

Towards a Macroscopic Science Policy Decision Making

Dr. Katy Börner

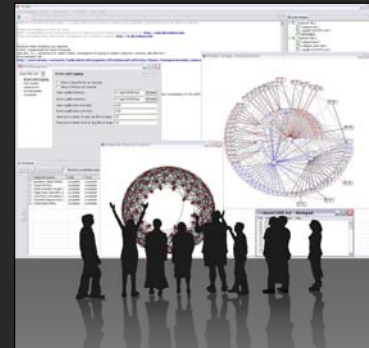
Cyberinfrastructure for Network Science Center, Director
Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
katy@indiana.edu

Kevin Boyack

SciTech Strategies Inc.
kboyack@mapofscience.com

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.

October 19, 2010
AAAS



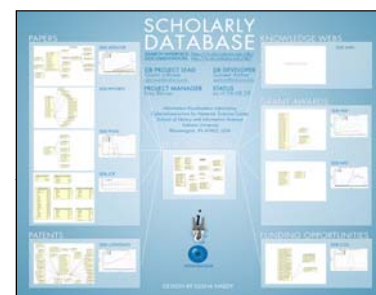
Computational Scientometrics Cyberinfrastructures



Scholarly Database: 25 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>




Science of Science (Sci²) Tool and CI Portal
<http://sci.slis.indiana.edu>



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





Sci² Tool

A tool for science of science research & practice

Email Address

Password

Login

Forgot your password?

To recover your account password, please visit our [password recovery page](#).

Not registered yet?

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Tutorials

Scott Weingart,†
Biberstine (2010)
Science, Indiana

Katy Börner (2010) Science of Science Research and Tools (12 Tutorials). Reporting Branch, Office of Extramural Research/Office of the Director, National Institutes of Health, Bethesda, MD.

- Tutorial #01: [Science of Science Research](#)
- Tutorial #02: [Network Science / Information Visualization](#)
- Tutorial #03: [CIShell Powered Tools: Network Workbench and Science of Science Tool](#)
- Tutorial #04: [Temporal Analysis—Burst Detection](#)
- Tutorial #05: [Geospatial Analysis and Mapping](#)
- Tutorial #06: [Topical Analysis & Mapping](#)
- Tutorial #07: [Tree Analysis and Visualization](#)
- Tutorial #08: [Network Analysis and Visualization](#)
- Tutorial #09: [Large Network Analysis and Visualization](#)
- Tutorial #10: [Using the Scholarly Database at IU](#)
- Tutorial #11: [VIVO National Researcher Networking](#)
- Tutorial #12: [Future Developments](#)

<http://sci.slis.indiana.edu/sci2>

Geetha Senthil (2010). [Multidisciplinary Nature of Work With Reference to PIs and ICs Within a Portfolio](#). PA Group at NIH.

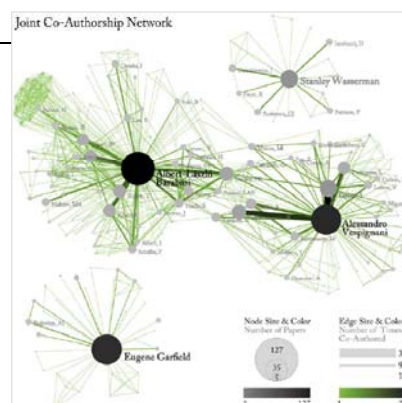
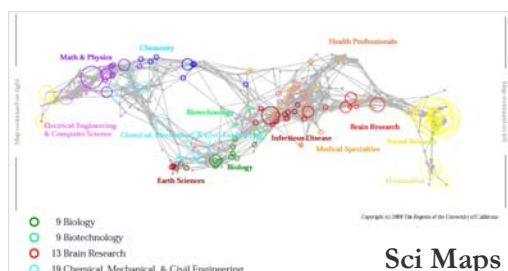
NIH Office of Extramural Research and Katy Börner (2010) [Network Visualizations Using SPIRES Data and the Sci2 Tool](#). Office of Extramural Research at NIH.

3



Sci² Tool – “Open Code for S&T Assessment”

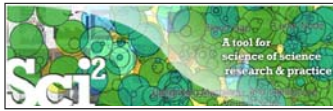
OSGi/CIShell powered tool with NWB plugins and many new scientometrics and visualizations plugins.



