

Impact Evaluation: Data, Tools, Analysis & Visualization

Katy Börner

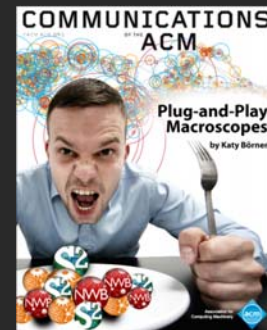
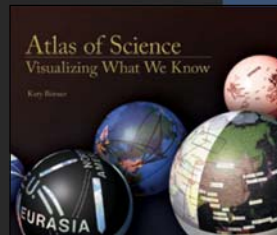
Cyberinfrastructure for Network Science Center, Director
Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
katy@indiana.edu



With special thanks to the members at the Cyberinfrastructure for Network Science Center, the Sci2 team, and the VIVO Collaboration

*EERE and ARPA-E Workshop on
Measuring and Communicating Program Impacts
Washington, D.C.*

September 14, 2011



Science of Science Studies: Sci2 Tool



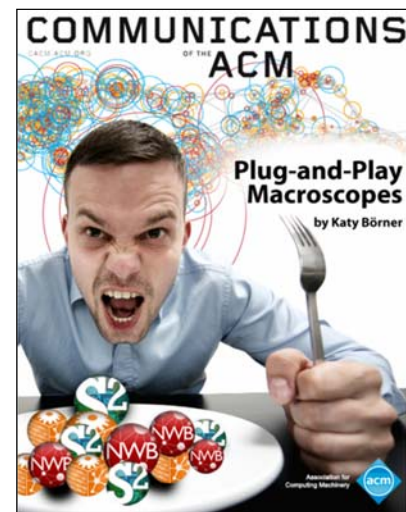
Plug-and-Play Macroscopes

While **microscopes** and **telescopes** are physical instruments, **macroscopes** resemble continuously changing bundles of software plug-ins.

Sharing algorithm components, tools, or novel interfaces becomes as easy as sharing images on Flickr or videos on YouTube. Assembling custom tools is as quick as compiling your custom music collection.

They provide a **common standard** for

- the design of **modular, compatible algorithm and tool plug-ins**
- that can be **easily combined into scientific workflows**, and
- **packaged as custom tools**.



Börner, Katy. (2011). Plug-and-Play Macroscopes. *Communications of the ACM*, 54(3), 60-69.

Video is at <http://www.scivee.tv/node/27704>

3

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?
[Register now](#)

Tutorials

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://sci2.cns.iu.edu>
<http://sci2.wiki.cns.iu.edu>

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

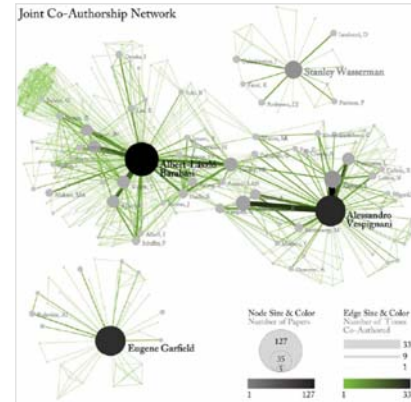
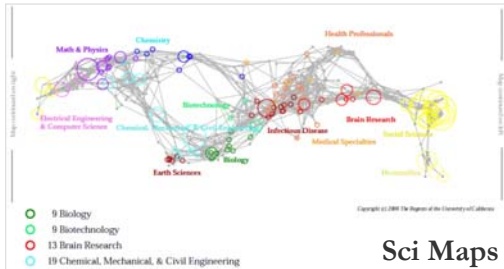
NIH Office of Extramural Research and Katy Börner (2010) [Network Visualizations Using SPIRES Data and the Sci2 Tool](#). Office of Extramural Research at NIH.

4

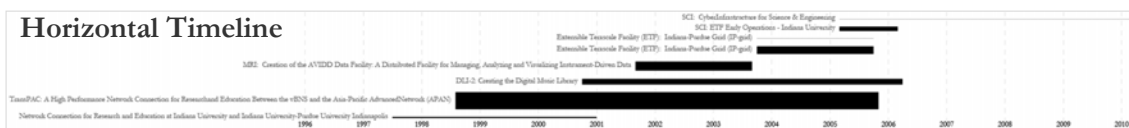


Sci² Tool – “Open Code for S&T Assessment” to run replicable workflows

OSGi/CIShell powered tool, see <http://cishell.org>
<http://sci2.cns.iu.edu> | <http://sci2.wiki.cns.iu.edu>



Horizontal Timeline



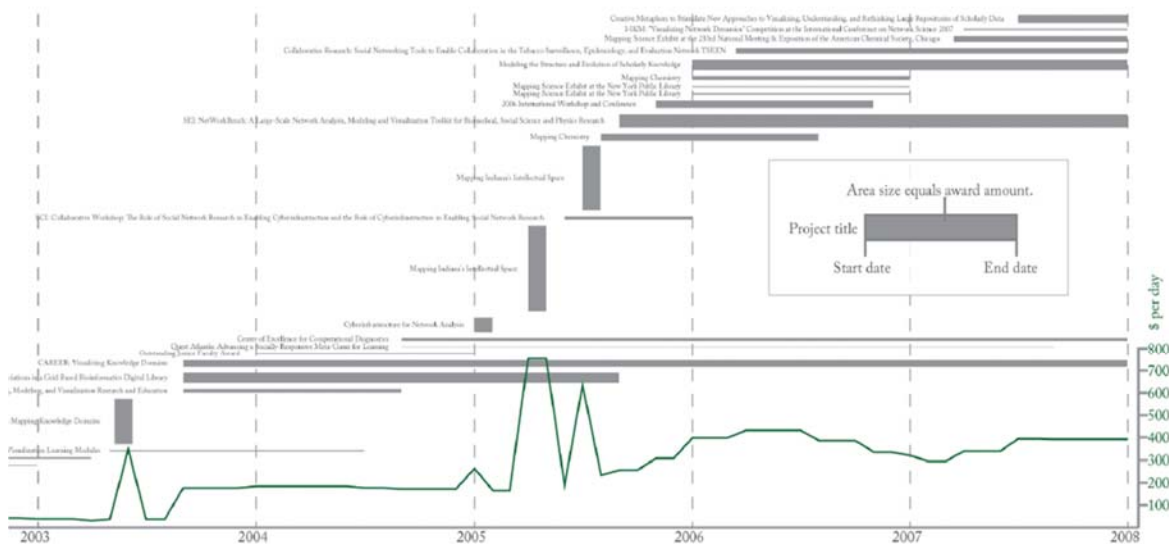
Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Dubon, Russell Jackson, Phillips, Patrick, Ma, Nianli, Zoss, Angela, Guo, Hanning & Price, Mark. (2009). *ReTe-Netzwerk-Red: Analyzing and Visualizing Scholarly Networks Using the Scholarly Database and the Network Workbench Tool. Proceedings of ISSI 2009: 12th International Conference on Scientometrics and Informetrics, Rio de Janeiro, Brazil, July 14-17. Vol. 2, pp. 619-630.*

5



Timeline Visualization: Example

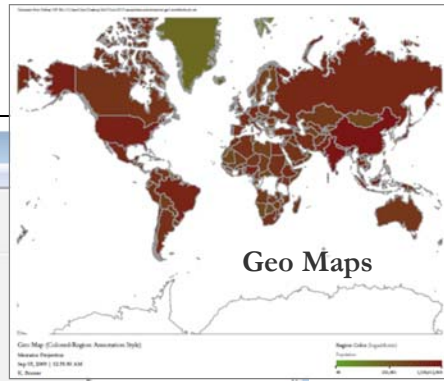
Project Timeline



6



Sci² Tool



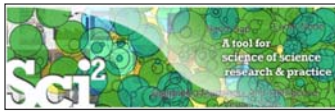
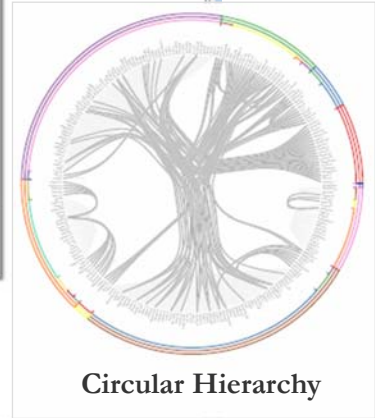
Sci² Tool
File Preprocessing Modeling Analysis Visualization Scientometrics Help

Console
Welcome to the Science of Science Tool (Sci²). The development of this tool is supported in Network Science center and the School of Li Indiana University, the National Science Foundation and IIS-0715303, and the James S. McDonnell Cyberinfrastructure portal (<http://sci.slis.indiana.edu>).
The primary investigators are Katy Börner, In SciTech Strategies Inc. The Sci² tool was developed by J. Duhon, Patrick A. Phillips, Chintan Tank, a Cyberinfrastructure Shell (<http://cishell.org>) for Network Science Center (<http://cns.slis.indiana.edu>). Many algorithm plugins were derived from the Network Science Center (<http://nwb.slis.indiana.edu>).
Please cite as follows:
Sci² Team. (2009). Science of Science Tool. In SciTech Strategies Inc., <http://sci.slis.indiana.edu>.

