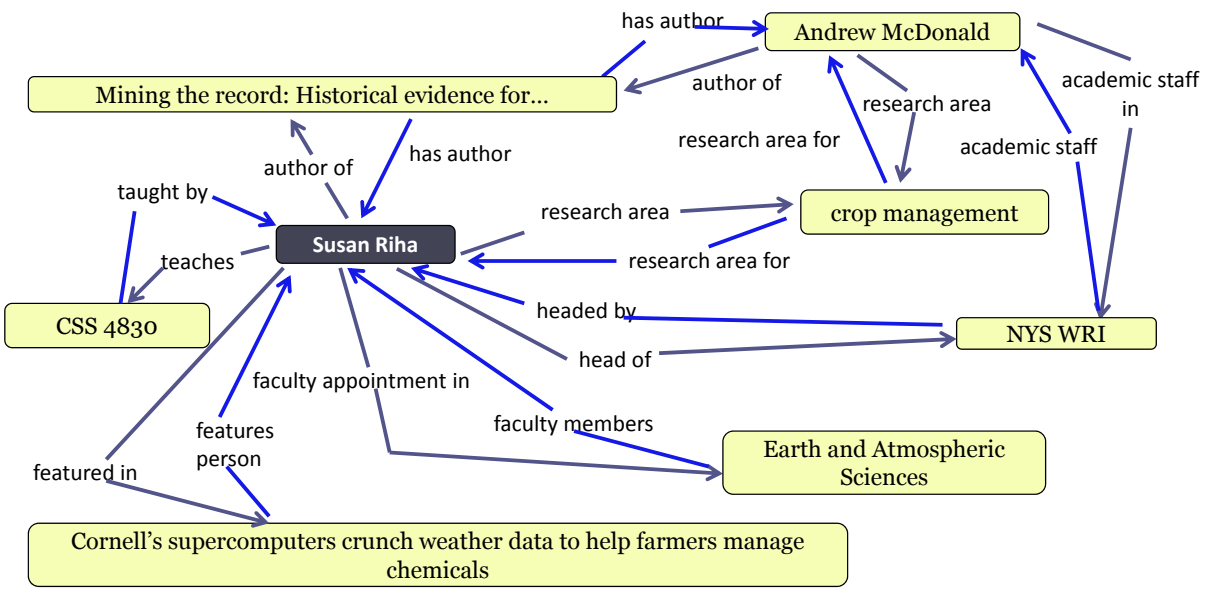
Institutional Architecture

- Three sources of VIVO information
  - User data
  - Institutional data
  - Provider data
- Two formats for output
  - Web Pages for users
  - Resource Description Framework for applications



Data Representation using RDF Triples

Detailed relationships for a researcher at Cornell U.
Open source code (BSD) and ontology available at http://vivoweb.org.



