

Design and Update of a Classification System: The UCSD Map of Science

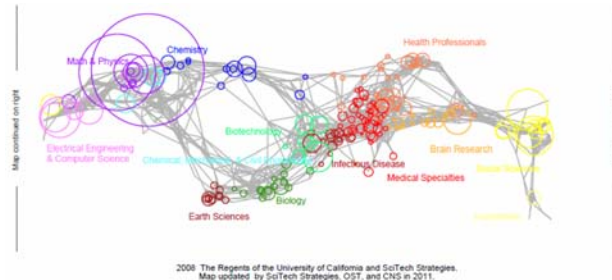


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Indiana University, Bloomington, IN*

Sept 10, 2012



Overview

- ❖ Motivation
- ❖ Design
- ❖ Validation
- ❖ Application
- ❖ Projection

Milestones in Mapping Science

1934

2007

1982-1998

Algorithms

- Quantitative Validation: McCane
- Cluster Analysis: Collins et al.
- Cluster Tracking and Mapping: Orford
- Spring Graph Layout: Taha
- Self-Organizing Map (SOM): Kohonen
- Kernals-Kernals Graph Layout: Kernals and Kavel
- Identifying Scientific Frontiers: Orford and Taha

Visualizations

- Map of Information Science: White and Orford
- Node Cards: Hildner, Moore and Trigg @ Xerox PARC
- Specialties in Sociology: Eason
- SOM of Newsgroup Postings: Kohonen
- Networks of Science: Orford
- Networks of Science: Orford

Tools

- 1985
- Science and Technology: Orford
- In-Flow: Kade
- Flow Mapper: Taha

Books

- The Disappearance of Books
- Forefront in Science: Picking the Winners: Lerner and Martin
- The Creative Process: The Role and Significance of Creativity in Scientific Communication: Lerner
- The Intellectual Organization of the Sciences: Whaley
- 200 Years of Science - Bibliography and Molecular Genetics 1982/82 covering 127 Research Fronts: Orford et al. (eds)
- Home: Arabesque (French): Baudouin
- Little Science, Big Science and Beyond: Papp
- Laboratory Life: The Construction of Scientific Facts: Latour and Woolgar
- Mapping the Dynamics of Science and Technology: Sociology of Science in the Real World: Collins, Law and Rip
- Concepts of an Information Science: Toward Scientography: Orford
- Mathematical Models in Individual Networks: Mathematical Models in the Exploration of Networks: Jahnke
- Science in Action: How to Follow Scientists and Engineers Through Theory: Latour
- Redi: magyarokk kommunikáció (Networks of Scientific Communication): Orford

30 Part 2: The History of Science Maps

Scope

- Individual
- Local
- Global
- Mixture

Layout

- Manual
- Algorithmic

Type

- Temporal
- Semantic
- Geographic
- Network
- Mixture

Exhibit Map

5

1930-1960

Algorithms

- Factor Analysis (FA): Thurstone
- Cluster Analysis: Tryon
- Information Theory: Shannon

Visualizations

- Sociometry: Morans
- Early Research: Lounsbury
- World Encyclopaedia: Wells
- Map of Science: Bernal
- Target Sociogram: Northrup
- Narrowed S&T Chart: Ellingham

Books

- Traité de Documentation: Le Livre ou le Livre - Théorie et Pratique: Otlet
- Who Shall Survive?: Morans
- World Brain: Wells
- The Social Function of Science: Bernal
- Documentation: Realität: De Meester
- Die Mechanisierung von der Weltanschauung: Dijksterhuis
- Putting Science in Its Proper Geographical Context: Ellingham

1930

1955

1930

Sociometry
Moreno

1935

Lady Bountiful
Lundberg & Ste...

