

Disciplinary Maps of Sustainability Science

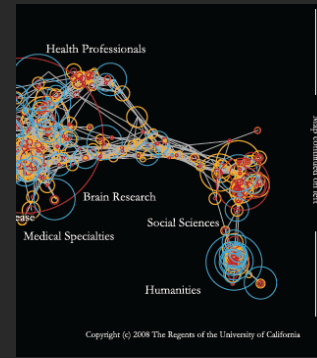
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Information Visualization Laboratory, Director
School of Library and Information Science
Indiana University, Bloomington, IN
katy@indiana.edu

With special thanks to Luís M. A. Bettencourt, Jasleen Kaur, and the members of the Cyberinfrastructure for Network Science Center.

*Mapping the Structure and Evolution of Sustainability Science
Workshop at AAAS*

December 1, 2010



Questions about Sustainability Science

- Who is funding what research and technology?
- What publications/expertise exist on a certain topic?
- What patents are filed by whom and where?
- What scholarly networks exist?
- Are there bursts of activity?

Approach

- Use open source tools to analyze and map 7 different publication, patent, and funding datasets on the topics “biomass” and “biofuel”.
- Design online interface to the data so that domain experts can interactively explore the field of sustainability research.

Datasets Used

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
- National Science Foundation (NSF) awards
- US Department of Agriculture (USDA) awards

Publications

- MEDLINE papers by the National Library of Medicine retrieved
- Web of Science (ISI) publications by Thomson Reuters identical to the one used in (Bettencourt and Kaur, 2010)
- Department of Energy (DOE) publications

Patents

- USPTO patents retrieved from the Scholarly Database (<http://sdb.slis.indiana.edu>) at Indiana University on 11/20/2010.

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Datasets Processing

Data Type	#Records Total / in US	Geo Location first affiliation First author/inventor	Science Location Using journal then text	Years Covered for US dataset (Full data)
Publications				
MEDLINE	19,328 / 4,998	100%	4,993 (99.9%)	1965-2010 (1952-2010)
DOE	13,902 / 3,559	2,431 (68.3%)	2,359 (97%)	1901-2008 (1901-2008)
ISI	1,563 / 328	100%	100%	1995-2011 (1974-2011)
Patents				
USPTO	1,253 / 741	100%	723 (97.6%)	1976-2010 (1976-2010)
Funding				
NSF	3,276 / 3,264	100%	3,088 (94.6%)	1972-2010 (1964-2010)
NIH	141 / 140	100%	139 (99.3%)	1971-2010 (1971-2010)
USDA	498 / 498	100%	100%	1993-2008 (1993-2008)
Total Records	... / 13, 528			1901-2010

4

Computational Scientometrics Cyberinfrastructures



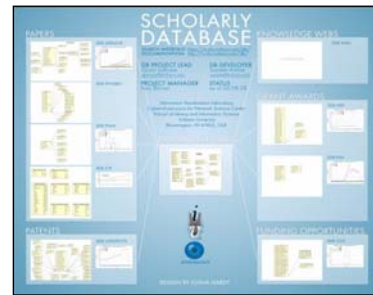
Scholarly Database: 25 million scholarly records

<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>



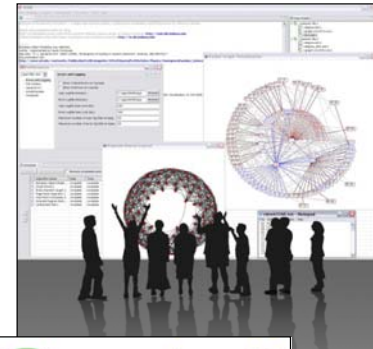
Science of Science (Sci²) Tool and CI Portal

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



Epidemics Cyberinfrastructure

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



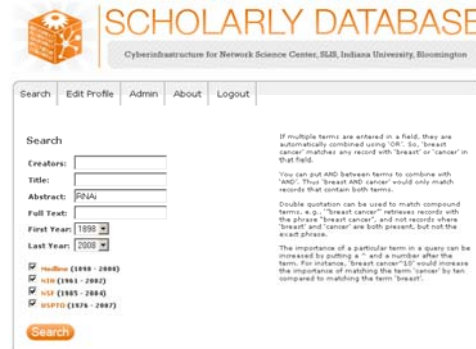
5



Scholarly Database: Web Interface

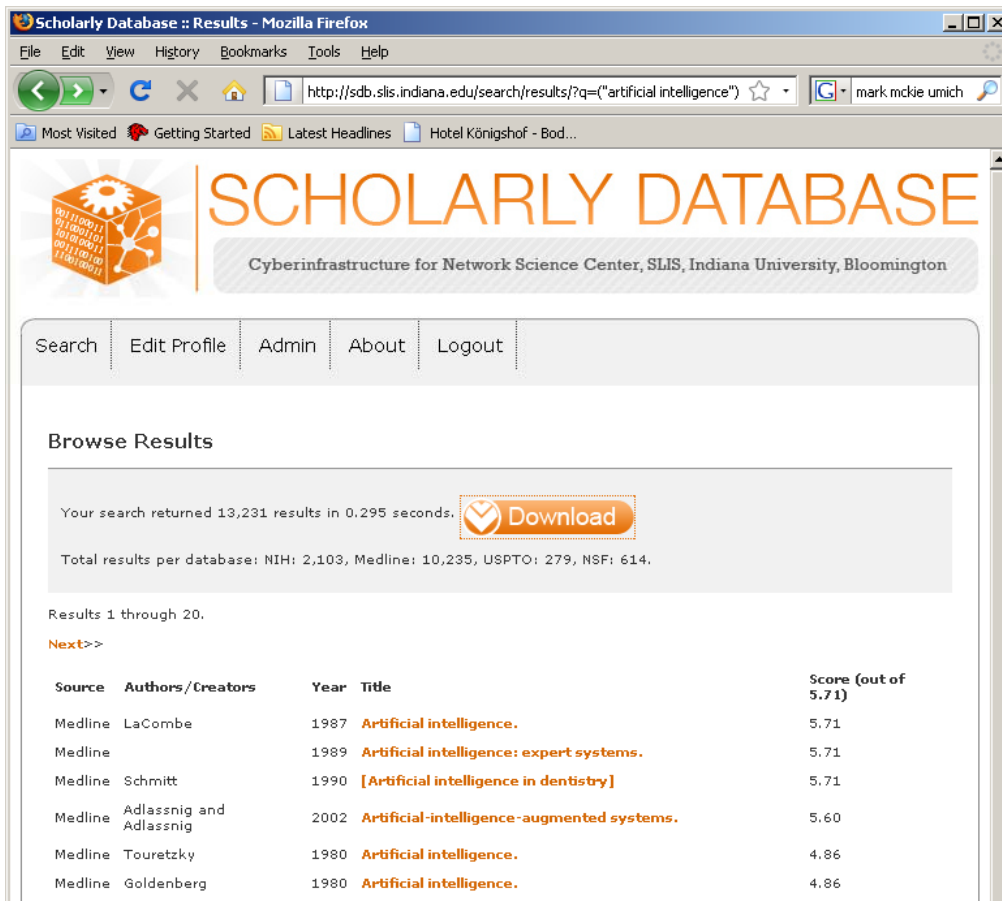
<http://sdb.slis.indiana.edu>

Supports federated search of 25 million publication, patent, grant records.
Results can be downloaded as data dump and (evolving) co-author, paper-citation networks.

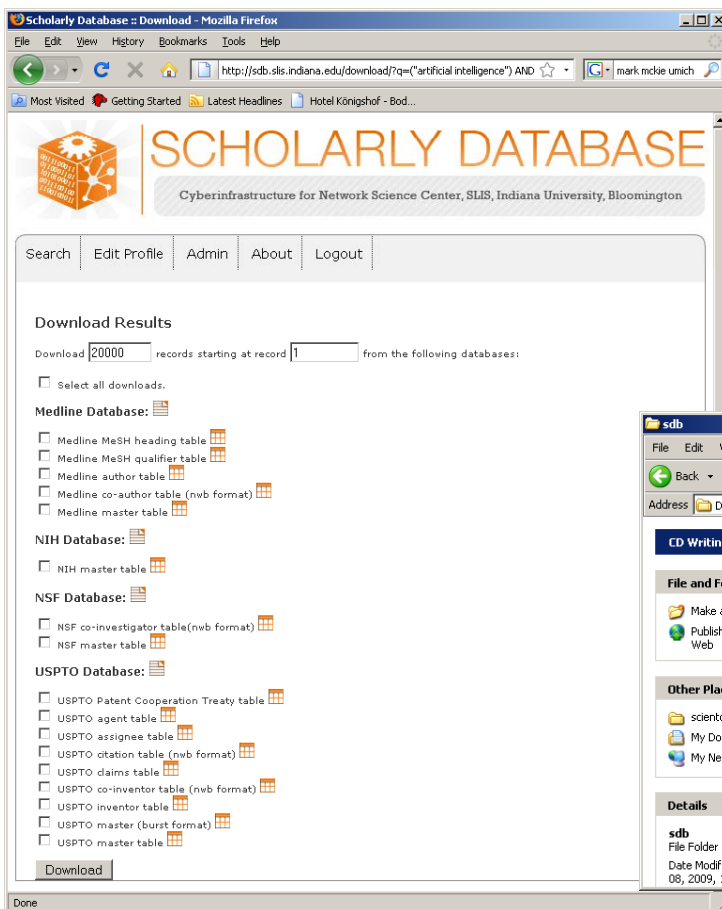


Register for free access at <http://sdb.slis.indiana.edu>

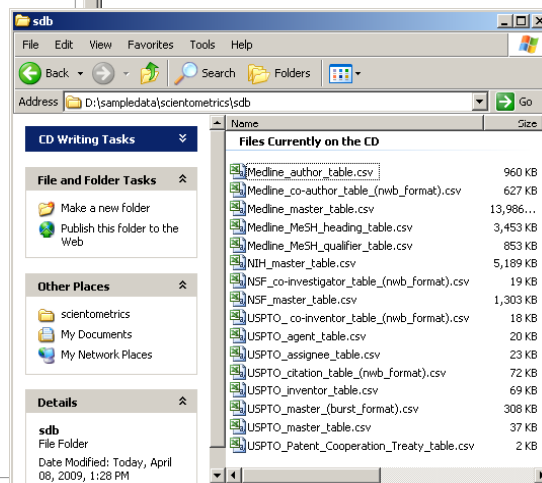
6



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Since March 2009:
Users can download networks:
- Co-author
- Co-investigator
- Co-inventor
- Patent citation
and tables for
burst analysis in NWB.