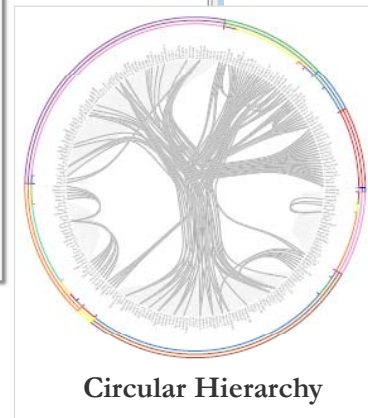
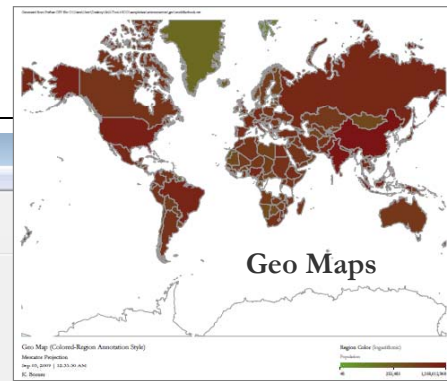
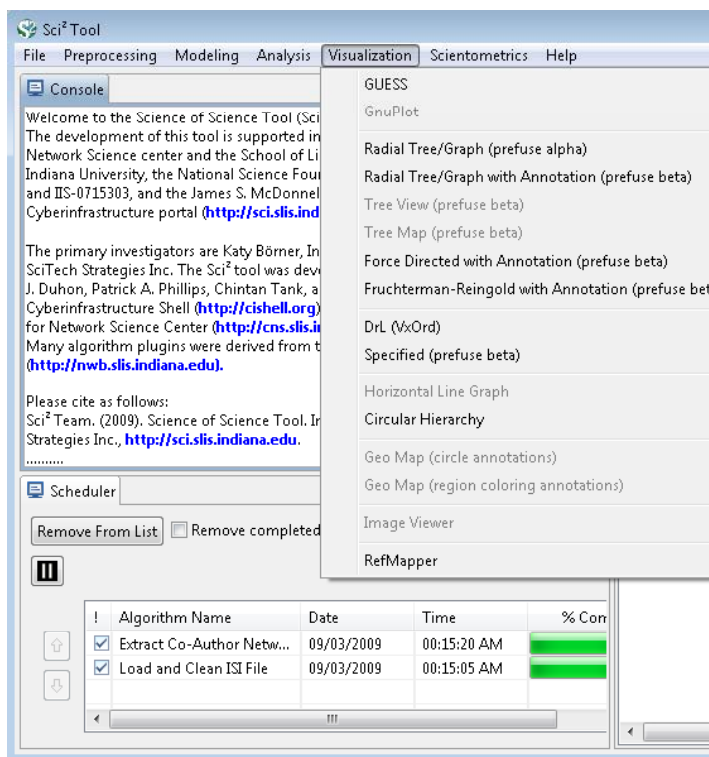
Horizontal Time Graphs



Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Dubon, 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



Sci² Tool: Algorithms

See <https://nwb.slis.indiana.edu/community>

Preprocessing

Extract Top N% Records
Extract Top N Records
Normalize Text
Slice Table by Line

Extract Top Nodes
Extract Nodes Above or Below Value
Delete Isolates

Extract top Edges
Extract Edges Above or Below Value
Remove Self Loops
Trim by Degree
MST-Pathfinder Network Scaling
Fast Pathfinder Network Scaling

Snowball Sampling (in nodes)
Node Sampling
Edge Sampling

Symmetrize
Dichotomize
Multipartite Joining

Geocoder
Extract ZIP Code

Modeling

Random Graph
Watts-Strogatz
Small World
Barabási-Albert Scale-Free
TARL

Analysis

Network Analysis Toolkit (NAT)
Unweighted & Undirected

Node Degree
Degree Distribution

K-Nearest Neighbor (Java)
Watts-Strogatz Clustering Coefficient
Watts Strogatz Clustering Coefficient over K

Diameter
Average Shortest Path
Shortest Path Distribution
Node Betweenness Centrality

Weak Component Clustering
Global Connected Components

Extract K-Core
Annotate K-Core-ness

HITS

Weighted & Undirected

Clustering Coefficient
Nearest Neighbor Degree
Strength vs Degree
Degree & Strength
Average Weight vs End-point Degree
Strength Distribution
Weight Distribution
Randomize Weights

Blondel Community Detection

HITS

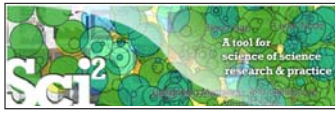
Unweighted & Directed

Node Indegree
Node Outdegree
Indegree Distribution
Outdegree Distribution

K-Nearest Neighbor
Single Node in-Out Degree Correlations

Dyad Reciprocity
Arc Reciprocity
Adjacency Transitivity

Weak Component Clustering
Strong Component Clustering



Sci² Tool: Algorithms cont.