Zoom into one map and legend
Review 350 references

Scope

- Individual
- Local
- Global
- Mixture

Layout

Manual

Algorithmic

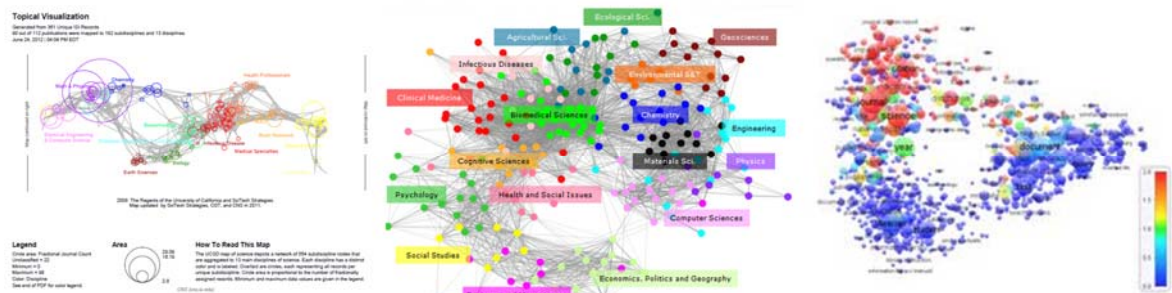
Type

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Exhibit Map



Currently Used Science Basemaps



UCSD Map

Loet et al science maps ISI categories

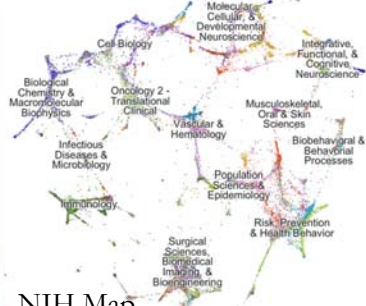
<http://vosviewer.com>



Elsevier's SciVal Map



Science-Metrix.com



NIH Map
<https://app.nihmaps.org>



User Groups and their Needs

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0039464>

Students. Maps of science can help students gain an overview of a particular knowledge domain, identify major research areas, experts, institutions, grants, publications, patents, citations, and journals as well as their interconnections, see the influence of certain theories, and gain a global picture of the domain.

Researchers. Science maps can be used to ease access to research results, relevant funding opportunities, and potential collaborators [9] inside and outside the fields of inquiry, and to detect social networks and invisible colleges [10].

Grant Agencies/R&D Managers. While maps of science cannot substitute for informed peer evaluation or expert panels, they can be used as tools to monitor (long-term) money flow and research developments, evaluate funding strategies for different programs, make informed decisions on project durations, and study funding patterns. In addition, they can also be used to identify the impact of research funding programs [11–14], scientific frontiers [15–18], the dynamics (speed of growth, diversification) of scientific fields [19], and complementary capabilities.

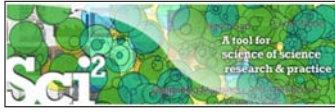
Industry/National Security Agency. Maps of science can be utilized to gain access to major scientific results, knowledge carriers, etc. Information on needed technologies could be incorporated into maps, facilitating industry pulls for specific directions of research.

Data Providers. Maps provide unique visual interfaces to digital libraries [20]. A successful example is the visual classification taxonomy developed and used in the MACE project.

Design:

How was the UCSD map of science made?

- ❖ Original Map (5 years of Scopus and WoS)
- ❖ Initial Update (5 years + Scopus)
- ❖ Full Update (10 years of Scopus and WoS)

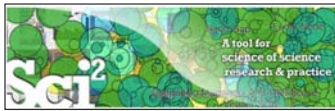
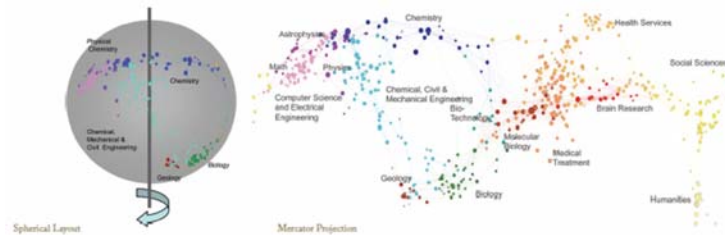


Original Map (5 years of Scopus and WoS)

Data: The original classification and map use 7.2 million papers and their references from Elsevier’s Scopus (about 15,000 source titles, 2001–2005) and Thomson Reuters’ Web of Science (WoS) Science, Social Science, Arts & Humanities Citation Indexes (about 9,000 source titles, 2001–2004)—about 16,000 unique source titles

Similarity Metric: Combination of bibliographic coupling and keyword vectors.
See Supplement 1 in <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0039464> for full details.