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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>

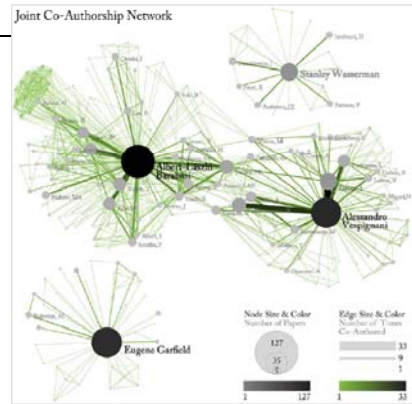
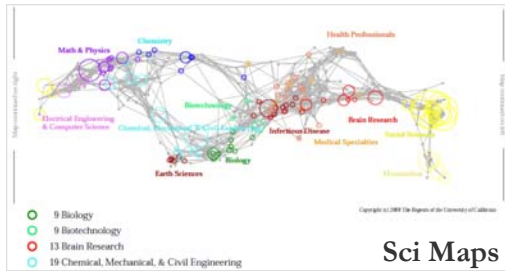
Geetha Senthil (2010). [Multidisciplinary Nature of Work With Reference to PIs and ICs Within a Portfolio](#). PA Group at NIH.

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

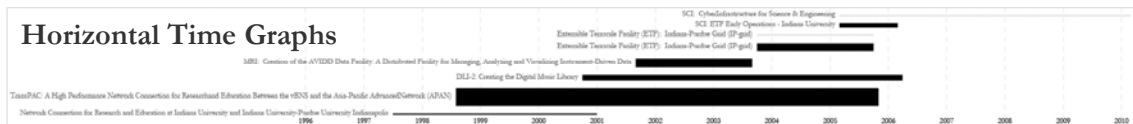


Sci² Tool – “Open Code for S&T Assessment”

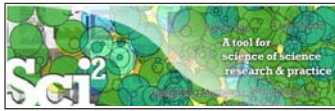
OSGi/CIShell powered tool with NWB plugins and many new scientometrics and visualizations plugins.



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 IS²I 2009: 12th International Conference on Scientometrics and Informetrics, Rio de Janeiro, Brazil, July 14-17*. Vol. 2, pp. 619-630.



Sci² Tool

Sci² Tool

File Preprocessing Modeling Analysis Visualization Scientometrics Help

Console

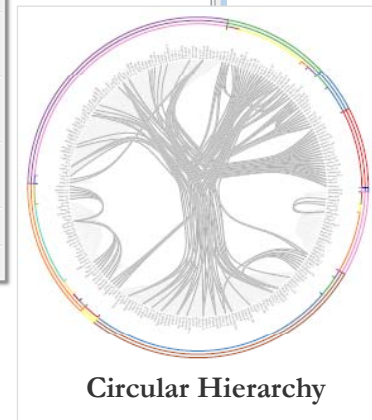
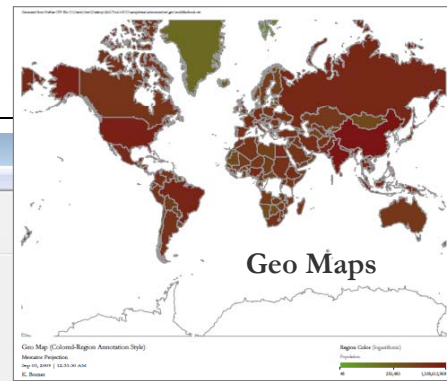
Welcome to the Science of Science Tool (Sci²). The development of this tool is supported in part by the Network Science center and the School of Li and Jiming at Indiana University, the National Science Foundation (NSF) grant IIS-0715303, and the James S. McDonnell Cyberscience Center (JSCC) at the University of Illinois at Urbana-Champaign. The primary investigators are Katy Börner, Ingrid Isenhardt, and SciTech Strategies Inc. The Sci² tool was developed by J. Duhon, Patrick A. Phillips, Chintan Tank, a Cyberscience Center 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 Proceedings of the 2009 ACM Conference on Information and Knowledge Management (CIKM'09), October 11-15, 2009, Beijing, China. Copyright 2009 ACM. <http://sci.slis.indiana.edu>.

Scheduler

Remove From List Remove completed

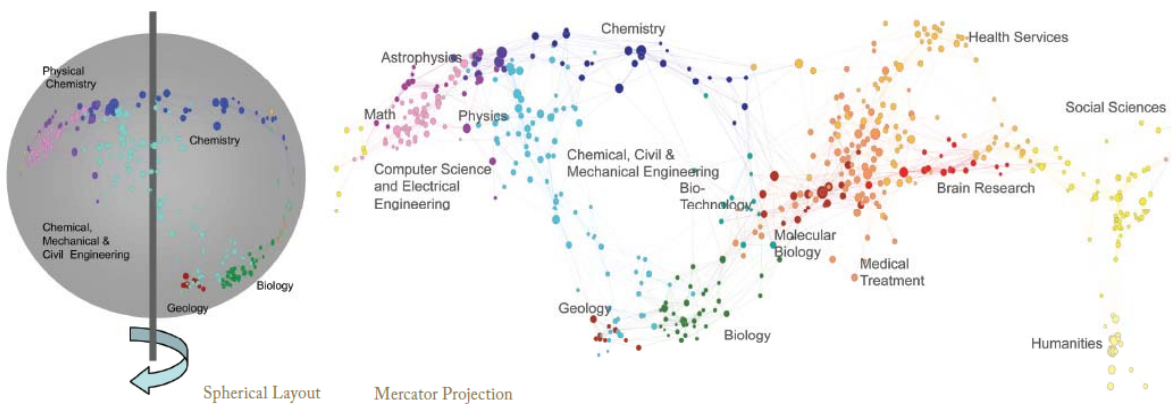
!	Algorithm Name	Date	Time	% Cor
<input checked="" type="checkbox"/>	Extract Co-Author Netw...	09/03/2009	00:15:20 AM	100%
<input checked="" type="checkbox"/>	Load and Clean ISI File	09/03/2009	00:15:05 AM	100%



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UCSD Base Map Of Science



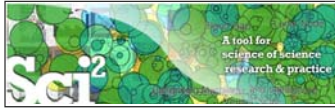
7.2 million papers published in over 16,000 separate journals, proceedings, and series published by Web of Science (WoS) by Thomson Reuters in 2001–2005.

Bibliographic coupling was applied to determine the similarity of journals.

Spherical Layout was then flattened using a Mercator Projection to create a 2D map.

Each of the 554 nodes represents a set of similar journals.

12

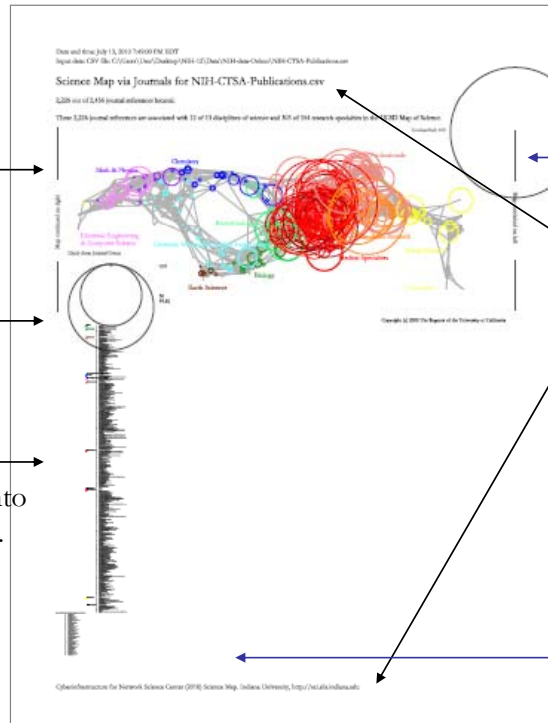


How to Read the UCSD Map

UCSD Science Map with data overlay.

Map legend of circle area size coding

Listing of all data records organized into UCSD science areas.

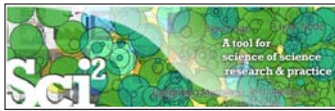


Circle of non-located, e.g., 'Unclassified' records.

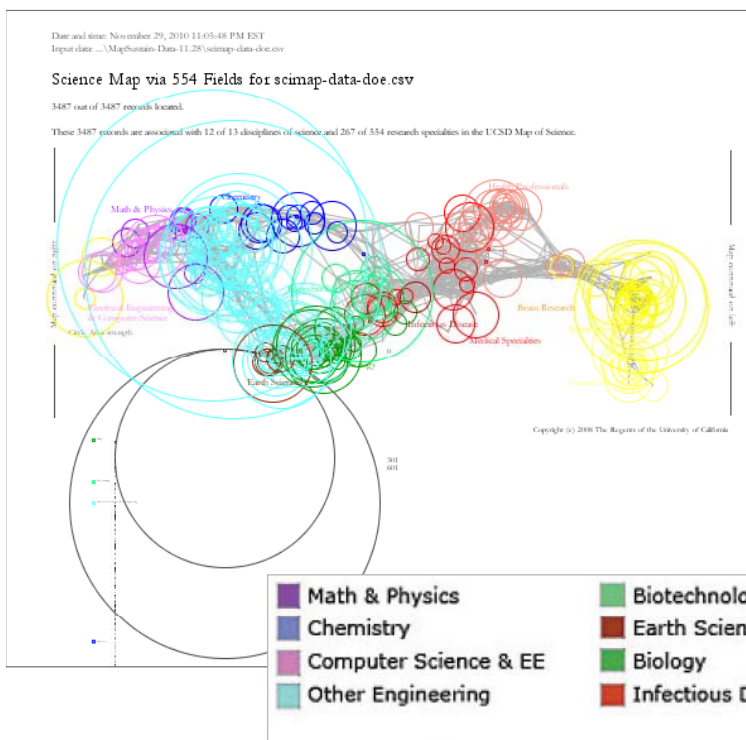
Header and footer with information when this map was created, by whom and using what data set.