Scheduler
Remove From List Remove completed

!	Algorithm Name	Date	Time	% Con
<input checked="" type="checkbox"/>	Extract Co-Author Network	09/03/2009	00:15:20 AM	100%
<input checked="" type="checkbox"/>	Load and Clean ISI File	09/03/2009	00:15:05 AM	100%

- GUESS
- GnuPlot
- Radial Tree/Graph (prefuse alpha)
- Radial Tree/Graph with Annotation (prefuse beta)
- Tree View (prefuse beta)
- Tree Map (prefuse beta)
- Force Directed with Annotation (prefuse beta)
- Fruchterman-Reingold with Annotation (prefuse beta)
- DrL (VxOrd)
- Specified (prefuse beta)
- Horizontal Line Graph
- Circular Hierarchy
- Geo Map (circle annotations)
- Geo Map (region coloring annotations)
- Image Viewer
- RefMapper



Network Extraction: Examples

Author co-occurrence network

	A	B
1	Publication	Authors
2	Paper1	A1
3	Paper2	A1;A2;A6
4	Paper3	A1;A3
5	Paper4	A1;A4;A5
6	Paper5	A5;A6
7	Paper6	A1;A2

Extract Network from Table

Extracts a network from a delimited table

Column Name: Authors

Text Delimiter: ;

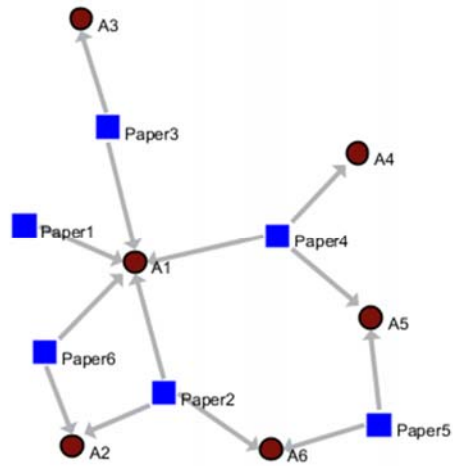
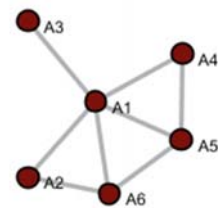
Extract Bipartite Network

Extract a bipartite network from two columns in the table. If the column values may list multiple entries, enter the special text which delimits them.

First column: Publication

Second column: Authors

Text Delimiter: ;

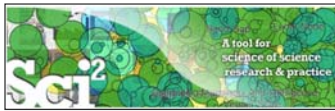
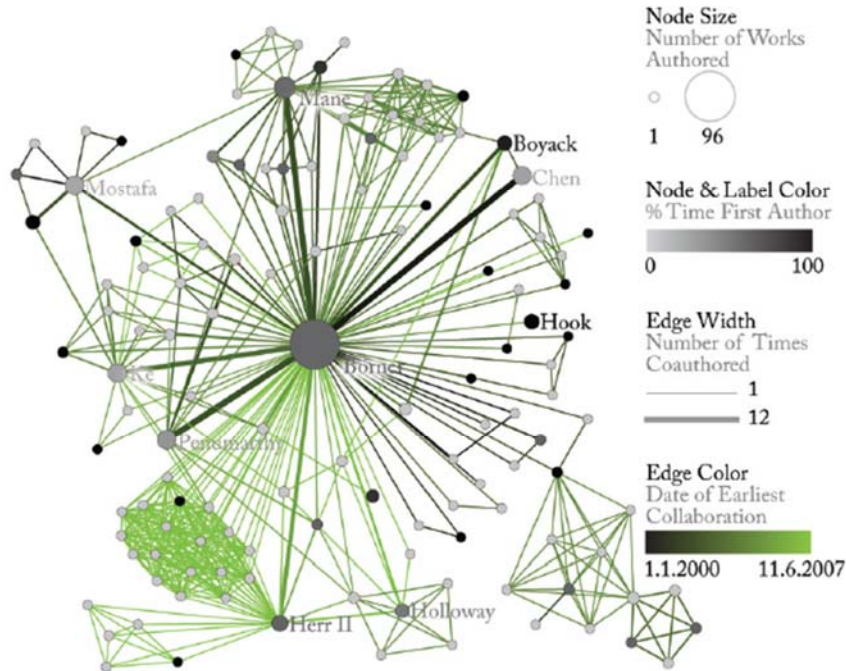


Paper-author 2-mode network



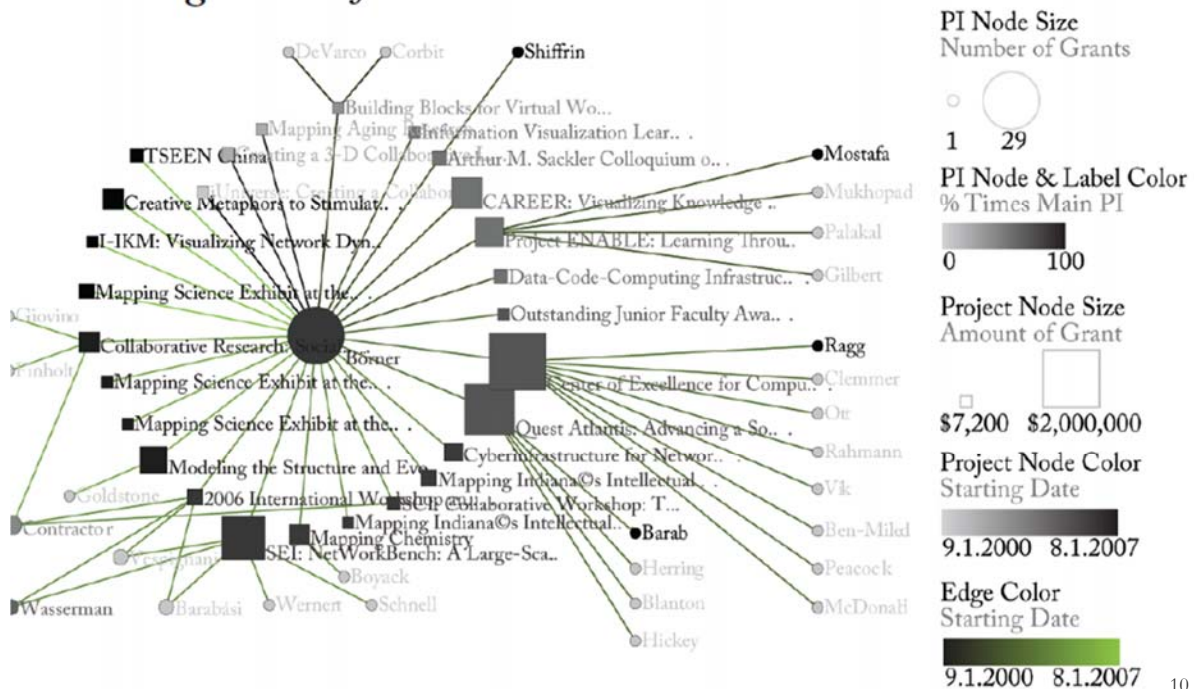
Network Visualization: Example

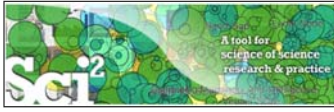
Coauthor Network



Network Visualization: Example

Investigator-Project Network





Sci2 Tool Adoption

The Sci² Tool is used by NSF, NIH, USDA, and private foundations.



Upcoming Tutorial:

Sci2: A Tool of Science of Science Research and Practice

- Instructor:** Dr. Katy Börner, Indiana University
- Time/Date:** 8:30a-11:30a on Oct 17, 2011
- Place:** Room II-555 in NSF's Stafford Place II Conference Center, 4121 Wilson Boulevard, Arlington, Virginia 22230, USA
- Audience:** This tutorial is designed for researchers, practitioners, program staff from federal agencies interested to use advanced data mining algorithms and visualizations in their work and daily decision making.
- Cost:** Free. Registration by Oct 10, 2012 required.
- Register:** Please use <http://www.surveymonkey.com/s/MVC8LWW> to register by Oct 10, 2012. NSF will issue visitor badges.