Layout: The 554 subdisciplines were laid out on the surface of a sphere; the spheric layout is then flattened using a Mercator projection to create a two-dimensional version of the map. Clusters are further aggregated into 13 main scientific disciplines that are labeled and color coded in a metaphorical way, e.g., Medicine is blood red and Earth Sciences are brown as soil.

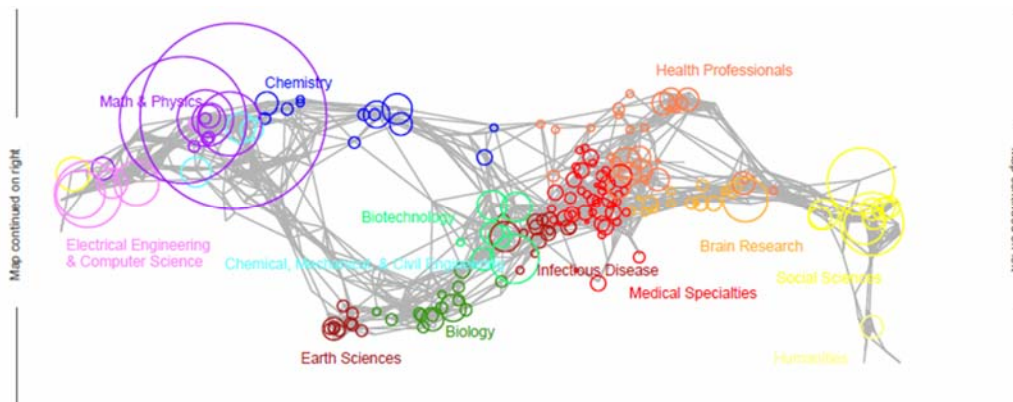


Original Map (5 years of Scopus and WoS)

Data Overlays:

Each node is labeled and has an extensive list of key phrases as metadata, which can be used to “science locate” nonjournal data, such as patents or grants. That is, key phrases from each patent or grant (titles and abstracts) are extracted; fractional assignment to map nodes proceeds by matching the associated metadata. Thus, each grant or patent is fractionally assigned to multiple nodes. Adding the fractions allows for the number of grants, dollars by agency, or patents associated with each node to be computed.

Problem: As time passes, new journals are created, e.g., PLoS, that cannot be mapped.





Initial Update (5 years + Scopus)

by Klavans & Boyack

Data: In June 2009, 7,464 new source titles (2006–2008) from Scopus were added to the existing category structure.

Process: Identifying all new journals that were not in the existing classification system, and assign each new journal to one of the existing categories by counting the numbers of times journals in each category were referenced by the articles in the new journals. Each journal was assigned to the category that it referenced the most, as long as it cited articles within that cluster a minimum of 10 times.

Result: Update increased the number of Scopus journals in the classification system by 47%, this only accounted for a 13% increase in the number of articles.

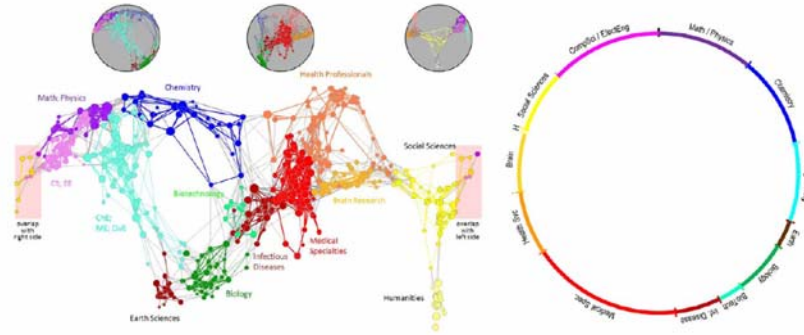


Figure 1. Visualizations of the UCSD Map: 2D Mercator projection (left) with three 3D spherical insets (top), 1D circular map (right). Note that the left hand side of the Mercator map connects to the right hand side. doi:10.1371/journal.pone.0039464.g001