Listing and circle of non-located, e.g., 'Unclassified' records.

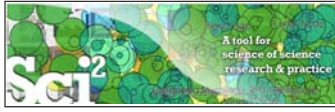
13



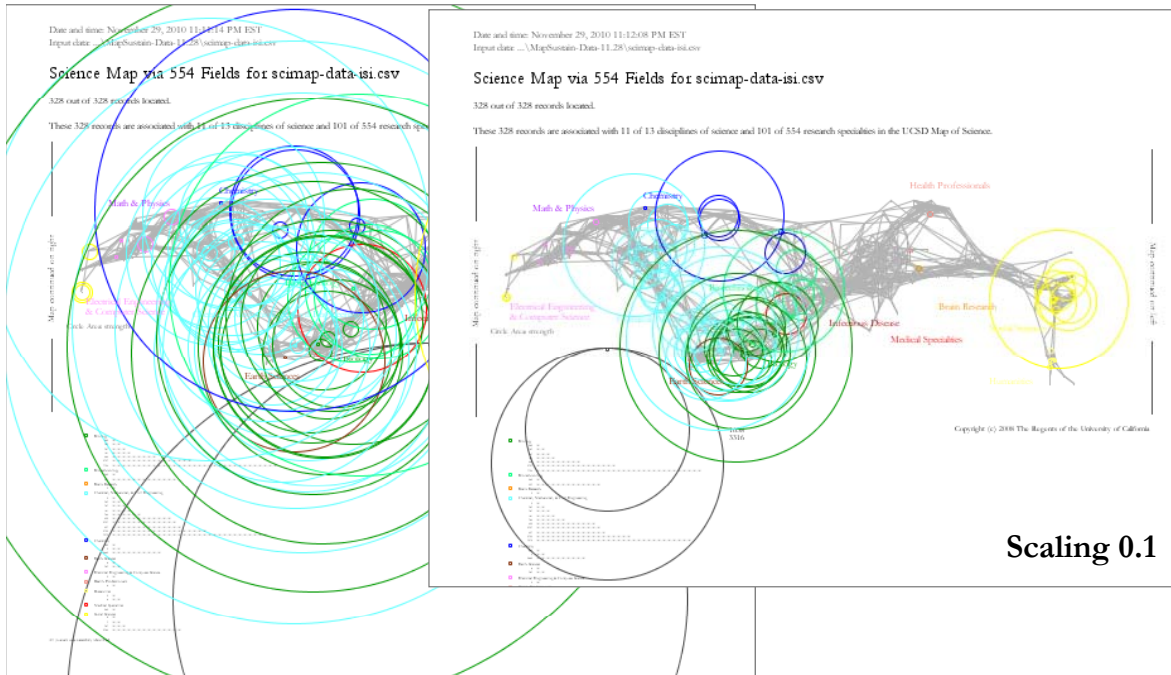
Publications - DOE



14



Publications - ISI



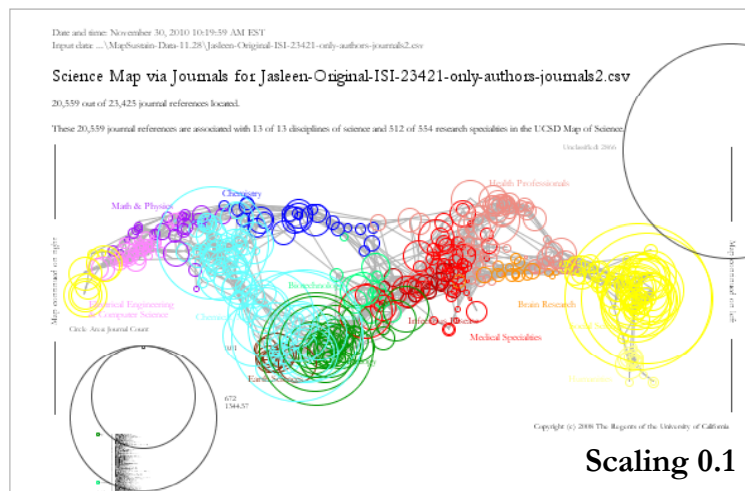
Scaling 0.1

15



Publications – ISI. All Sustainability Research

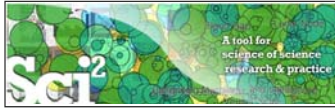
The Web of Science data was retrieved from the Science Citation Index Expanded (SCI-EXPANDED), Social Sciences Citation Index (SSCI), Arts & Humanities Citation Index (A&HCI), by running a query "Sustainability" over the Title and Abstract fields on 4/30/2009.