See <https://nwb.slis.indiana.edu/community>

<p>-----</p> <p>Extract K-Core</p> <p>Annotate K-Coreness</p> <p>-----</p> <p>HITS</p> <p>PageRank</p> <p>Weighted & Directed</p> <p>HITS</p> <p>Weighted PageRank</p> <p>-----</p> <p>Textual</p> <p>Burst Detection</p>	<p>Visualization</p> <p>GnuPlot</p> <p>GUESS</p> <p>Image Viewer</p> <p>-----</p> <p>Radial Tree/Graph (prefuse alpha)</p> <p>Radial Tree/Graph with Annotation (prefuse beta)</p> <p>Tree View (prefuse beta)</p> <p>Tree Map (prefuse beta)</p> <p>Force Directed with Annotation (prefuse beta)</p> <p>Fruchterman-Reingold with Annotation (prefuse beta)</p> <p>-----</p> <p>DrL (VxOrd)</p> <p>Specified (prefuse beta)</p> <p>-----</p> <p>Horizontal Line Graph</p> <p>Circular Hierarchy</p> <p>Geo Map (Circle Annotation Style)</p> <p>Geo Map (Colored-Region Annotation Style)</p> <p>Science Map (Circle Annotation)</p>	<p>Scientometrics</p> <p>Remove ISI Duplicate Records</p> <p>Remove Rows with Multitudinous Fields</p> <p>Detect Duplicate Nodes</p> <p>Update Network by Merging Nodes</p> <p>-----</p> <p>Extract Directed Network</p> <p>Extract Paper Citation Network</p> <p>Extract Author Paper Network</p> <p>-----</p> <p>Extract Co-Occurrence Network</p> <p>Extract Word Co-Occurrence Network</p> <p>Extract Co-Author Network</p> <p>Extract Reference Co-Occurrence (Bibliographic Coupling) Network</p> <p>-----</p> <p>Extract Document Co-Citation Network</p>
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NEW:

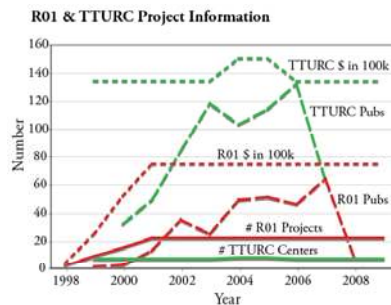
Database support for ISI and NSF data.

7

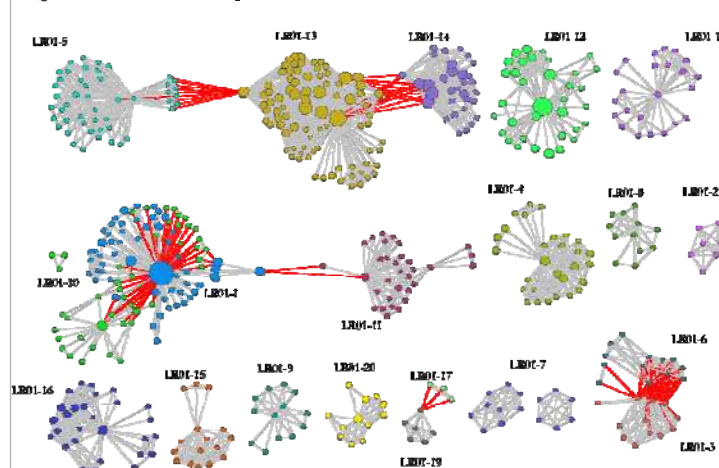
Mapping Transdisciplinary Tobacco Use Research Centers Publications

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

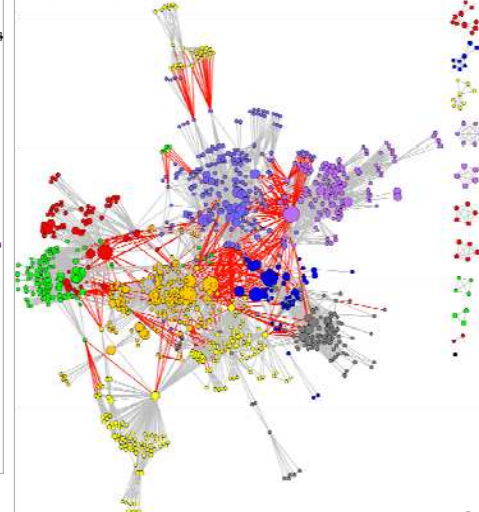
Zoss & Börner, *forthcoming*.