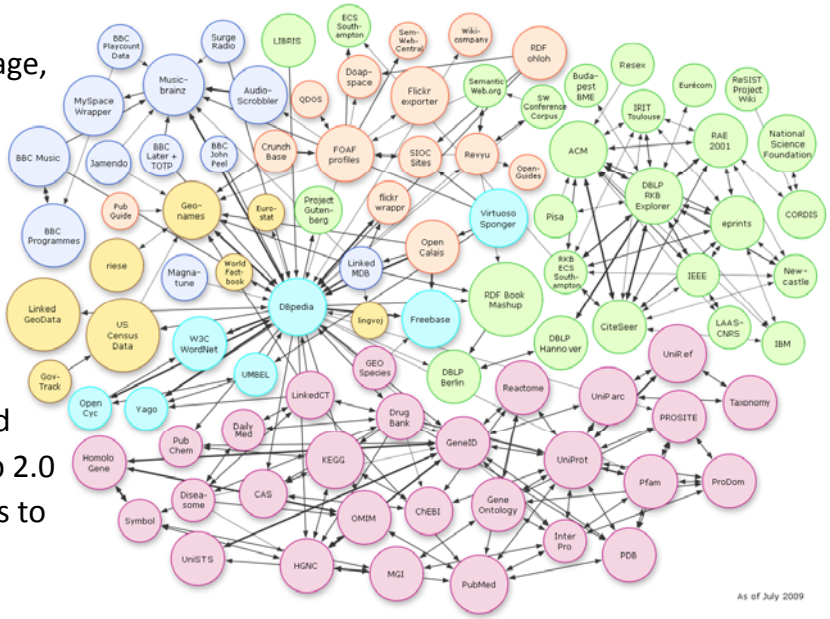
VIVO & Linked Open Data

2010 National VIVO Conference August 12&13, NYC
http://conferences.dce.ufl.edu/vivo

VIVO makes high coverage, high quality data from systems of record

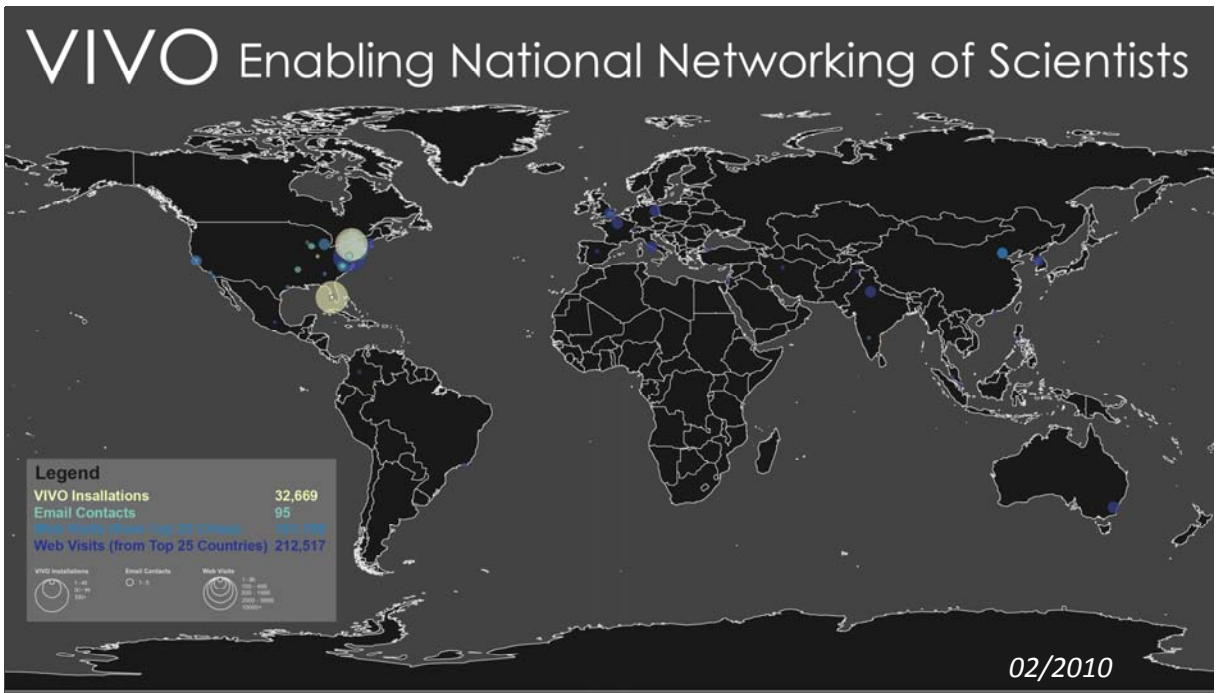
- available online
- for free, and
- in machine readable format.

VIVO ontology is aligned with many existing Web 2.0 and scholarly ontologies to ease interoperability.