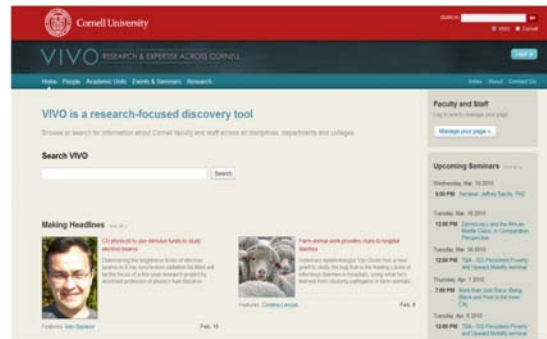
11

Communicating and Analyzing Institutional Data: VIVO

12

VIVO: A Semantic Approach to Creating a National Network of Researchers (<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.
- Simplify reporting tasks, e.g., generate biosketch, department report.



Funded by \$12 million NIH award.

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 Ping, 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.



University of Florida

How do you want to compare?
by Grants

Who do you want to compare?
Search: X

Records 1 - 10 of 30

Entity Label	Grant Count	Entity Type
<input checked="" type="checkbox"/> Continuing Education	562	UF Department, Agent, Non-Academic Department, Department
<input checked="" type="checkbox"/> Florida Museum of Natural History	203	Museum, Agent
<input checked="" type="checkbox"/> College of Agricultural and Life Sciences	166	Agent, UF College, College
<input checked="" type="checkbox"/> College of Engineering	103	Agent, UF College, College
<input checked="" type="checkbox"/> Evelyn F. and William L. McKnight Brain Institute of the University of Florida	64	UF Center, Agent, Center
<input checked="" type="checkbox"/> International Center	54	UF Department, Agent, Non-Academic Department, Department
<input checked="" type="checkbox"/> Florida Sea Grant	44	UF Center, Agent, Center
<input type="checkbox"/> Whitney Laboratory for Marine Bioscience	42	UF Research Laboratory, Agent, Laboratory, Research Laboratory
<input type="checkbox"/> Water Institute	38	UF Center, Agent, Center
<input type="checkbox"/> College of Dentistry	35	Agent, UF College, College

[Save as CSV](#) [Clear](#)

Comparing Grants of Organizations in University of Florida

Total Number of Grants

You have selected 7 of a maximum 10 organizations to compare. [Clear](#)

- Florida Sea Grant 44
- International Center 54
- Evelyn F. and William L. McKnight Brain Institute of the University of Florida 64
- College of Engineering 103
- College of Agricultural and Life Sciences 166
- Florida Museum of Natural History 203
- Continuing Education 562

Temporal Analysis (When) Temporal visualizations of the number of papers/funding award at the institution, school, department, and people level

Index Log in

Search

Home

People

Organizations

Research

Events

University of Florida

Explore 487 publications activity across 554 scientific sub-disciplines

13 Disciplines | 554 Sub-Disciplines

Search: X

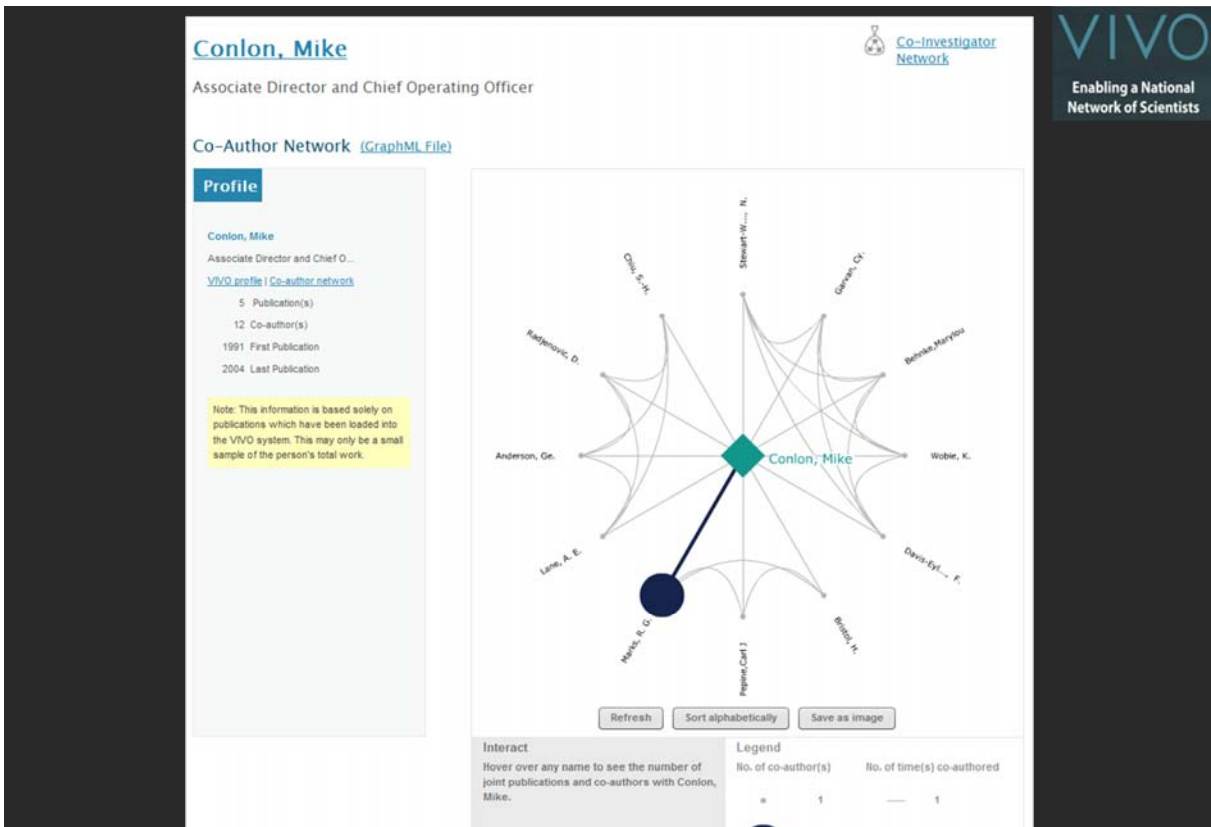
1 - 13 of 554

Sub-Disciplines	# of pubs.	% activity
Pest Management Science	24.2	5.0
Wildlife Research	19.1	3.9
Protein Science	13.1	2.7
Clinical Cancer Research	12.6	2.6
Pain	12.0	2.5
Environmental Contamination	11.2	2.3
Insect Physiology	11.1	2.3
Organic Chemistry	10.9	2.2
Marine Biology	10.3	2.1
Computer Aided Molecular Design	10.2	2.1
BioStatistics	9.0	1.9

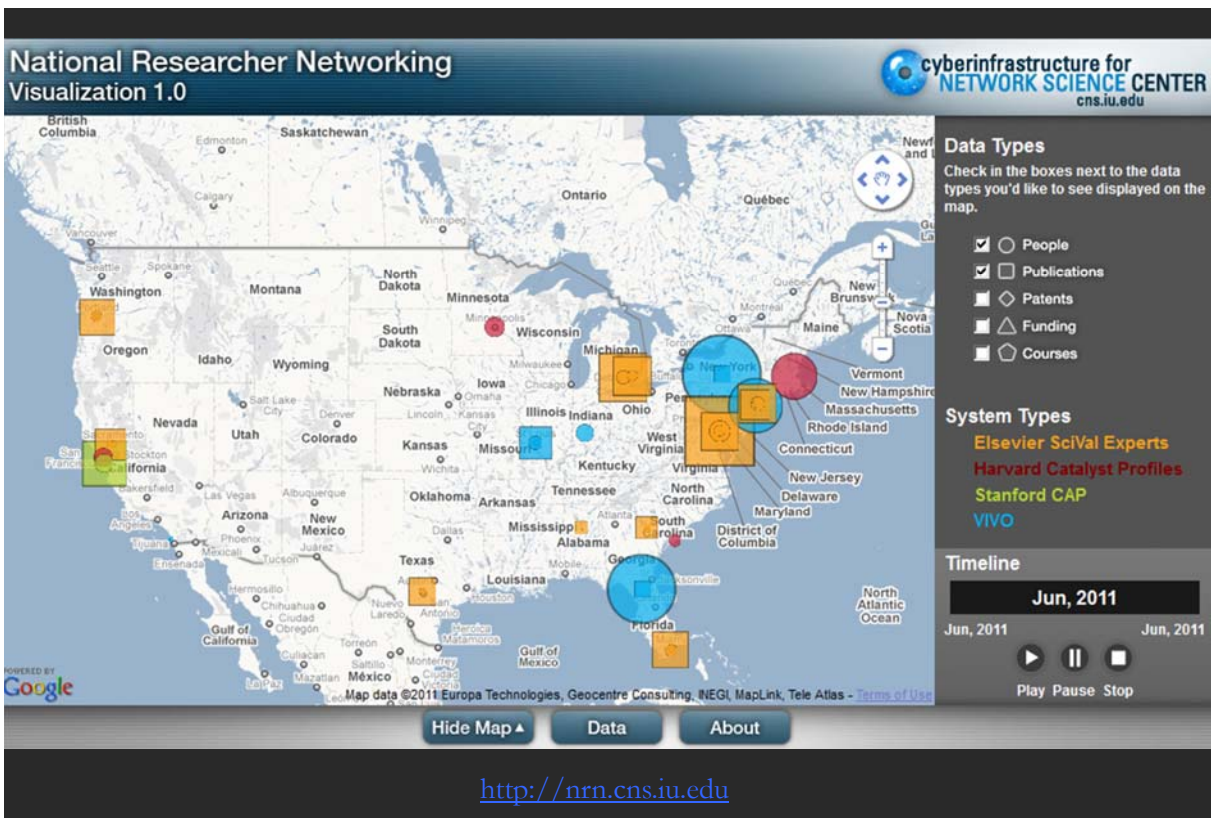
Top 290 disciplines shown

mapped 14.55% of 3,346 publications

Topical Analysis (What) Science map overlays will show where a person, department, or university publishes most in the world of science. (in work)