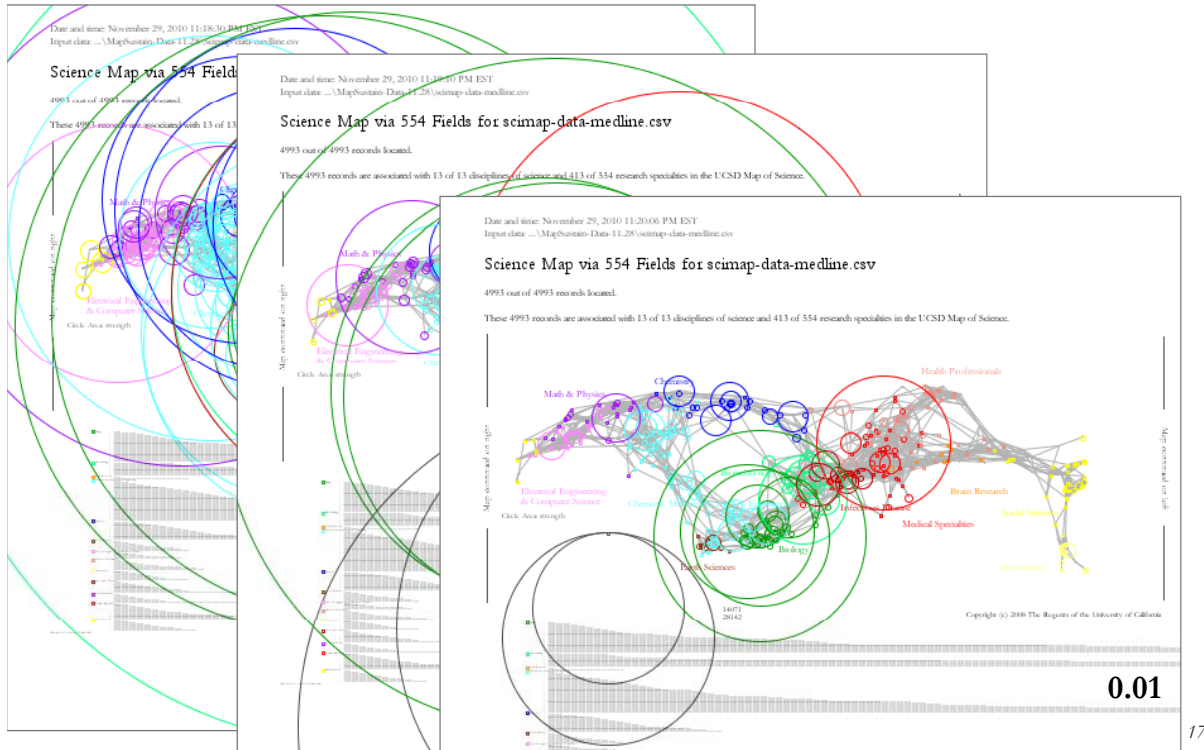
Scaling 0.1



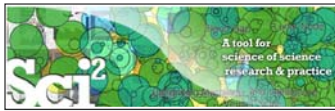
16



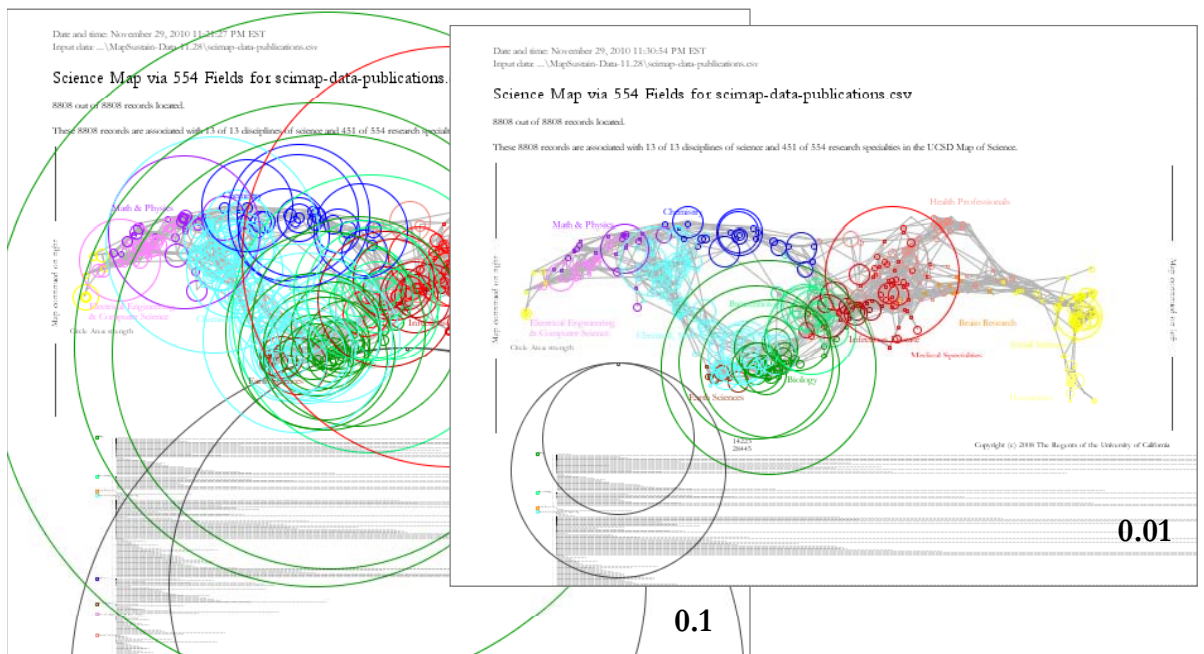
Publications - MEDLINE



17

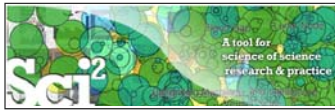


Publications - DOE+MEDLINE+ISI

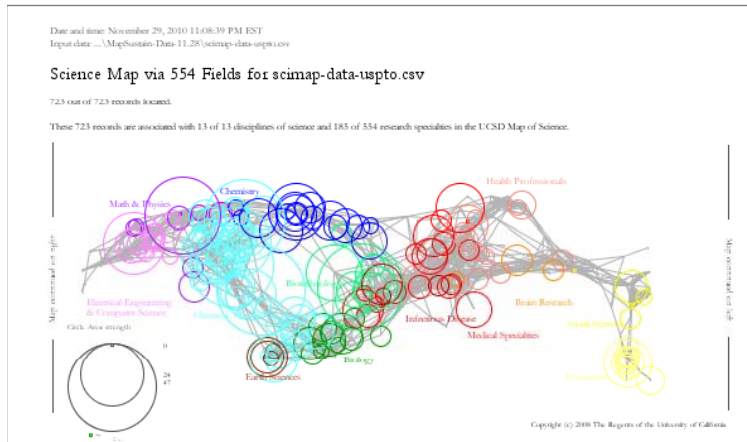


0.1

18



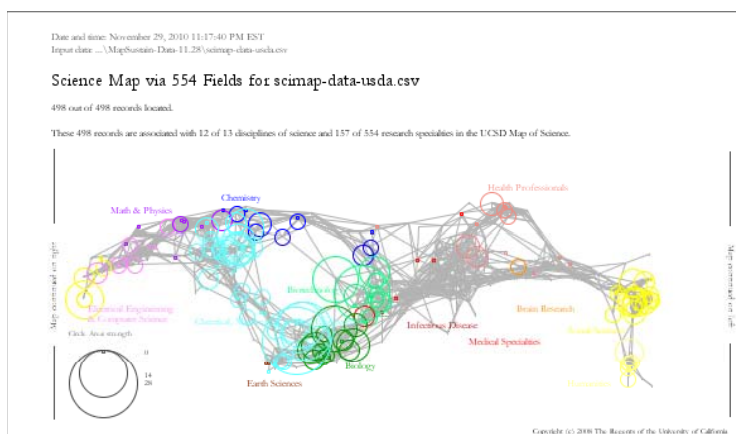
Patents - USPTO



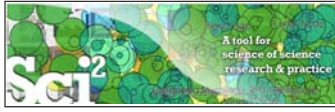
19



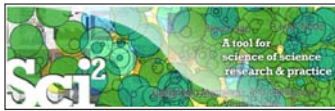
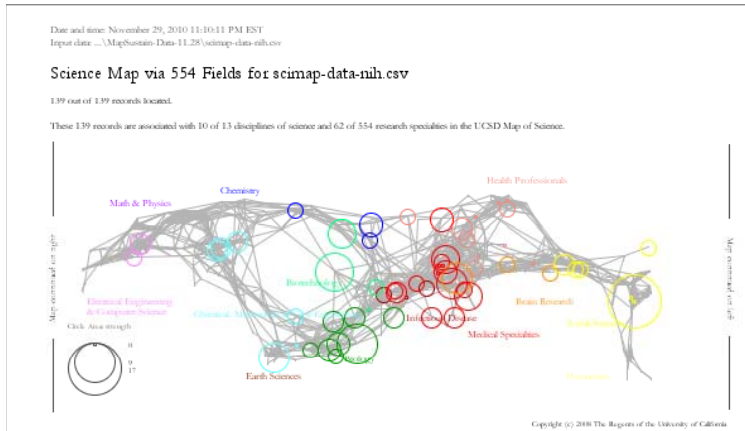
Funding - USDA



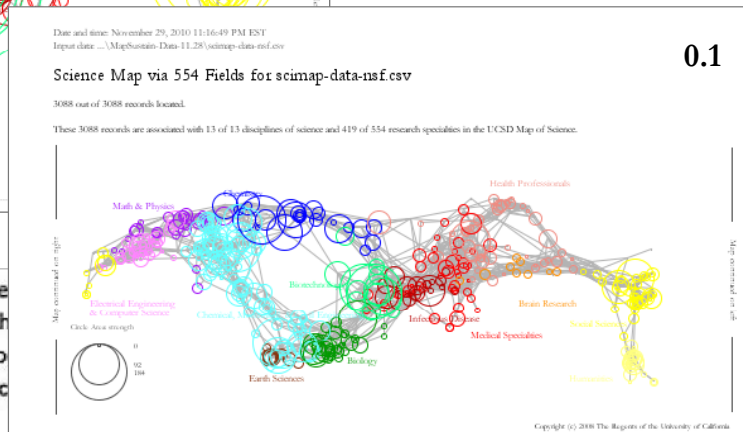
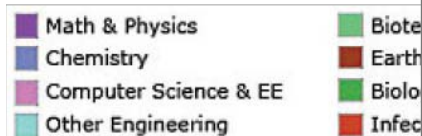
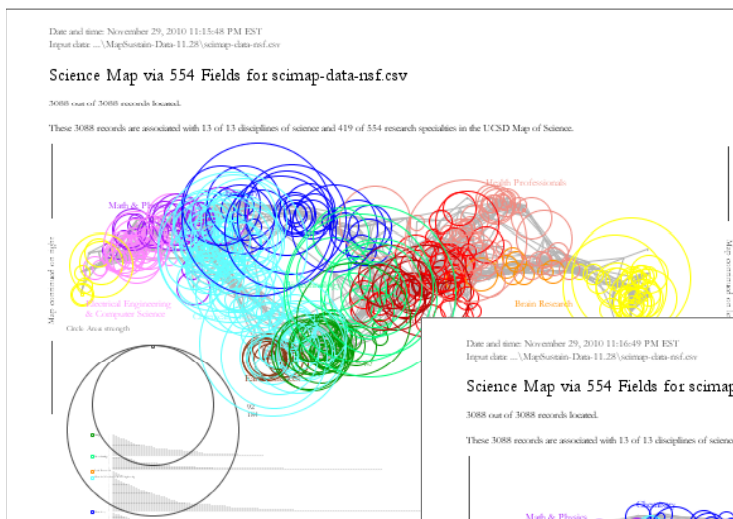
20



Funding - NIH



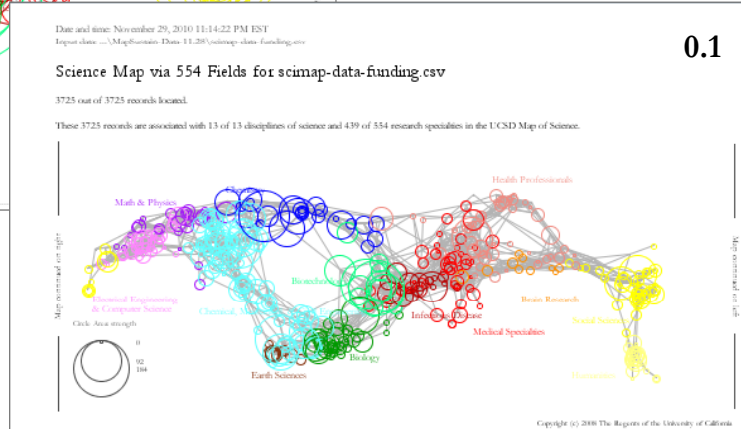
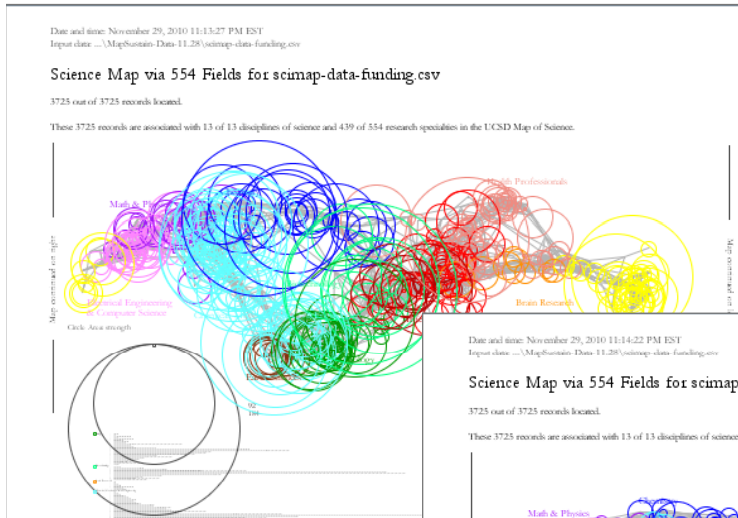
Funding - NSF