Longitudinal R01 Co-Authorship Network



TTURC Co-Authorship Network



8

Interactive Science Map of NIH Funding

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

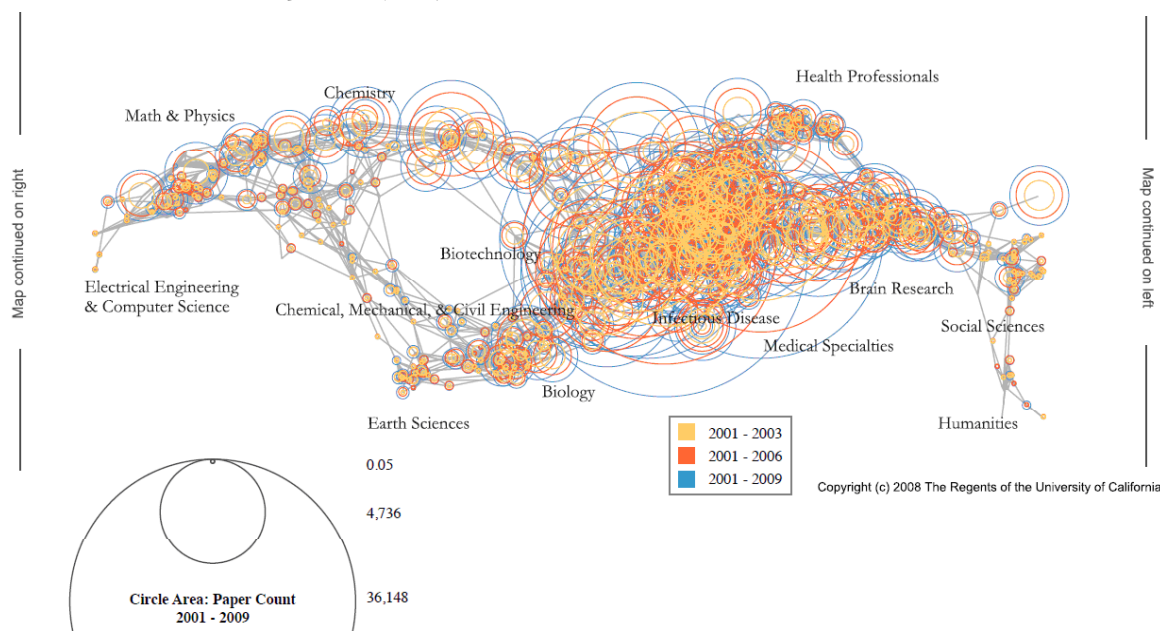


<http://scimaps.org/maps/nih/2007>

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MEDLINE Publication Output by The National Institutes of Health (NIH) Using Nine Years of ExPORTER Data

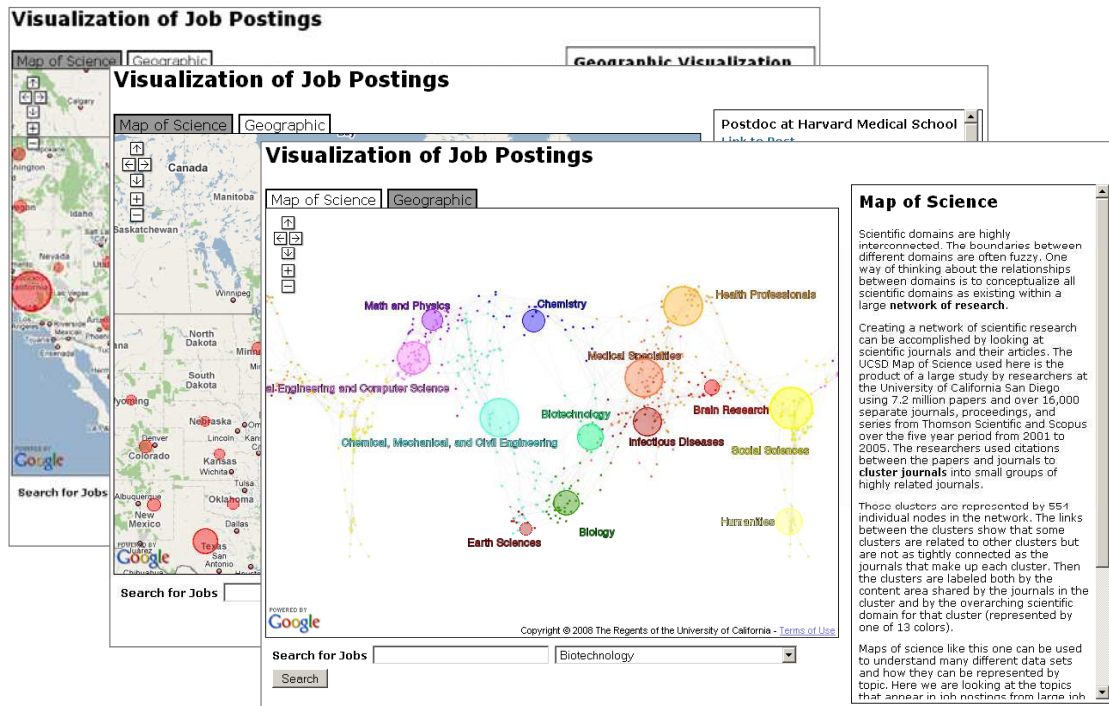
Katy Börner, Nianli Ma, Joseph R. Biberstine, Cyberinfrastructure for Network Science Center, SLIS, Indiana University, Robin M. Wagner, Rediet Berhane, Hong Jiang, Susan E. Ivey, Katrina Pearson and Carl McCabe, Reporting Branch, Division of Information Services, Office of Research Information Systems, Office of Extramural Research, Office of the Director, National Institutes of Health (NIH), Bethesda, MD.