Network Analysis (With Whom?) Who is co-authoring, co-investigating, co-inventing with whom? What teams are most productive in what projects? 17

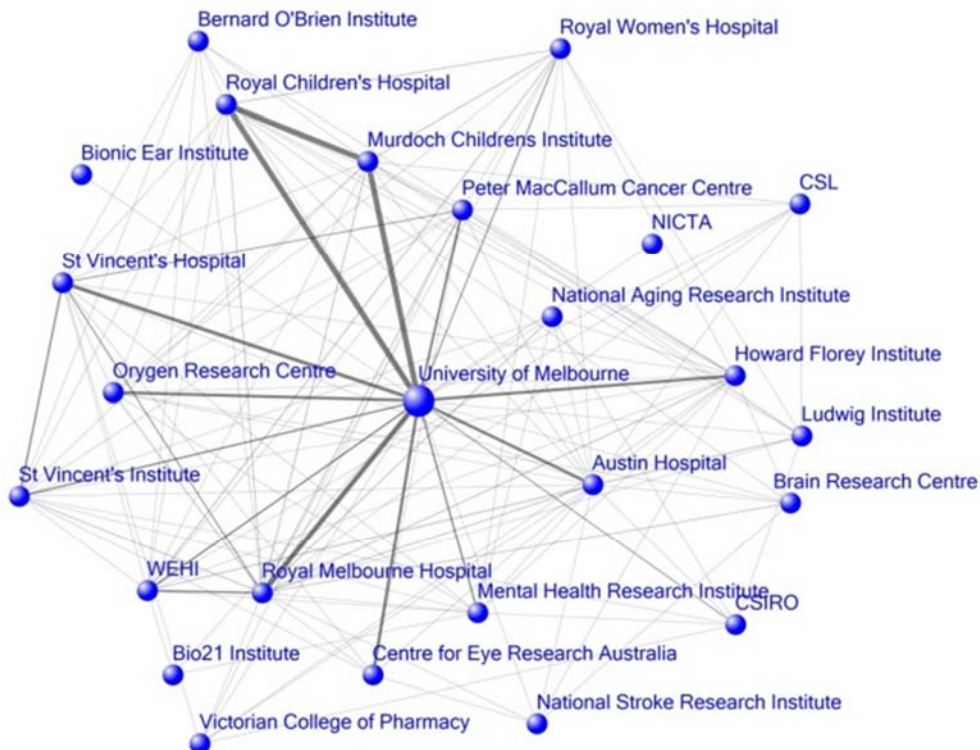


Geospatial Analysis (Where) Where is what science performed by whom? Science is global and needs to be studied globally. 18

VIVO was recently adopted by USDA as a means to federate and serve institutional data; to analyze and communicate funding impact.

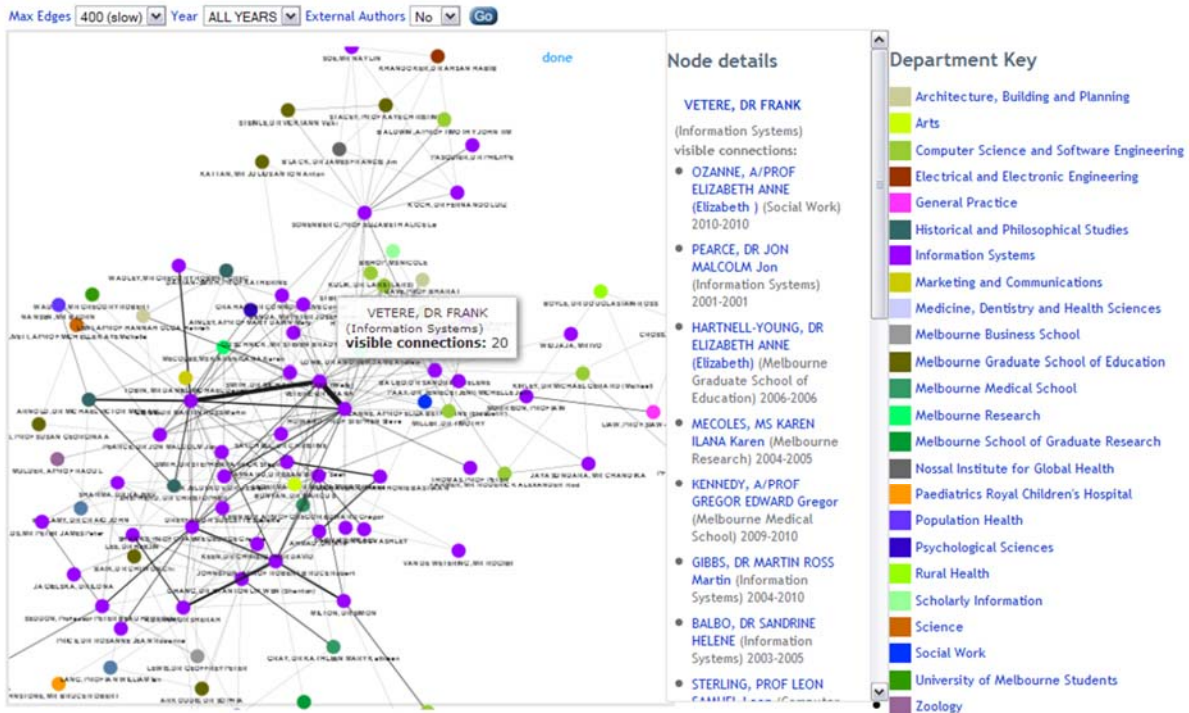


19



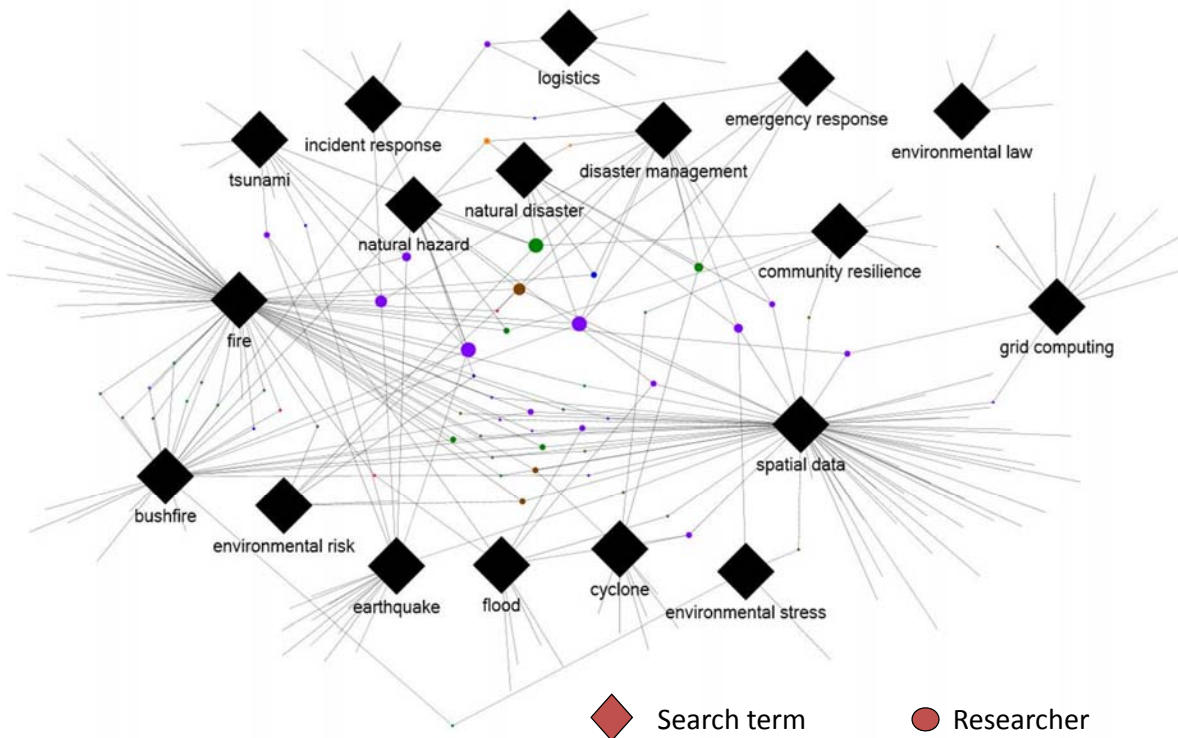
2008 collaboration patterns for medical institutions located close to Melbourne University
 Source: Web of Science co authorship information. Compiled by Simon Porter