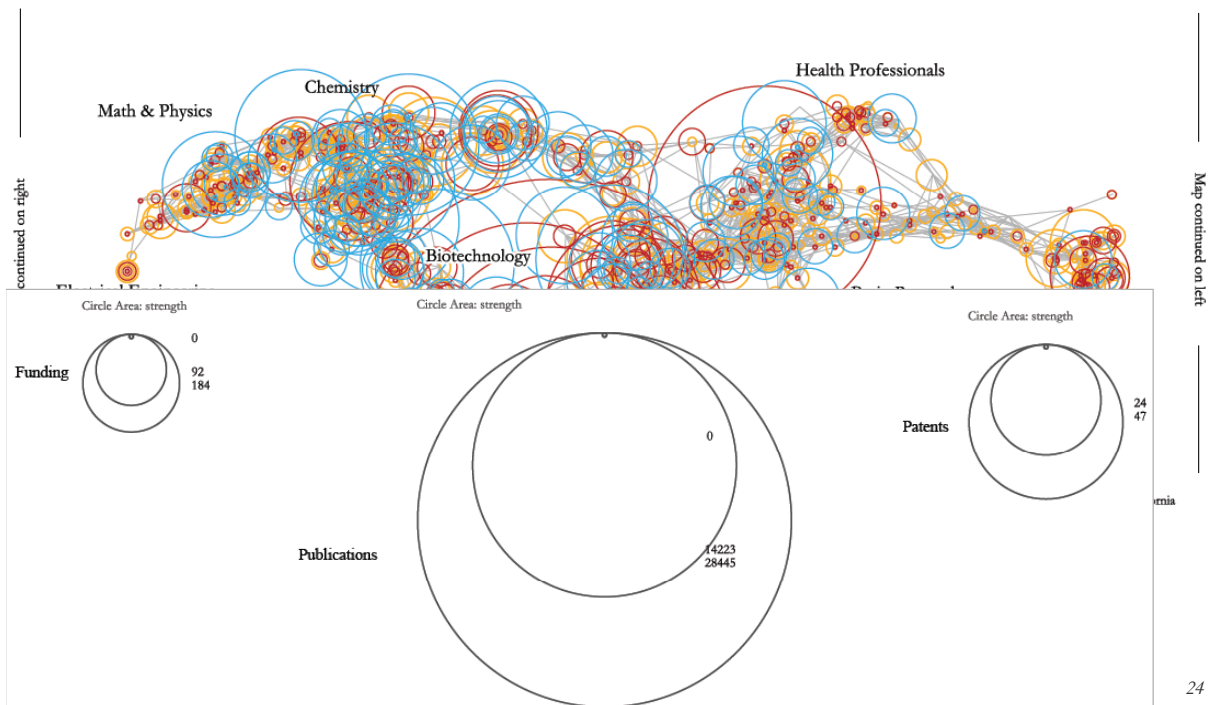
0.1



Funding – NIH+NSF+USDA



Funding vs. Publications vs. Patents



DOE

“SUBJECT” tag co-occurrence network

MST-Pathfinder Network Scaling was applied to reduce the number of edges.

01 Coal, Lignite, And Peat

010000 -- Coal, Lignite, & Peat

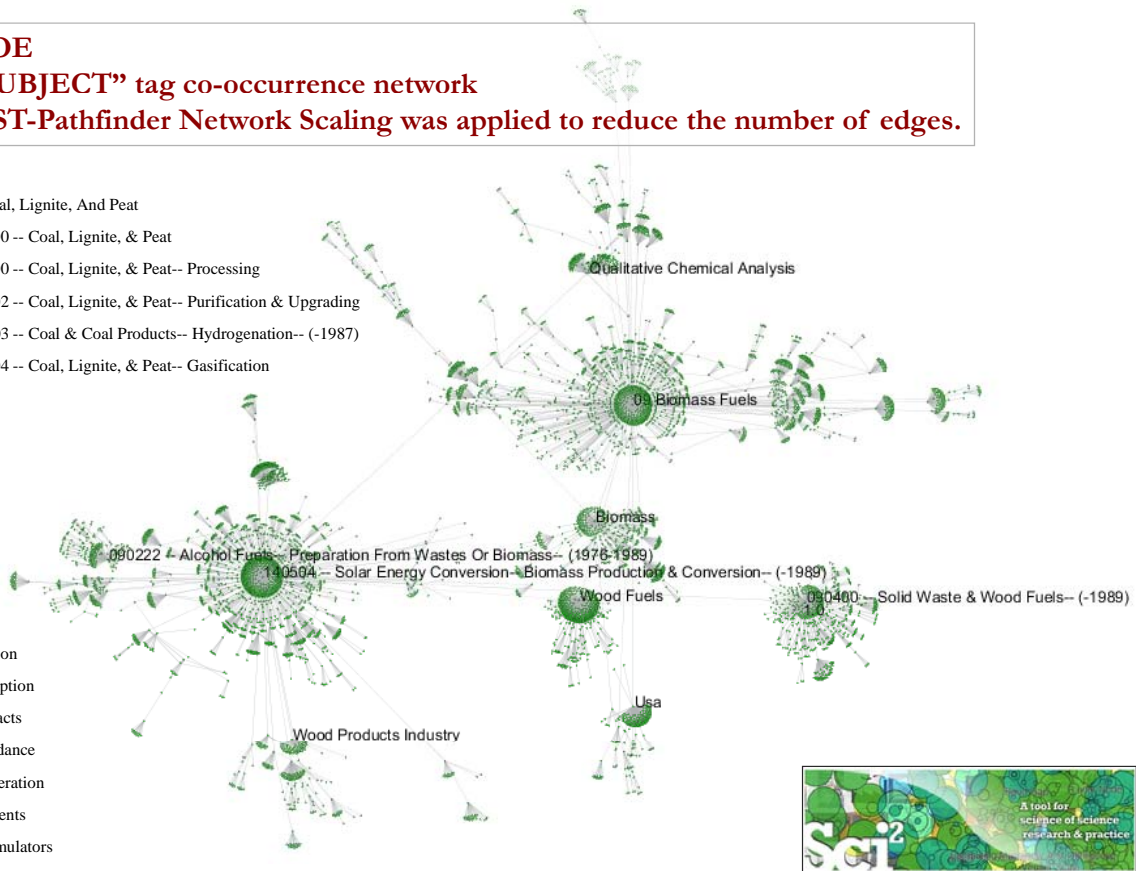
010400 -- Coal, Lignite, & Peat-- Processing

010402 -- Coal, Lignite, & Peat-- Purification & Upgrading

010403 -- Coal & Coal Products-- Hydrogenation-- (-1987)

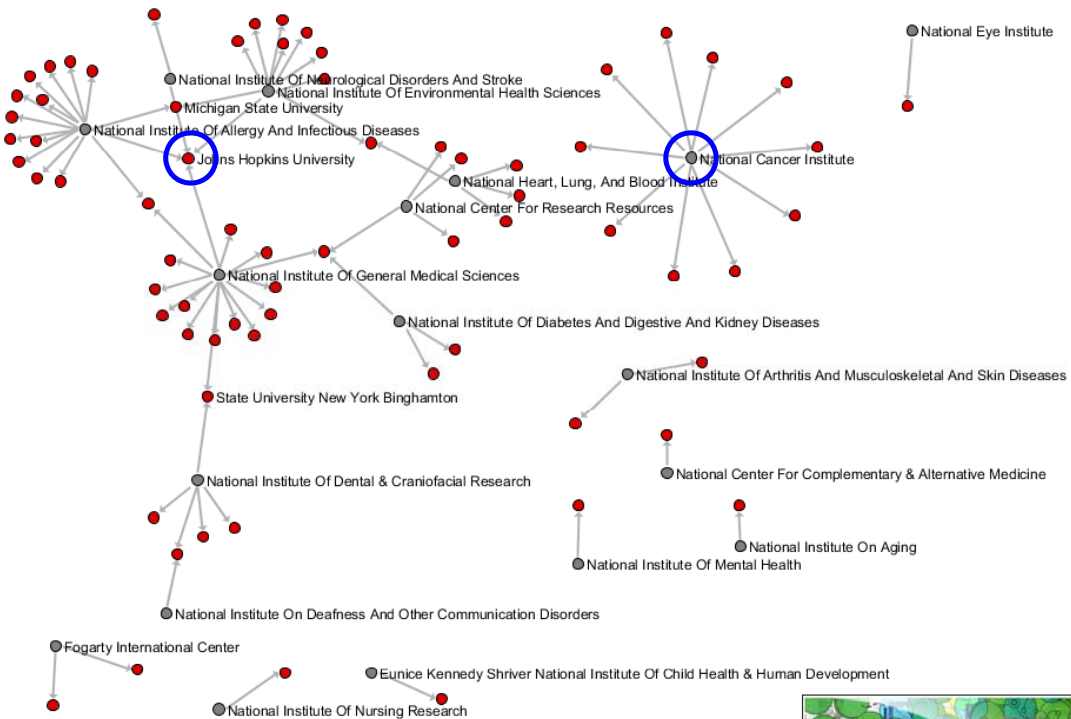
010404 -- Coal, Lignite, & Peat-- Gasification