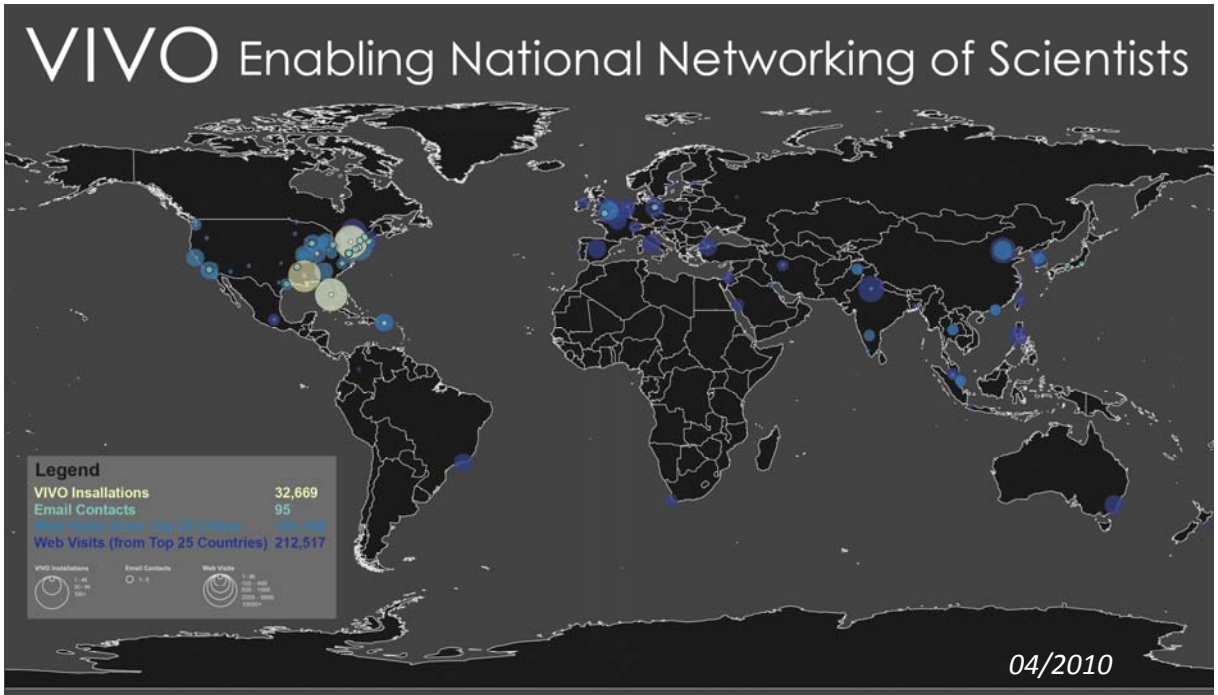
http://www4.wiwiss.fu-berlin.de/bizer/pub/lod-datasets_2009-07-14_colored.png

VIVO ENABLING NATIONAL NETWORKING OF SCIENTISTS



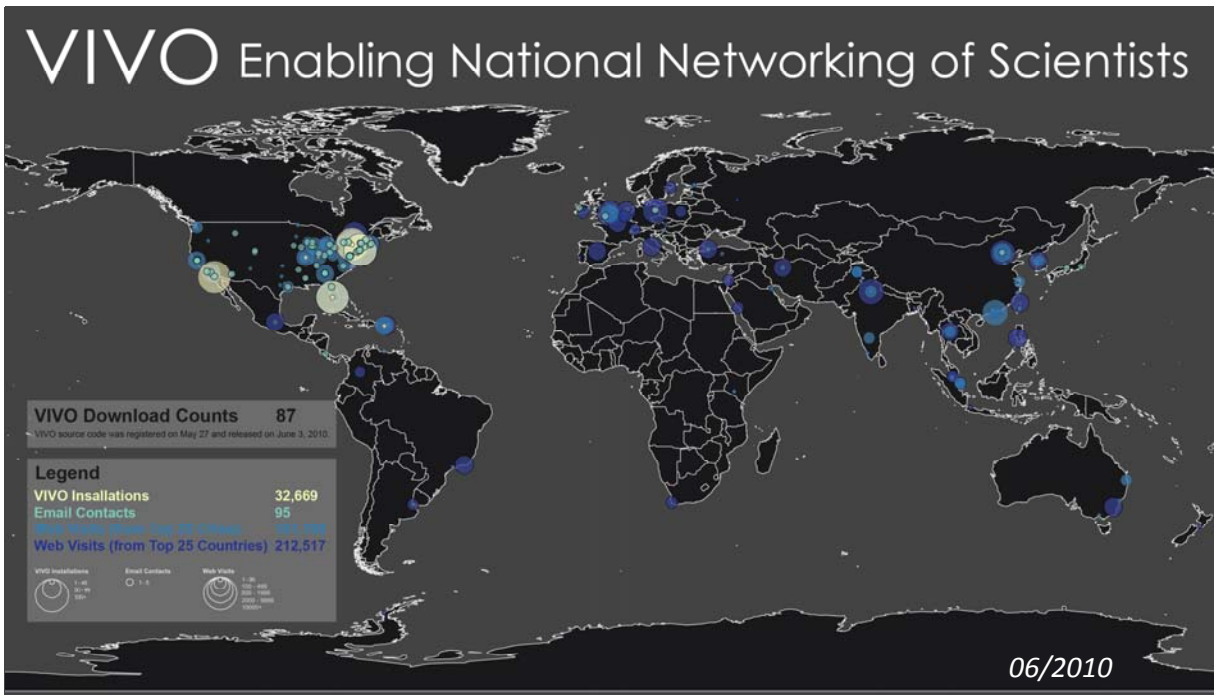
Visualization created by: Katy Börner (concept), Jeni Coffey (design), Kaveh Ekbia (ArcGIS) and Justin Peters (ArcGIS).