20



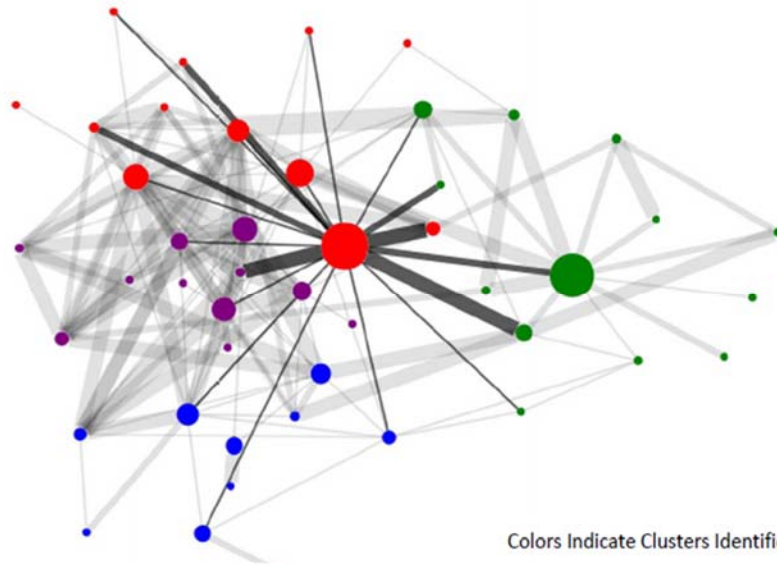
Co-authorship network for the department of Information Systems

Source: Melbourne Research Windows. Contact Simon Porter simon.porter@unimelb.edu.au



Bimodal network of search terms and researchers extracted from research profile search results to show the **University's capability in Disaster Management** to the Government

Contact: simon.porter@unimelb.edu.au



Colors Indicate Clusters Identified by Algorithm

Key
 ● Researcher ●●● Increasing 'Betweenness Centrality' (Bridging Effect on Network)
 — Co-Authorship — Co-Participation on Sponsored Project — Co-Authorship and Co-Participation on Sponsored Project

P30 Member Collaborations – Sponsored Project Co-Participation and Co-Authorship Network. Used in **successful! P30** funding application. Shows the PI's relationships with various P30 members, conveying that the PI was not only the formal center of the group but also the informal center and the person who exhibited the highest betweenness centrality. Contact: Jeffrey Horon, J.Horon@elsevier.com

Exploring and Monitoring S&T Landscapes: Online Interactive Maps

Geographic Map Science Map



Funding
 NIH
 NSF
 USDA

Publications
 DOE
 ISI
 Medline

Patents
 USPTO

Citations Count

Amount Count

From year 1901 to year 2009

Search by keyword

<http://mapsustain.cns.iu.edu>

Detail About

Geographic Visualization

Here we have a more traditional view of the records - a geographic overlay. Featured here are the records that list both a city and state in the United States. Feel free to search, zoom, pan, and click for descriptions.

The dataset covers 13,528 records on "biomass" and "biofuel" research and technology from seven different publication, patent, funding datasets.

Geographic Map Science Map



Funding
 NIH
 NSF
 USDA

Publications
 DOE
 ISI
 Medline

Patents
 USPTO

Maps Detail **Data** About

Datasets

The dataset covers 13,528 records on "biomass" and "biofuel" research and technology from seven different publication, patent, funding datasets for the years 1901 to 2010.

Funding

National Institutes of Health (NIH) awards retrieved from the Scholarly Database (<http://sdb.slis.indiana.edu>) at Indiana University on 11/20/2010. Search query used was biomass OR biofuel OR "bio mass" OR "bio fuel" in the 'All Text' field.

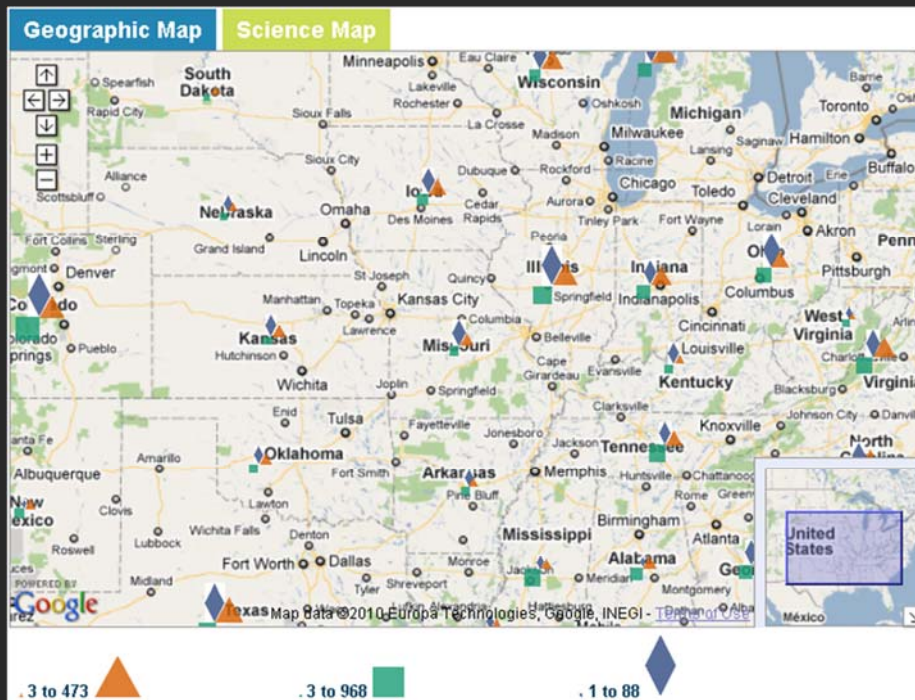
National Science Foundation (NSF) awards retrieved from the Scholarly Database (<http://sdb.slis.indiana.edu>) at Indiana University on 11/20/2010. Search query used was biomass OR biofuel OR "bio mass" OR "bio fuel" in the 'All Text' field.

US Department of Agriculture (USDA) awards made available by a staff member of the Office of Scientific and Technical Information from the US Department of Energy (DOE).

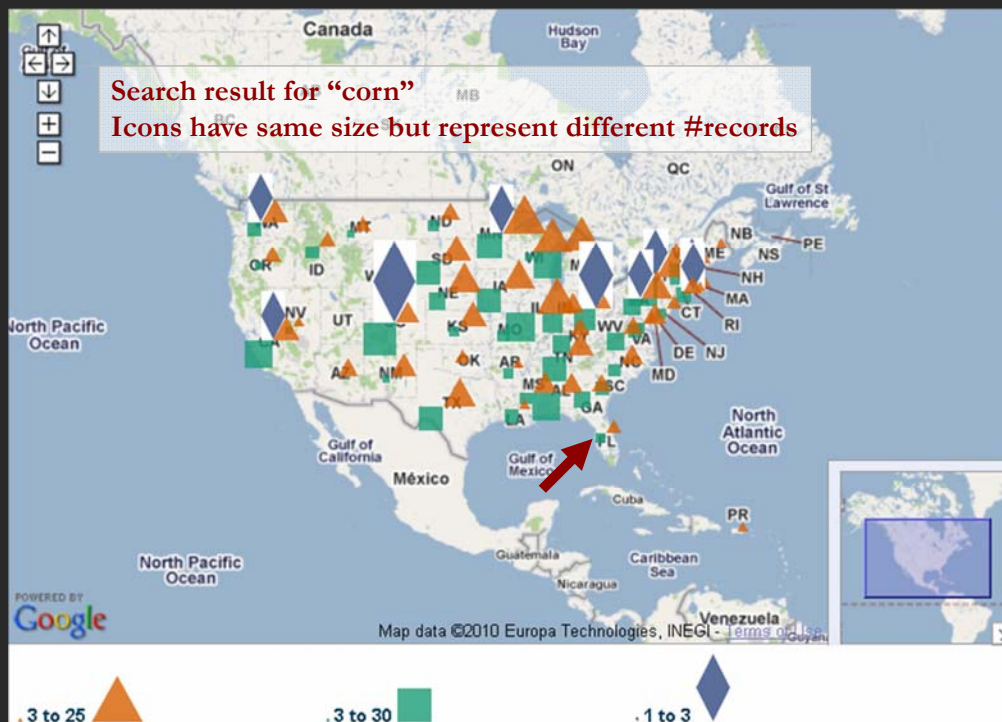
Publications

MEDLINE papers by the National Library of Medicine retrieved from the Scholarly Database (<http://sdb.slis.indiana.edu>) at Indiana University on 11/20/2010. Search query used was biomass OR biofuel OR "bio mass" OR "bio fuel" in the 'All Text' field.