Ablation
Absorption
Abstracts
Abundance
Acceleration
Accidents
Accumulators



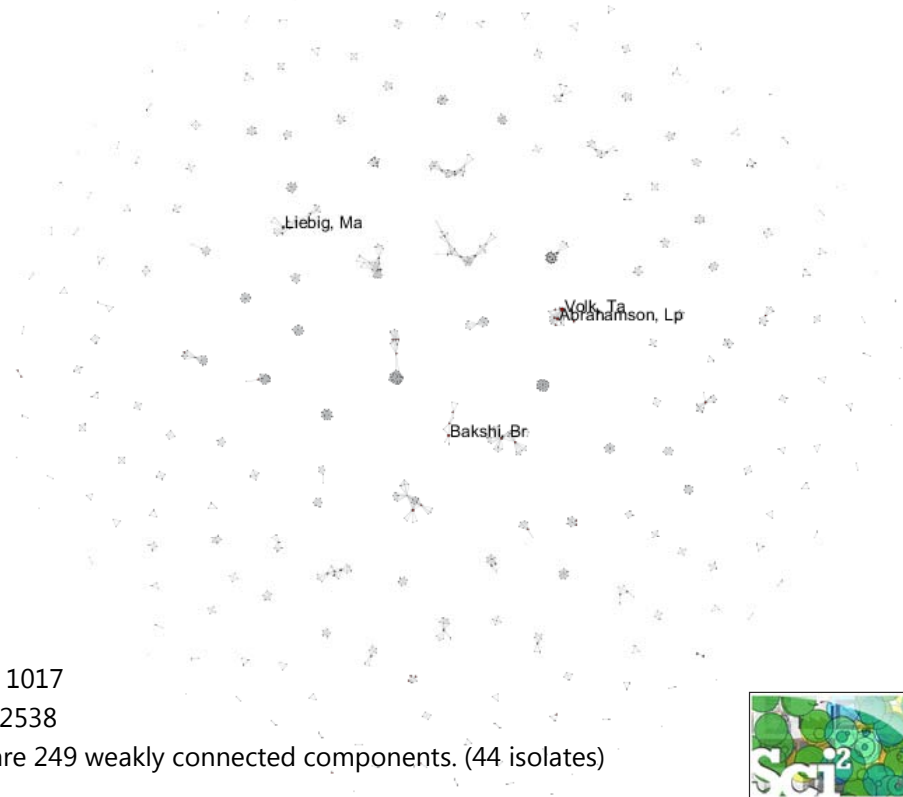
NIH

Bimodal network of ICD (gray) to institutions (red).

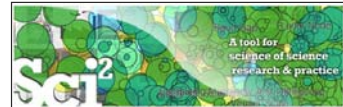


ISI

Co-author network. Author nodes with more or equal 5 papers are labeled.

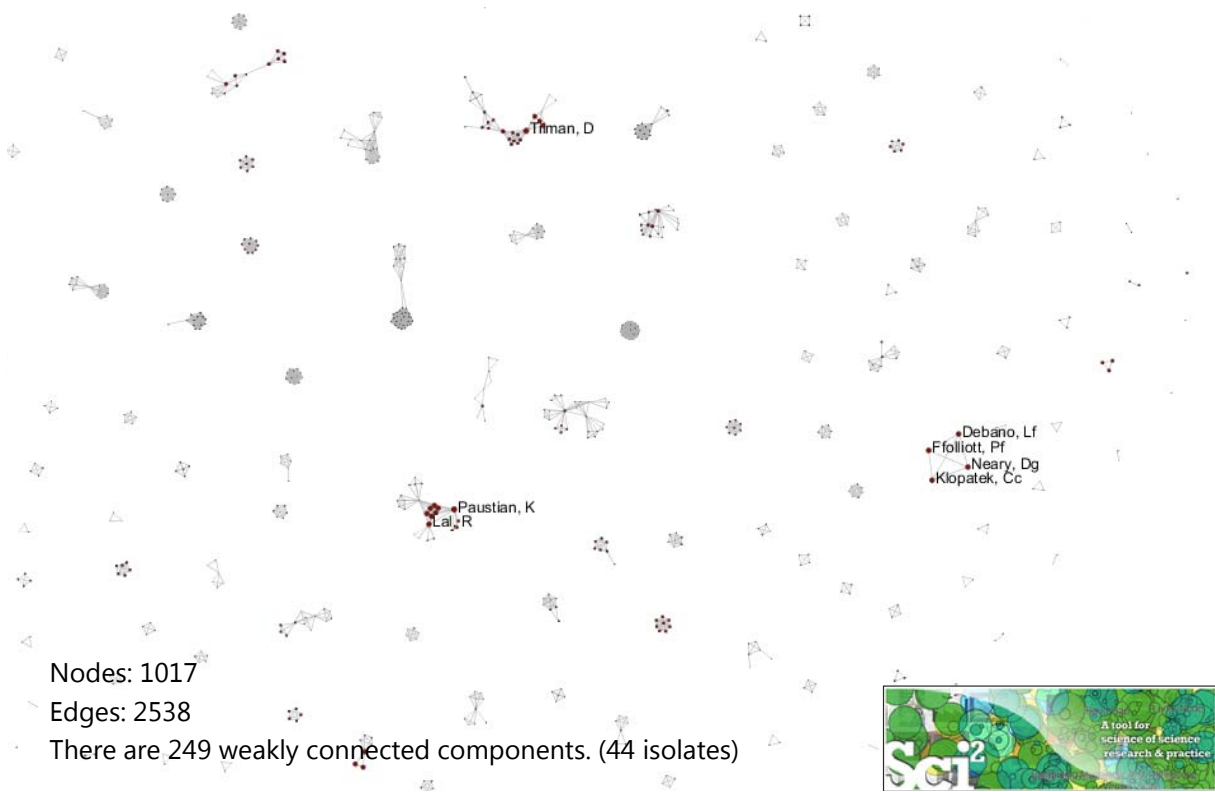


Nodes: 1017
Edges: 2538
There are 249 weakly connected components. (44 isolates)



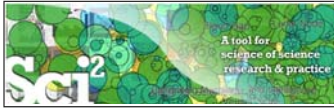
ISI

Co-author network. Author nodes with more or equal 200 citations are labeled.



Nodes: 1017
Edges: 2538
There are 249 weakly connected components. (44 isolates)





Publications – ISI. All Sustainability Research Co-Author Network (23,421 not 328 publications)

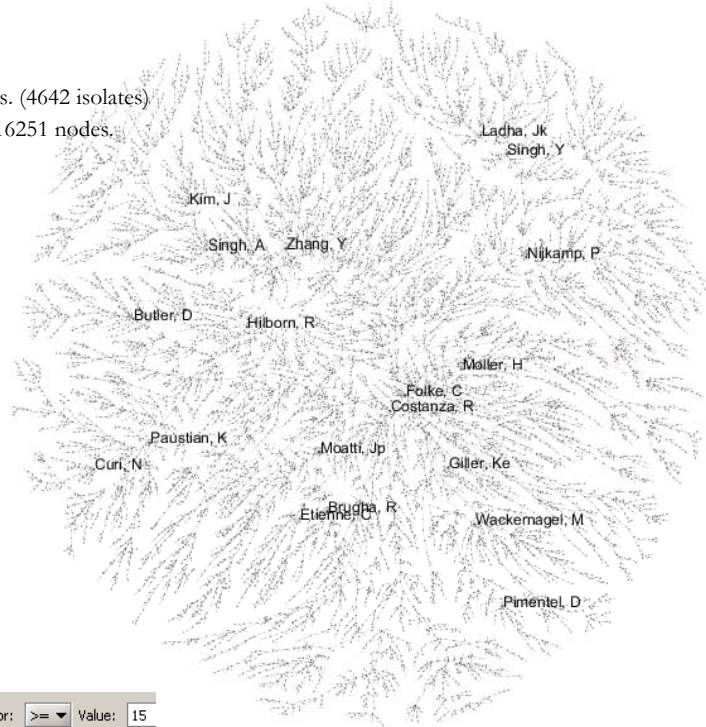
Nodes: 47439

Edges: 118838

There are 11322 weakly connected components. (4642 isolates)

The largest connected component consists of 16251 nodes.

- Extracted Network on Column Authors
- Graph and Network Analysis Log
- Weak Component Cluster of 16251 nodes
- Weak Component Cluster of 76 nodes
- Weak Component Cluster of 72 nodes
- Weak Component Cluster of 67 nodes
- Weak Component Cluster of 65 nodes
- Weak Component Cluster of 64 nodes
- Weak Component Cluster of 49 nodes
- Weak Component Cluster of 47 nodes
- Weak Component Cluster of 44 nodes
- Weak Component Cluster of 43 nodes



MST-Pathfinder Network Scaling

Nodes: 16251

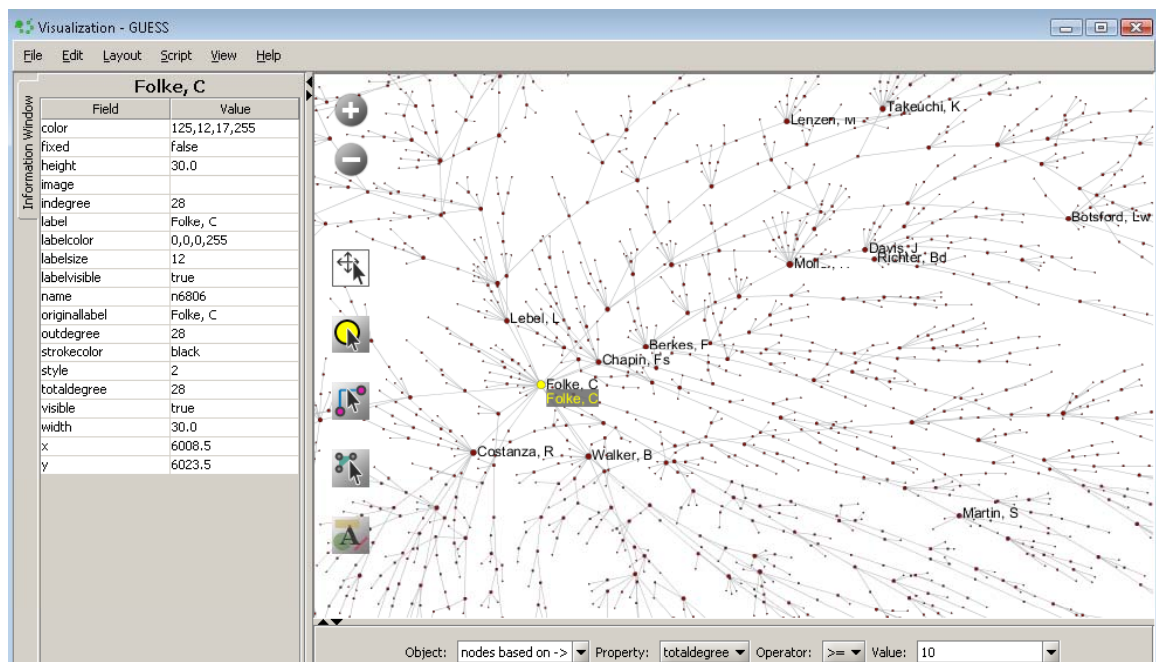
Edges: 16250

Object: nodes based on -> Property: totaldegree Operator: >= Value: 15

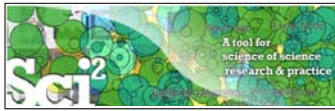
29



Publications – ISI. All Sustainability Research Co-Author Network cont.