10

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

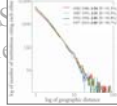
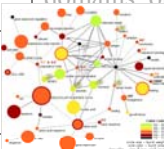



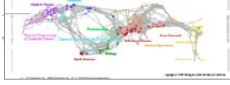
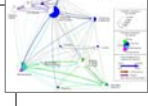
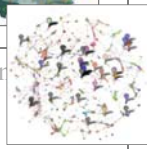

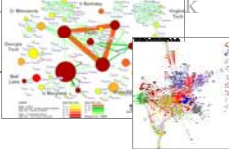
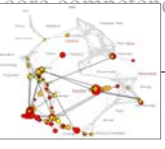
Angela Zoss, Michael Connover, Katy Börner (2010)



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

11

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)
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains or states	All of NSF, SA, all of science 
Temporal Analysis (When)	Funding portfolio of one individual	Topic bursts of PNAS 	113 Years of P Research 
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a state intellectual landscape 	PNAS 
Topical Analysis (What)		flows in research 	VxOrd/Topic r NIH funding 
Network Analysis (With Whom?)	NSF one 	work of 	NIH's 

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Computational Scientometrics Cyberinfrastructures



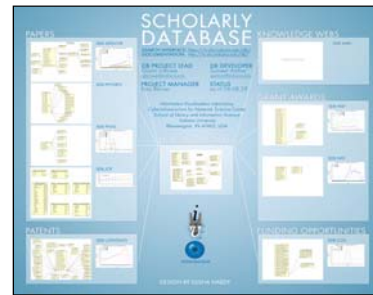
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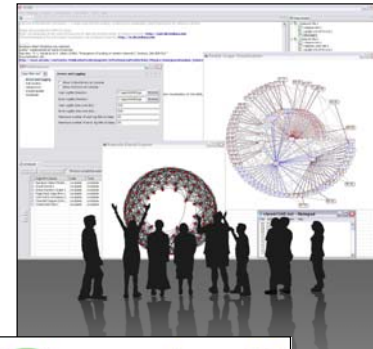
Science of Science (Sci²) Tool and CI Portal

<http://sci.slis.indiana.edu>

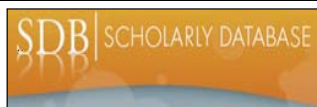


Epidemics Cyberinfrastructure

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



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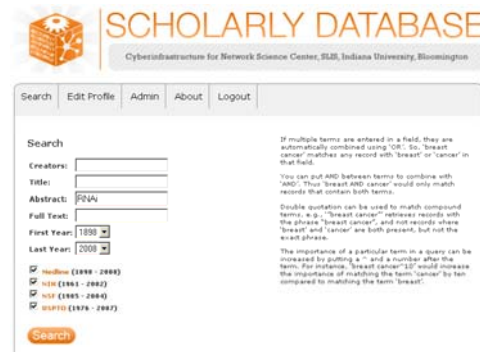
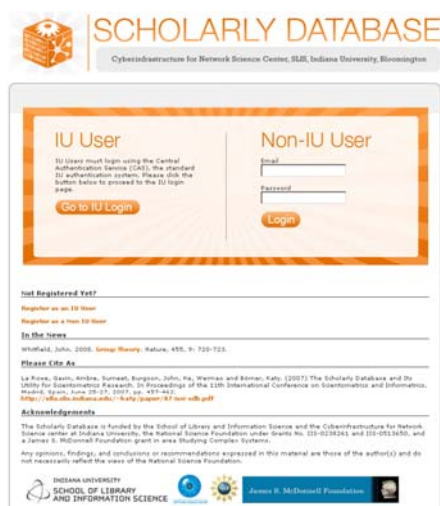


Scholarly Database: Web Interface

<http://sdb.slis.indiana.edu>

Supports federated search of 25 million publication, patent, grant records.

Results can be downloaded as data dump and (evolving) co-author, paper-citation networks.



Register for free access at <http://sdb.slis.indiana.edu>

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Scholarly Database :: Results - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://sdb.slis.indiana.edu/search/results?q=("artificial intelligence")

mark mckie umich

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SCHOLARLY DATABASE

Cyberinfrastructure for Network Science Center, SLIS, Indiana University, Bloomington

Search Edit Profile Admin About Logout

Browse Results

Your search returned 13,231 results in 0.295 seconds. [Download](#)

Total results per database: NIH: 2,103, Medline: 10,235, USPTO: 279, NSF: 614.

Results 1 through 20.