The geographic map at state level.

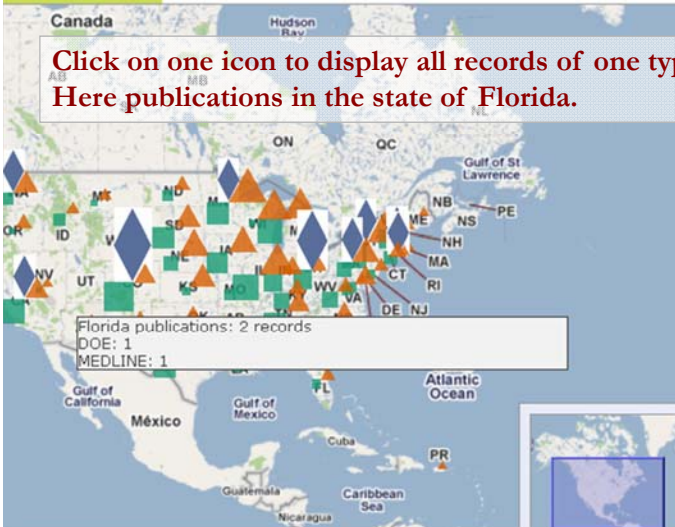


The geographic map at city level.



Science Map

Click on one icon to display all records of one type.
Here publications in the state of Florida.



Maps

Detail

Data

About

> Florida

MEDLINE

2002

- [Recovery Of Dairy Manure Nutrients By Benthic Freshwater Algae](#)

DOE

1985

- [Enzymatic Hydrolysis And Fermentation Of Corn For Fuel Alcohol](#)

29

Information Bridge: DOE Scientific and Technical Information - - Document #5789929 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.osti.gov/bridge/product.biblio.jsp?osti_id=5789929

MapSustain x Information Bridge: DOE Scientifi... x

DOE Scientific and Technical Information

DOE • OSTI

INFORMATION BRIDGE

Home • Basic Search • Fielded Search • Alerts • Help

FAQ • Widget • Site Map

SHARE

Bibliographic Citation

[See/Add Document Discussions](#) [Return to Search Results](#) [Return to Original Search Page](#) [Download as EndNote](#)

Full Text Availability information may be found in the Availability, Publisher, Research Organization, Resource Relation and/or Author (affiliation information) fields and/or via the "Full-text Availability" link. For a journal article, please see the Resource Relation field.

Title Enzymatic hydrolysis and fermentation of corn for fuel alcohol
[Word Cloud](#) | [More Like This](#)

Creator/Author [Mullins, J.T.](#)

Publication Date 1985 Jan 01

OSTI Identifier OSTI ID: 5789929

Other Number(s) Journal ID: CODEN: BIBA

Resource Type Journal Article

Resource Relation Journal Name: Biotechnol. Bioeng.; (United States); Journal Volume: 27:3

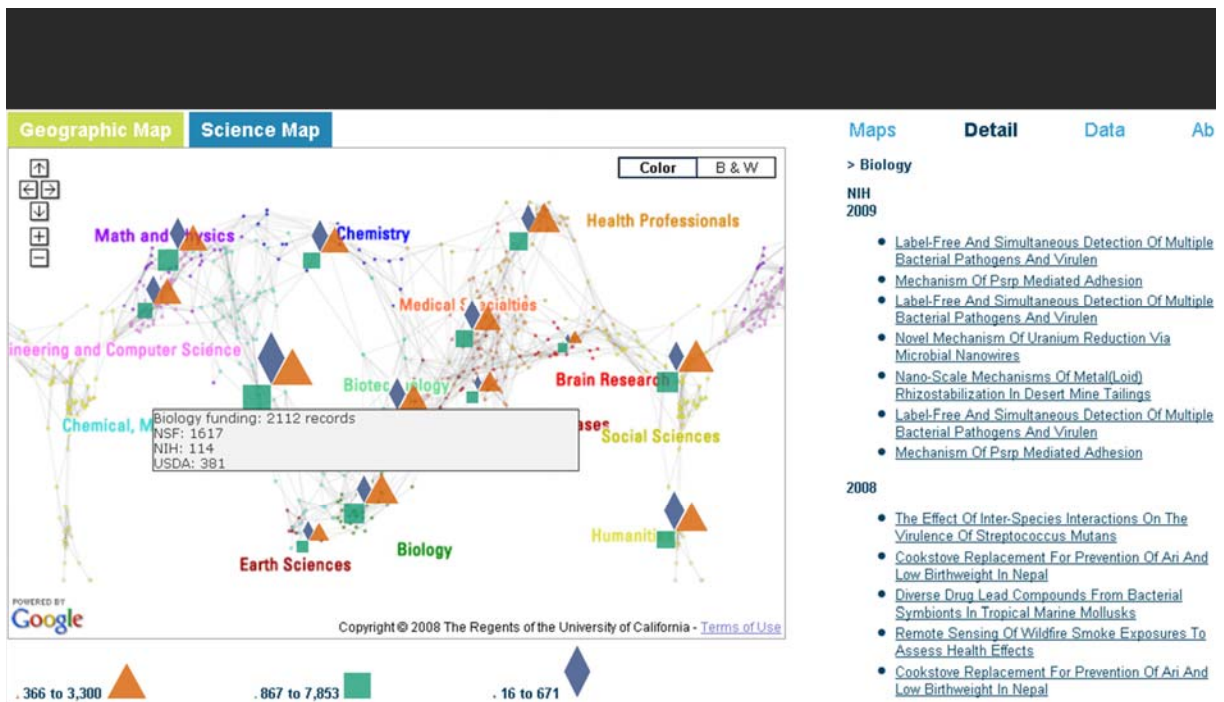
Research Org Univ. of Florida, Gainesville

Subject 09 BIOMASS FUELS; 32 ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION; ETHANOL FUELS; BIOSYNTHESIS; MAIZE; ENZYMATIC HYDROLYSIS; FERMENTATION; PRODUCTIVITY; COST; ENERGY EFFICIENCY; EXPERIMENTAL DATA; WASTE PRODUCT UTILIZATION; ALCOHOL FUELS; BIOCONVERSION; CEREALES; CHEMICAL REACTIONS; DATA; DECOMPOSITION; EFFICIENCY; FUEL; GLASS; HYDROLYSIS; INFORMATION; LYSIS; NUMERICAL DATA; PLANTS;

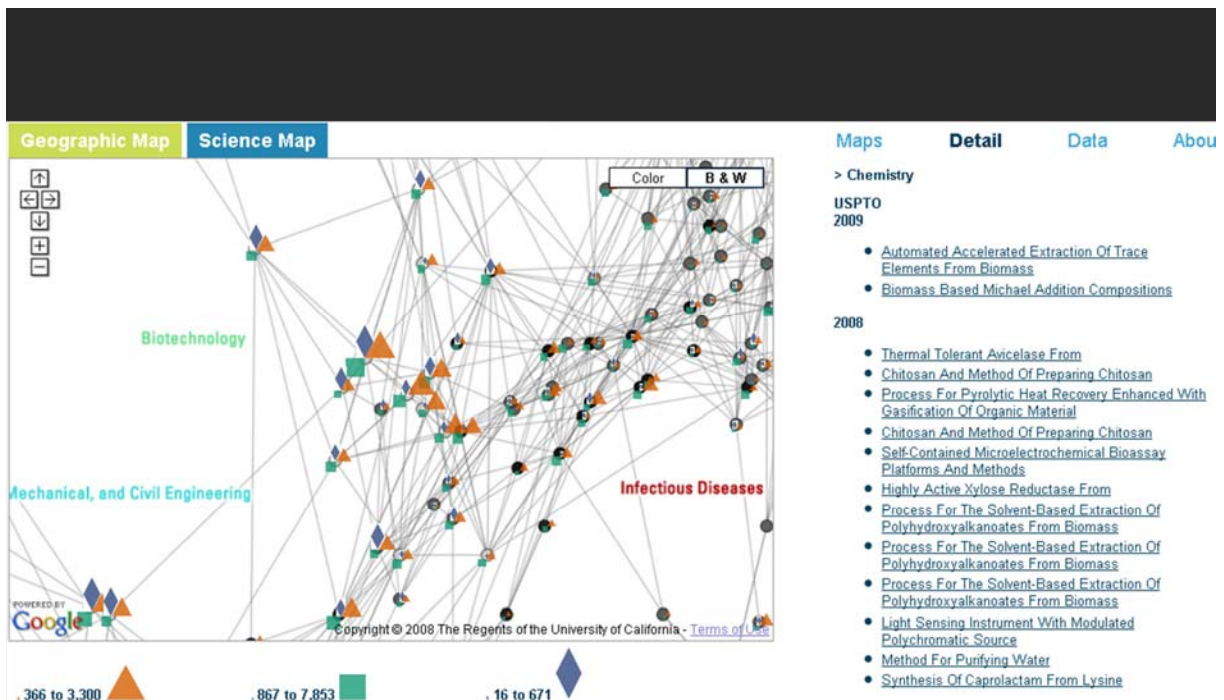
Done

Detailed information on demand
via original source site for exploration and study.