30



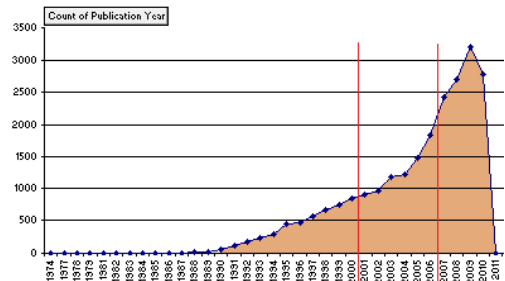
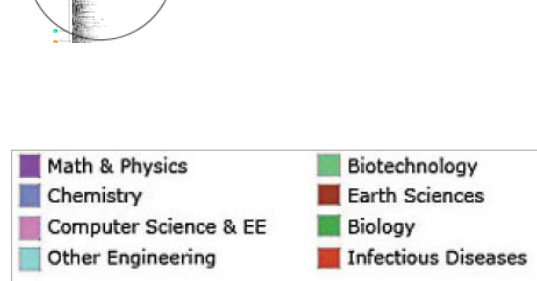
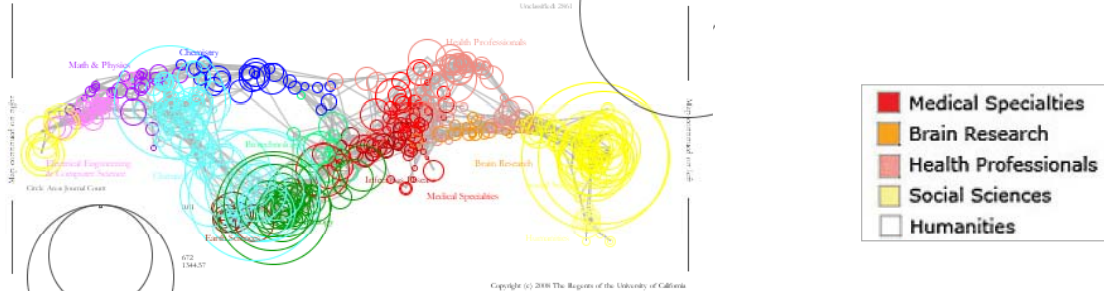
Publications – ISI. All Sustainability Research Evolution over 3 time periods (74-00, 01-06, 07-11)

Date and time: November 30, 2010 6:18:48 PM EST
 Input date: ...MapSustain-Data-11.28\Jasleen-Original-ISI-23421-2011.csv

Science Map via Journals for Jasleen-Original-ISI-23421-2011.csv

20,557 out of 23,418 journal references located.

These 20,557 journal references are associated with 13 of 13 disciplines of science and 512 of 554 research specialties in the UCSD Map of Science



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MAPSustain

Mapping Sustainability Research

Geographic Map
Science Map

Map data ©2010 Europa Technologies, NGA

Funding

NIH

NSF

USDA

Publications

DOE

ISI

Medline

Patents

USFTO

Citations Count

Amount Count

From year to year

Search by keyword

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.

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

School of Library and Information Science, Indiana University

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Geographic Map
Science Map

Maps
Detail
Data
About

About

A new field of *Sustainability Science and Engineering* is emerging that seeks to understand the fundamental character of interactions between nature and human society and to help steer the impact of humanity's needs on the planet's natural resources towards sustainable trajectories. The field is unified in clear terms by its ultimate goals but occupies an interdisciplinary position among traditional research fields, spanning both science and engineering and spreading across disciplines as diverse as agriculture, ecology, oceanography, climate studies, economics, a diverse set of social sciences, energy and materials and several additional aspects of engineering, physics, biology, and chemistry. Although Sustainability Science and engineering is by now widely discussed in the scientific and engineering community, and is beginning to be connected to the political agenda for economic and social development, it remains unclear to what extent its many facets are being integrated into a global perspective and whether researchers are utilizing it as a nexus to collaborate across traditional scientific and engineering fields.

Please consult the [Mapping the Structure and Evolution of Sustainability Science](#) workshop web page for further information and details.

Web Page Design

This web site provides an interactive interface to publication, patent, and funding data on 'biomass' and 'biofuel' research. Visitors are invited to explore what funding is available in what geospatial regions and in what areas of science and what publications and patents

Google Map JavaScript API was used to implement both maps with two aggregation layers for each. The geographic map aggregates to the **state level** and the **city level**. The science map has a high level of aggregation of 13 top-level scientific **disciplines** and a low level of 554 **sub-disciplines**.

Geographic Map
Science Map

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.

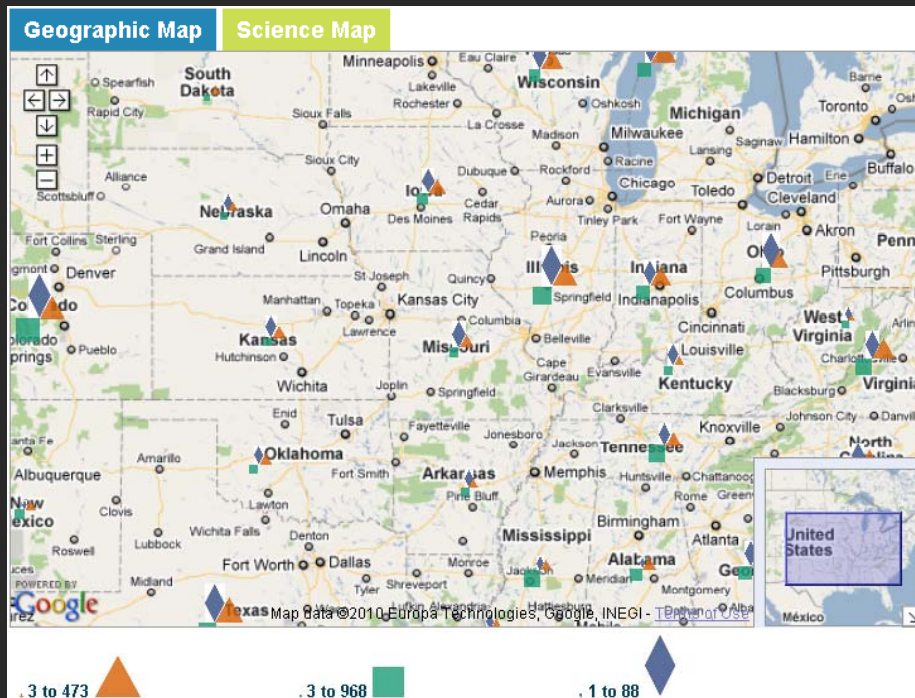
National Science Foundation (NSF) awards retrieved from the Scholarly Database (<http://sdb.slis.indiana.edu>) at Indiana University on 11/20/2010. Search query used was biomass OR biofuel OR "bio mass" OR "bio fuel" in the 'All Text' field.

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).

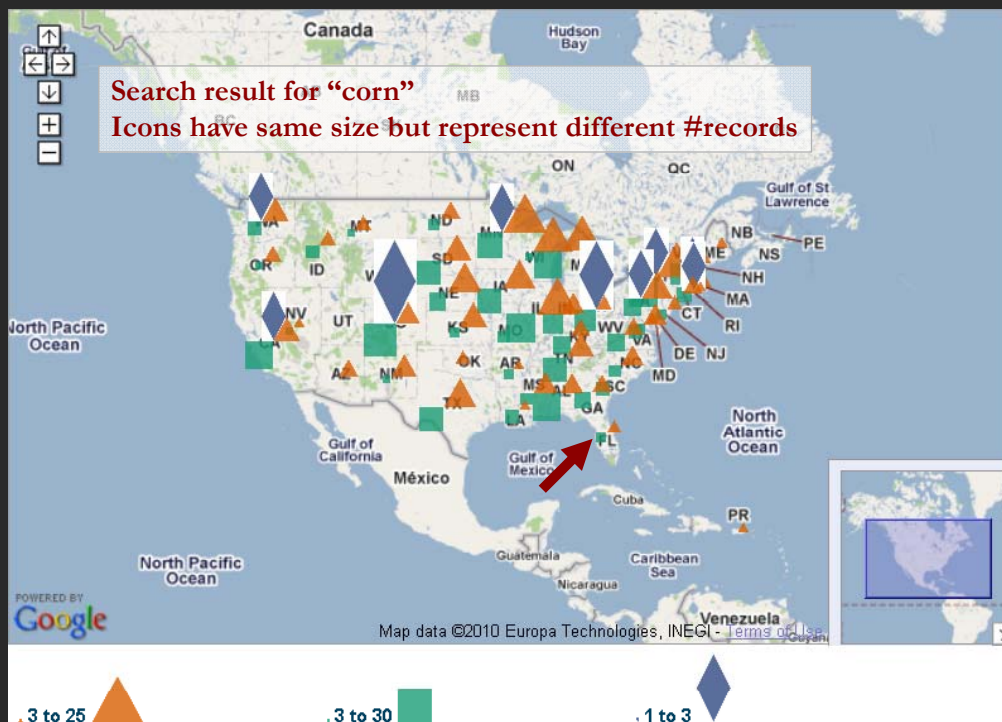
Publications

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.