[Next>>](#)

Source	Authors/Creators	Year	Title	Score (out of 5.71)
Medline	LaCombe	1987	Artificial intelligence.	5.71
Medline		1989	Artificial intelligence: expert systems.	5.71
Medline	Schmitt	1990	[Artificial intelligence in dentistry]	5.71
Medline	Adlassnig and Adlassnig	2002	Artificial-intelligence-augmented systems.	5.60
Medline	Touretzky	1980	Artificial intelligence.	4.86
Medline	Goldenberg	1980	Artificial intelligence.	4.86

Scholarly Database :: Download - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://sdb.slis.indiana.edu/download?q=("artificial intelligence") AND

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SCHOLARLY DATABASE

Cyberinfrastructure for Network Science Center, SLIS, Indiana University, Bloomington

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Download Results

Download records starting at record from the following databases:

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Medline Database:

- ☐ Medline MeSH heading table
- ☐ Medline MeSH qualifier table
- ☐ Medline author table
- ☐ Medline co-author table (nwb format)
- ☐ Medline master table

NIH Database:

- ☐ NIH master table

NSF Database:

- ☐ NSF co-investigator table (nwb format)
- ☐ NSF master table

USPTO Database:

- ☐ USPTO Patent Cooperation Treaty table
- ☐ USPTO agent table
- ☐ USPTO assignee table
- ☐ USPTO citation table (nwb format)
- ☐ USPTO claims table
- ☐ USPTO co-inventor table (nwb format)
- ☐ USPTO inventor table
- ☐ USPTO master (burst format)
- ☐ USPTO master table

[Download](#)

Since March 2009:
Users can download networks:

- Co-author
- Co-investigator
- Co-inventor
- Patent citation

and tables for
burst analysis in NWB.

sdb

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Address D:\sampledata\scientometrics\sdb

Go

CD Writing Tasks

File and Folder Tasks

- Make a new folder
- Publish this folder to the Web

Other Places

- scientometrics
- My Documents
- My Network Places

Details

sdb
File Folder
Date Modified: Today, April 08, 2009, 1:28 PM

Name Size

Files Currently on the CD

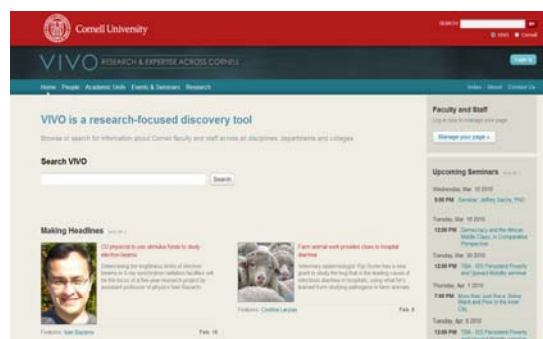
- Medline_author_table.csv 960 KB
- Medline_co-author_table (nwb format).csv 627 KB
- Medline_master_table.csv 13,986...
- Medline_MeSH_heading_table.csv 3,453 KB
- Medline_MeSH_qualifier_table.csv 853 KB
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- USPTO_agent_table.csv 20 KB
- USPTO_assignee_table.csv 23 KB
- USPTO_citation_table (nwb format).csv 72 KB
- USPTO_inventor_table.csv 69 KB
- USPTO_master (burst format).csv 308 KB
- USPTO_master_table.csv 37 KB
- USPTO_Patent_Cooperation_Treaty_table.csv 2 KB

VI VO: A Semantic Approach to Creating a National Network of Researchers ([http:// vivoweb.org](http://vivoweb.org))

- 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:

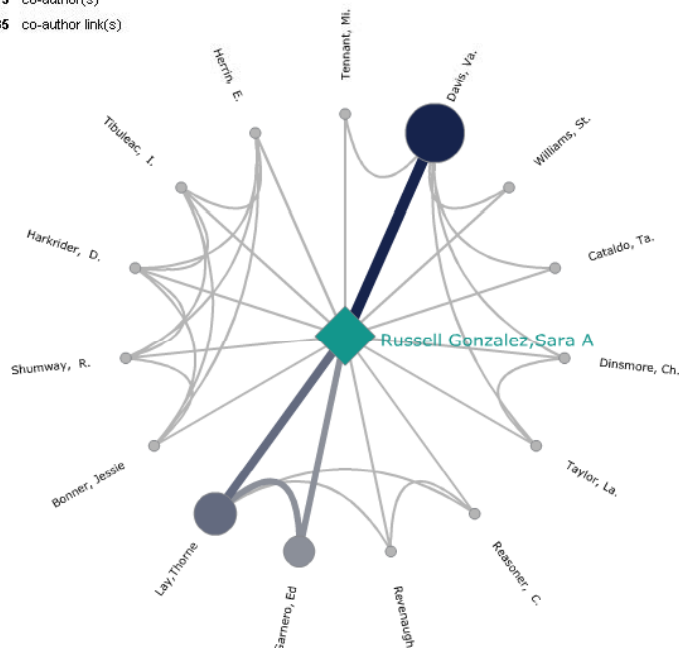
- Simplify reporting tasks, e.g., generate biosketch, department report.



Cornell University: Dean Krafft (Cornell PI), Manolo Bevia, Jim Blake, Nick Cappadona, Brian Caruso, Jon Corson-Rikert, Elly Cramer, Medha Devare, John Ferreira, 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, Michaelen 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.