The National Research Network: VIVO: Enabling National Networking of Scientists NIH U24RR029822
Start: Sept 2009
PI: Michael Conlon, University of Florida
Award amount: $12,300,000



Visualization created by: Katy Börner (concept), Jeni Coffey (design), Kaveh Ekbia (ArcGIS) and Justin Peters (ArcGIS).

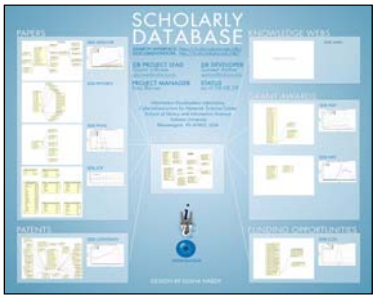
Shown are the number of people profiles in the 7 different installation sites.
Email contacts by data and service providers as well as institutions interested to adopt VIVO.
The number of visitors on http://vivoweb.org



Visualization created by: Katy Börner (concept), Jeni Coffey (design), Kaveh Ekbia (ArcGIS) and Justin Peters (ArcGIS).

VIVO 1.0 source code was publicly released on April 14, 2010
87 Downloads by June 11, 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.

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

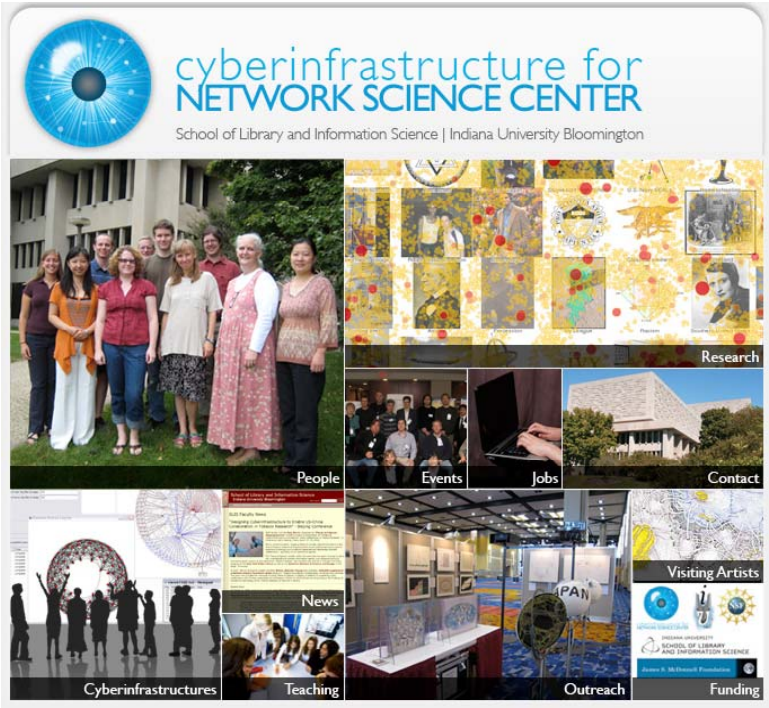
Network Workbench Tool & Community Wiki
http://nwb.slis.indiana.edu

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



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