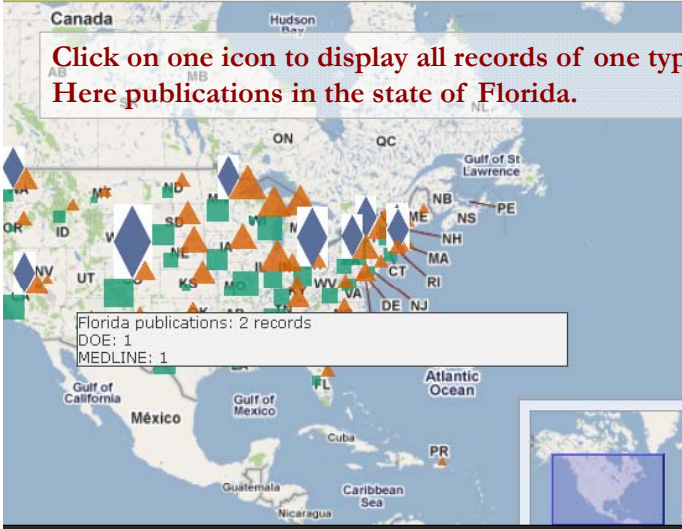
The geographic map at **state level**.



The geographic map at city level.



Science Map



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



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Title Enzymatic hydrolysis and fermentation of corn for fuel alcohol
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Creator/Author Mullins, J.T.

Publication Date 1985 Jan 01

OSTI Identifier OSTI ID: 5789929

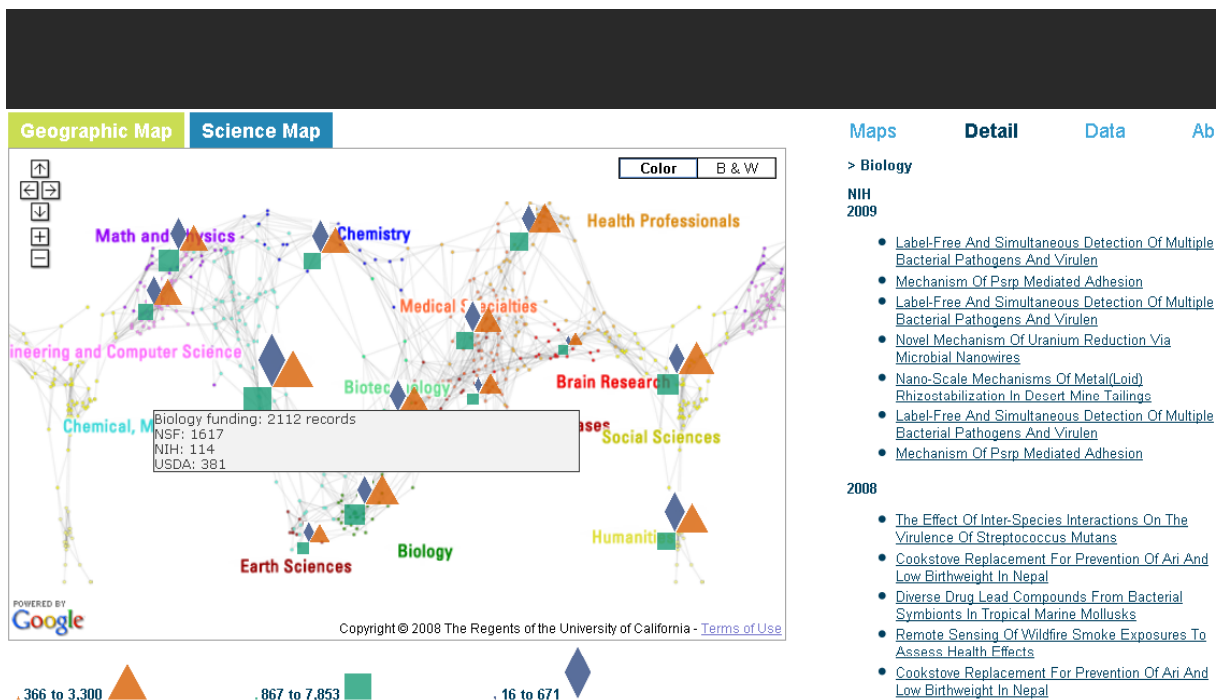
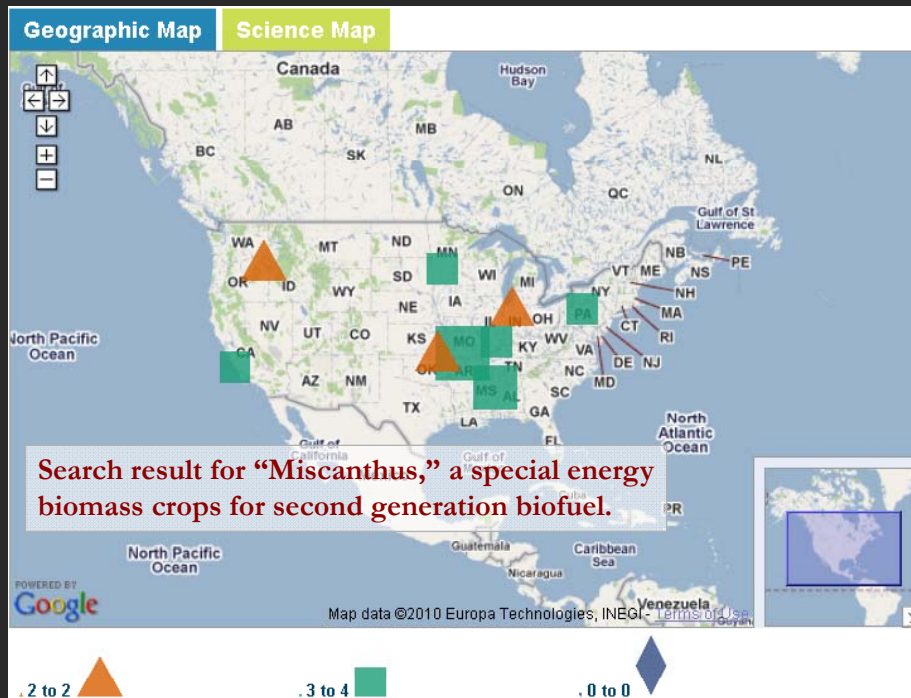
Other Number(s) Journal ID: CODEN: BIBIA

Resource Type Journal Article

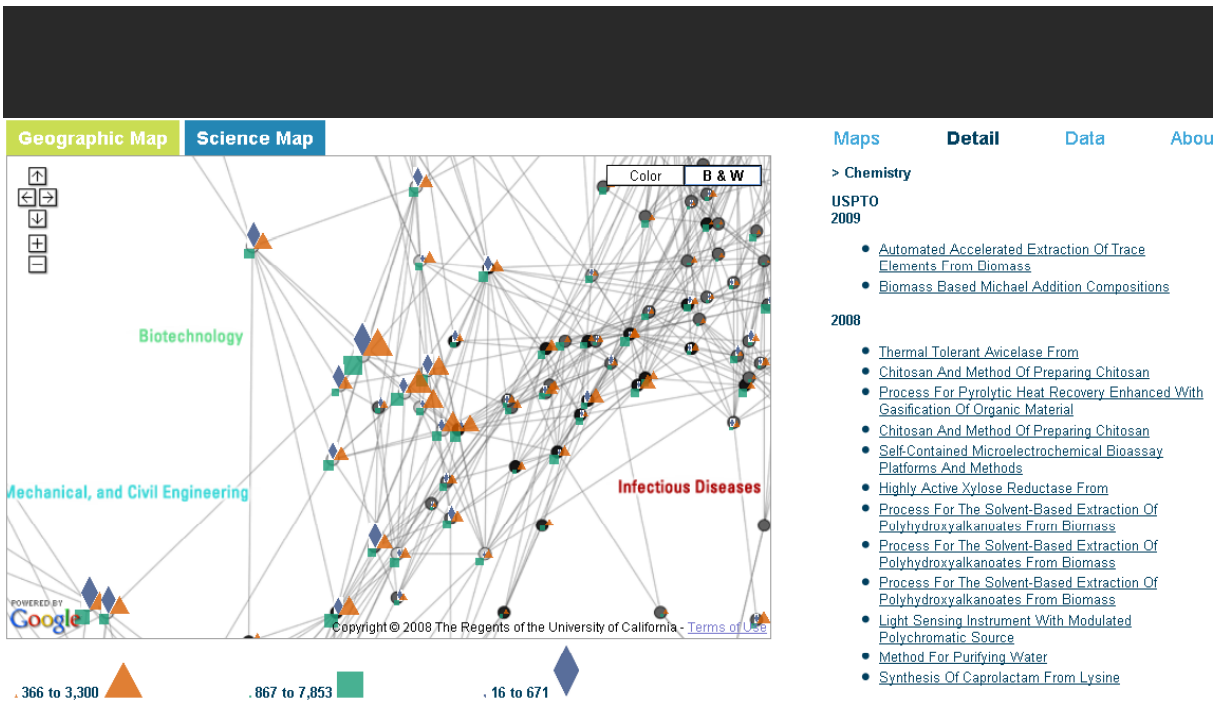
Resource Relation Journal Name: Biotechnol. Bioeng.; (United States); Journal Volume: 27:3

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; CEREALS; CHEMICAL REACTIONS; DATA; DECOMPOSITION; EFFICIENCY; FUELS; GRASS; HYDROLYSIS; INFORMATION; LYSIS; NUMERICAL DATA; PLANTS;



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



The science map at 554 sub-disciplines level.