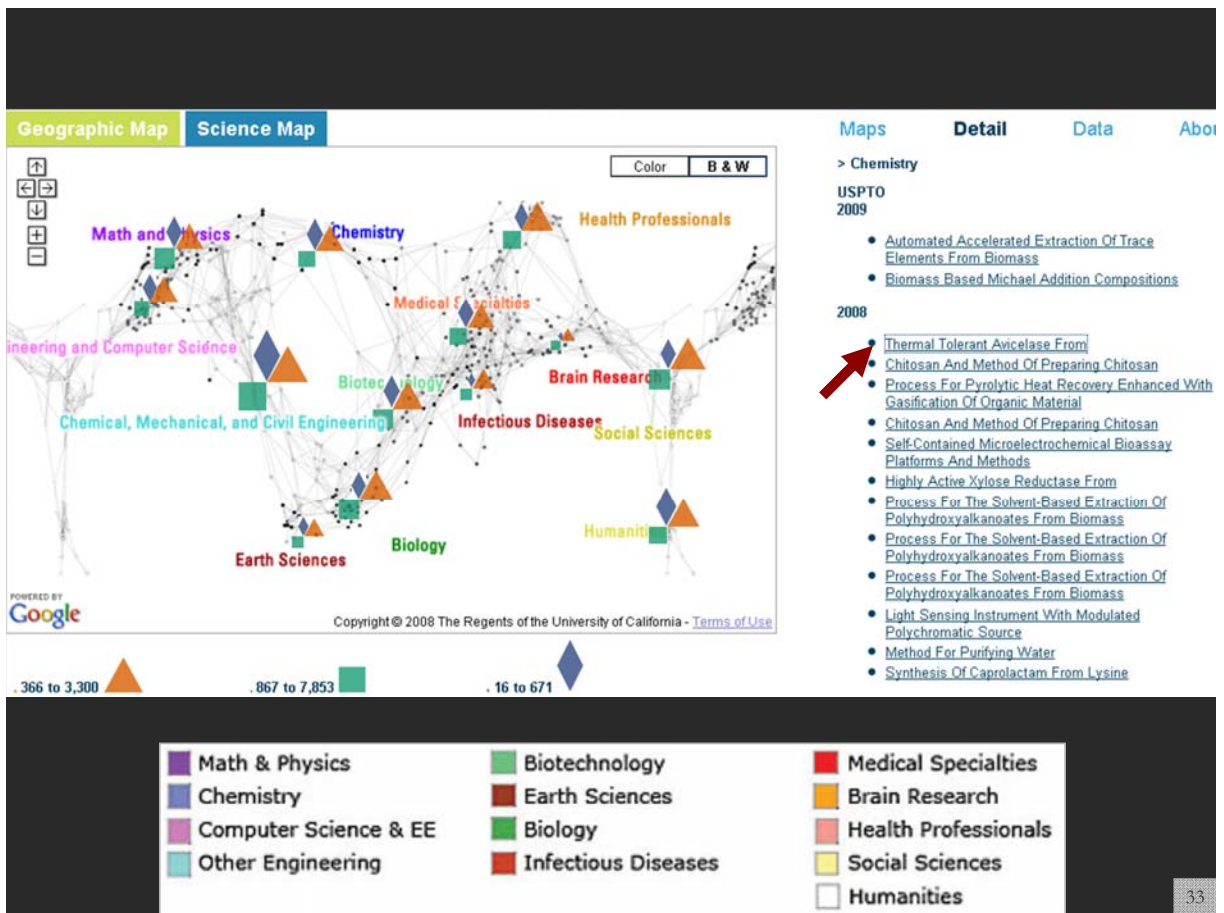
30



The science map at 13 top-level scientific disciplines level.



The science map at 554 sub-disciplines level.



- Maps Detail Data About
- > Chemistry
- USPTO
- 2009
- Automated Accelerated Extraction Of Trace Elements From Biomass
 - Biomass Based Michael Addition Compositions
- 2008
- Thermal Tolerant Avicelase From Chitosan And Method Of Preparing Chitosan
 - Process For Pyrolytic Heat Recovery Enhanced With Gasification Of Organic Material
 - Chitosan And Method Of Preparing Chitosan
 - Self-Contained Microelectrochemical Bioassay Platforms And Methods
 - Highly Active Xylose Reductase From Process For The Solvent-Based Extraction Of Polyhydroxyalkanoates From Biomass
 - Process For The Solvent-Based Extraction Of Polyhydroxyalkanoates From Biomass
 - Process For The Solvent-Based Extraction Of Polyhydroxyalkanoates From Biomass
 - Light Sensing Instrument With Modulated Polychromatic Source
 - Method For Purifying Water
 - Synthesis Of Caprolactam From Lysine

United States Patent: 7364890 - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://patft.uspto.gov/netacgi/nph-Parser?Sect1=PTO1&Sect2=HITOFF&d=PALL&p=1&u=/netacgi/PTO/srch

MapSustain United States Patent: 7364890 United States Patent: 7364890 Information Bridge: DOE Scientific a...

USPTO PATENT FULL-TEXT AND IMAGE DATABASE

Home Quick Advanced Pat Num Help

Bottom

View Cart Add to Cart

Images

(1 of 1)

United States Patent 7,364,890
Ding, et al. April 29, 2008

Thermal tolerant avicelase from *Acidothermus cellulolyticus*

Abstract

The invention provides a thermal tolerant (thermostable) cellulase, AvIII, that is a member of the glycoside hydrolase (GH) family. AvIII was isolated and characterized from *Acidothermus cellulolyticus* and, like many cellulases, the disclosed polypeptide and/or its derivatives may be useful for the conversion of biomass into biofuels and chemicals.

Inventors: Ding; Shi-You (Golden, CO), Adney; William S. (Golden, CO), Vinzant; Todd B. (Golden, CO), Himmel; Michael E. (Littleton, CO)
Assignee: Midwest Research Institute (Kansas City, MO)
Appl. No.: 09/017,276

Done

34

Showcasing Impact to a Large and Diverse Audience: Large-Format Visualizations

35

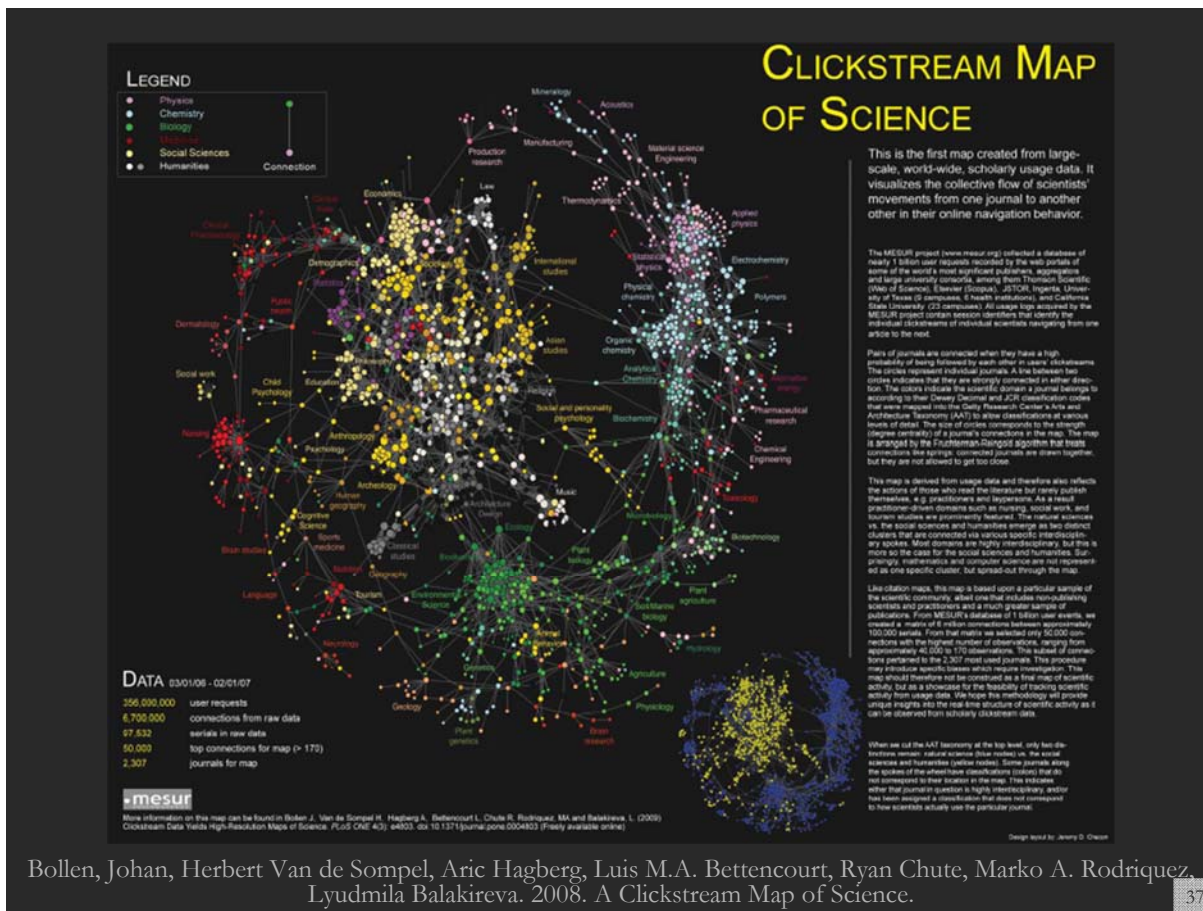
Mapping Science Exhibit – 10 Iterations in 10 years