Co-Author Network ([GraphML File](#))

15 co-author(s)
35 co-author link(s)

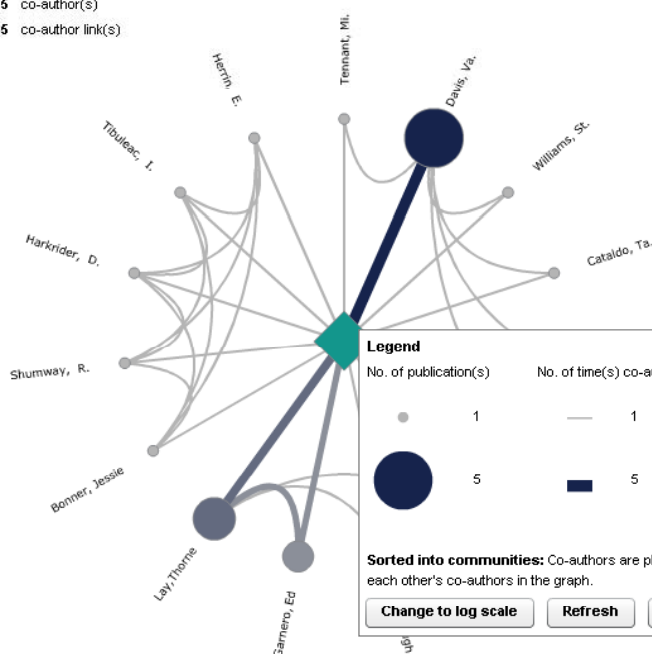


Russell Gonzalez, Sara A
Physical Sciences Librarian
[VIVO profile](#) | [Co-author network](#)

9 Publication(s)
15 Co-author(s)
1998 First Publication
2010 Last Publication

Co-Author Network (GraphML File)

15 co-author(s)
35 co-author link(s)



Russell Gonzalez, Sara A
Physical Sciences Librarian
[VIVO profile](#) | [Co-author network](#)

9 Publication(s)
15 Co-author(s)
1998 First Publication
2010 Last Publication

Legend

No. of publication(s) No. of time(s) co-authored

1 1

5 5

Interact

Hover over any name to see the number of joint publications and co-authors with Russell Gonzalez, Sara A.
Click on a name to see details on the right.

Thresholding

Only people that co-authored more than 0 paper(s) with Russell Gonzalez, Sara A. are shown.
0 out of 0 co-author(s) are shown.

Sorted into communities: Co-authors are placed near one another if they frequently collaborate with each other and each other's co-authors in the graph.

[Change to log scale](#)

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[Sort alphabetically](#)

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Borner, Katy

This information is based solely on publications which have been loaded into the VIVO system. This may only be a small sample of the person's total work.

General Statistics

35 publication(s) from 2001 to 2010
80 co-author(s) from 2001 to 2010

Co-Author Network

15 co-author(s)
26 co-author link(s)



Legend

No. of publication(s) No. of time(s) co-authored

1 1

5 5

Interact

Hover over any name to see the number of joint publications and co-authors with Borner, Katy.
Click on a name to see details on the right.

Thresholding

Only people that co-authored more than 1 paper(s) with Borner, Katy are shown.
15 out of 80 co-author(s) are shown.

Tables

Publications per Year	Co-author Publications with Borner, Katy
2001	2
2002	4
2003	2
2004	7
2005	7
2006	3
2007	10

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-vis.slis.indiana.edu/vivo1/visualization?uri=http%3A%2F%2Fvivo.slis.indiana.edu%2Fvivo1%2Fcore%2Fperson72&vis=person_level&render_mode=standalone

20

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

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.; Penumarthi S.; Thakur S.; Sooriarmurthi R.; Maru J.T.; Shiffrin R.M.; Mane K.; Moor K.A.;

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

Co-author network ([GraphML File](#))