<http://scimaps.org>

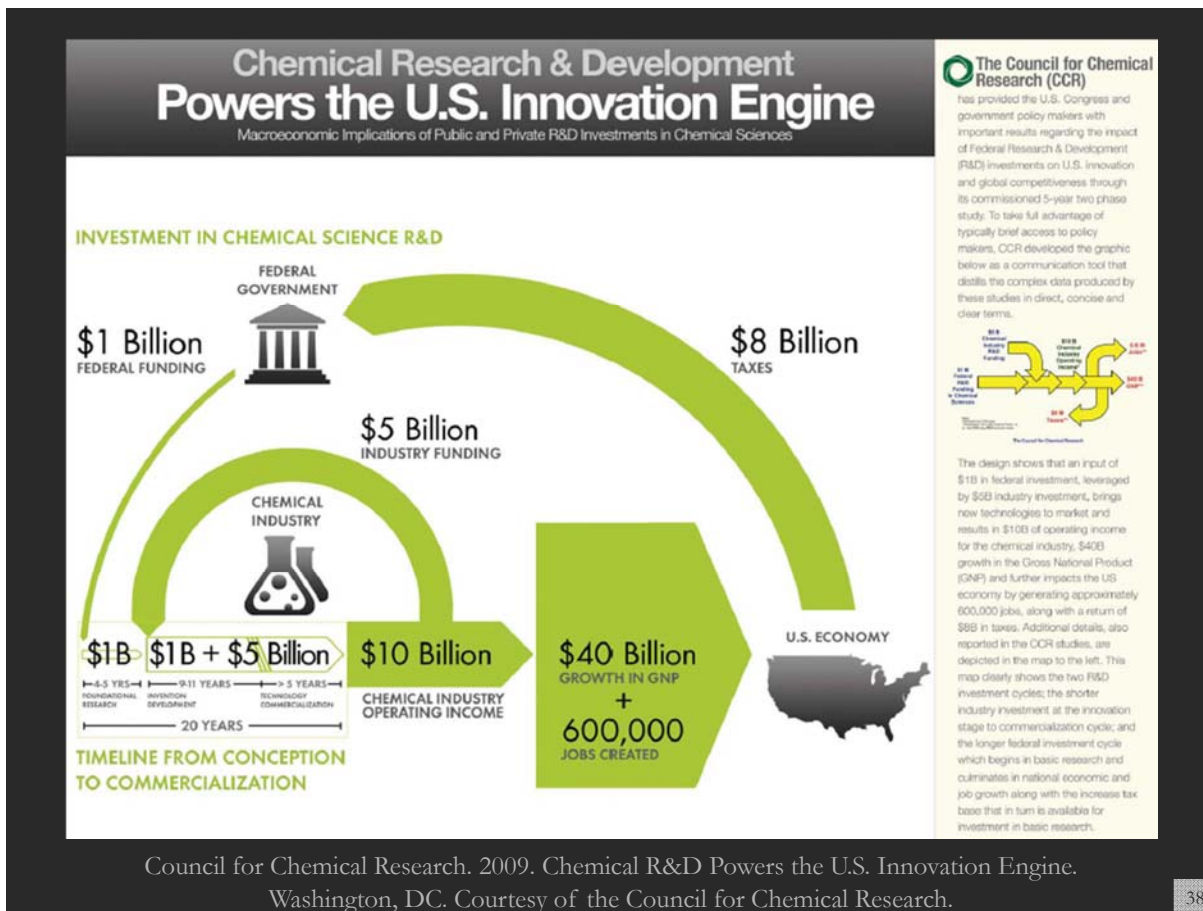


Mapping Science Exhibit at MEDIA X, Wallenberg Hall, Stanford University
<http://mediax.stanford.edu>, <http://scaleindependentthought.typepad.com/photos/scimaps>

36



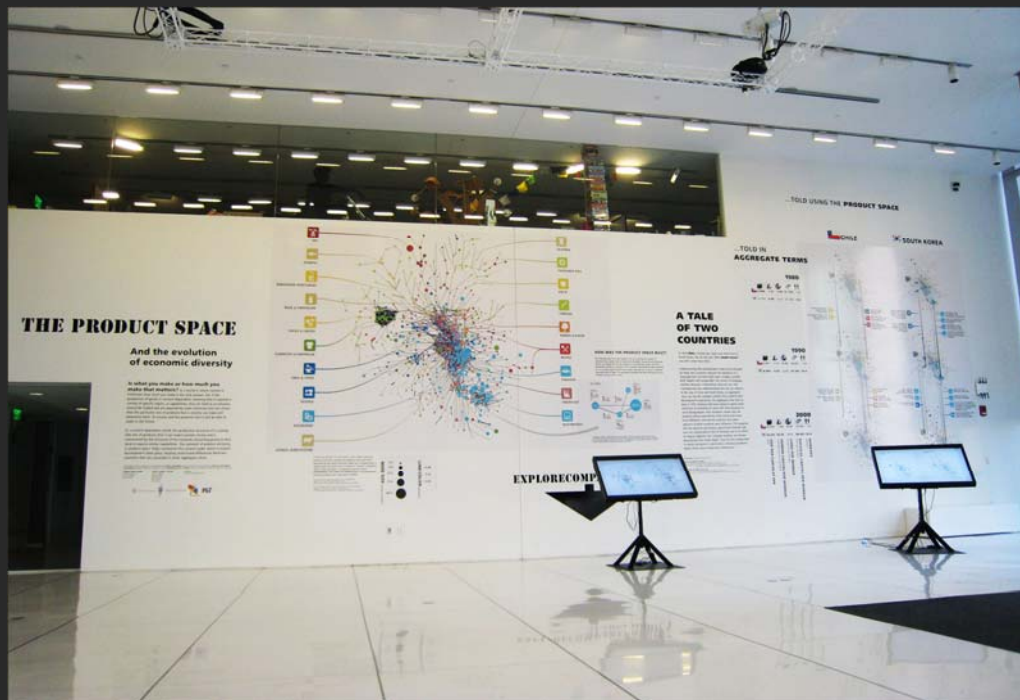
Bollen, Johan, Herbert Van de Sompel, Aric Hagberg, Luis M.A. Bettencourt, Ryan Chute, Marko A. Rodriguez, Lyudmila Balakireva. 2008. A Clickstream Map of Science. 37



Council for Chemical Research. 2009. Chemical R&D Powers the U.S. Innovation Engine. Washington, DC. Courtesy of the Council for Chemical Research. 38



Science Maps in “Expedition Zukunft” science train visiting 62 cities in 7 months, 12 coaches, 300 m long. <http://www.expedition-zukunft.de>



"The Product Space" by Cesar A. Hidalgo, Bailey Klinger, Albert-László Barabási, and Ricardo Hausmann on prominent, interactive display at the MIT Media Lab. See also http://scimaps.org/maps/map/the_product_space_5



References

Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains**. In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, 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., 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>

Scharnhorst, Andrea, Börner, Katy, van den Besselaar, Peter (2011) **Models of Science Dynamics**. Springer Verlag.