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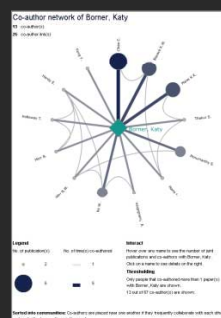
```

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



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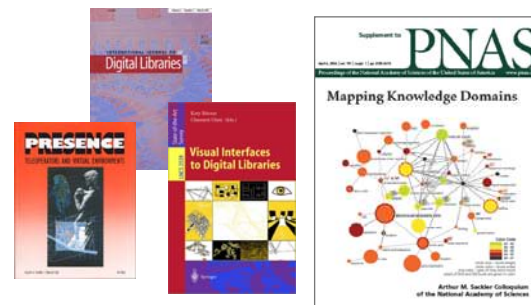
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http://www.pnas.org/content/vol101/suppl_1/

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.
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<http://scimaps.org/atlas>

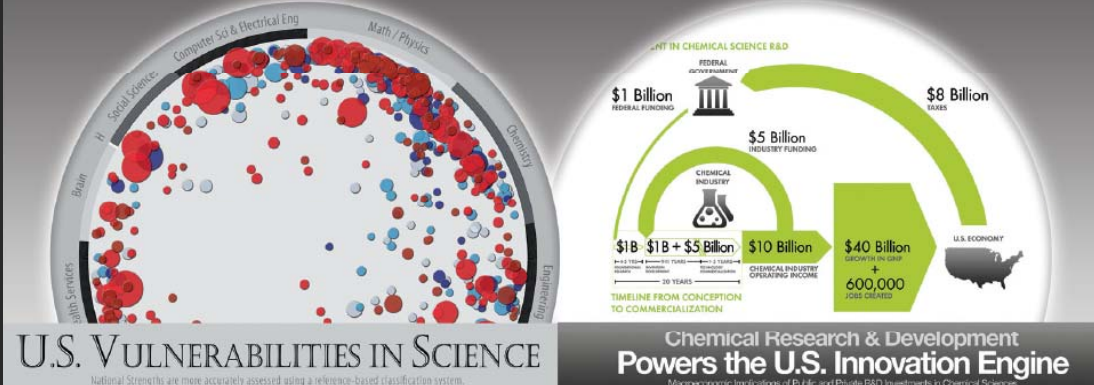


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Mapping Innovation for Congress

CREATING AN **Innovation Dashboard** TO INFORM POLICY MAKERS

A Seminar and Interactive Session | Thursday, December 10, 2009 | Rayburn HOB 2103 | 3:00 p.m. - 4:30 p.m.



Have you ever wondered what an "Innovation Dashboard" of your state or congressional district would reveal? Where would the "Pockets of Innovation" lie and what pathways do those innovations take to impact education, health, or profit? Where are the jobs or the innovative education programs? How would you use such a dashboard in your daily work?

This seminar series brings together R&D researchers with a strong background in data analysis and visualization and selected Members of Congress and Congressional Staff. The main goal is to collectively identify features and functionality of an "Innovation Dashboard" for Congress.

AGENDA

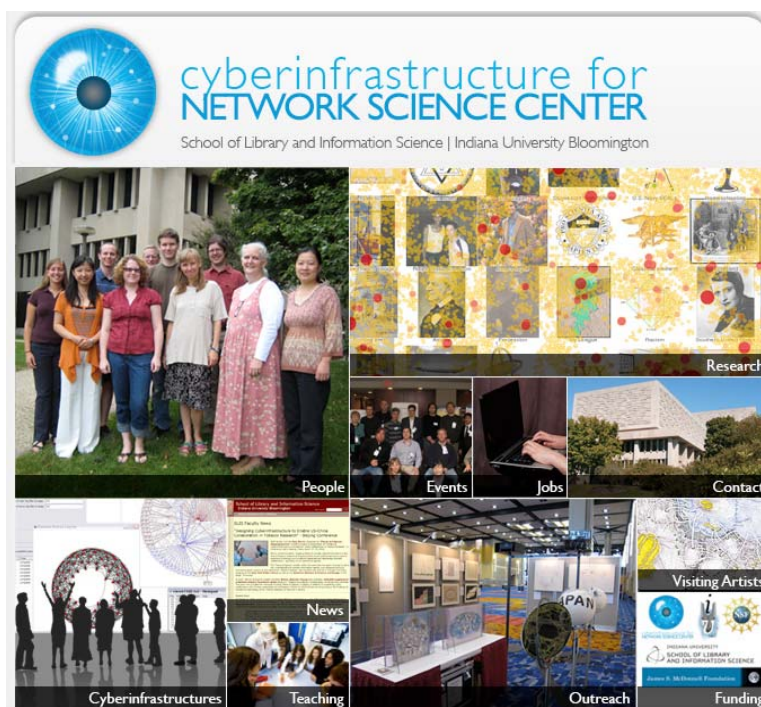
- 3:00 p.m. Welcome & Introductions
- 3:10 p.m. Overview of R&D Analyses and Maps
- 3:45 p.m. Open Discussion Forum
- 4:30 p.m. Adjourn

Take ASTRA's Mapping Innovation for Congress Survey—please visit <https://www.surveymonkey.com/s/C9XTPLB>

The first session in this series features Dr. Katy Börner of Indiana University. Dr. Börner will describe different approaches to R&D data analysis and visualization, discuss sample maps from the international Mapping Science exhibit (<http://scimaps.org>) and insights derived from them, as well as near-term developments in the mapping of R&D data. This presentation is followed by a structured but open discussion on desirable features and functionality for "State-Oriented R&D Fact Sheets" and "Innovation Dashboards" and how they would be used to understand, improve, and communicate State and Congressional District innovation metrics.

Please RSVP to the rhoege@comcast.net by December 7, 2009 and confirm your attendance as seating is limited.

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