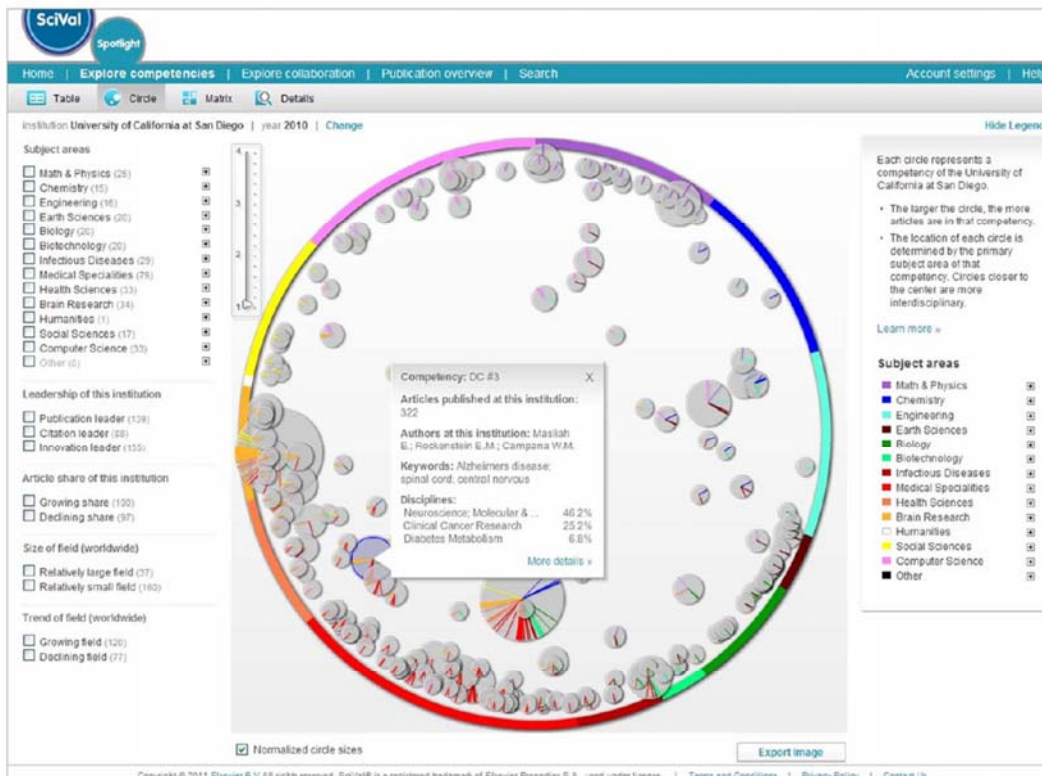


Figure 2. SciVal Spotlight map of one institution, here UCSD, showing institutional competencies. Each node within the circle map represents a competency (a group of linked topics), and is positioned at the average location of its articles. Node size reflects the number of articles. Coloured rays within each node show the disciplines that contribute to the competency. doi:10.1371/journal.pone.0039464.g002



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Desirable features for a map of science classification system:

1. Use highest quality/coverage paper-level data to generate the science map classification system. Using journal level data or highly cited papers exclusively lead to distortions [22].
2. Employ advanced dimensionality reduction techniques to map a high dimensional semantic space to a two-dimensional map that preserves the most important data structures [23].
3. Select a clustering and layout that has easy to read, distinct clusters, e.g., subdisciplines, which have about the same number of records, are disjoint (i.e., they do not overlap or occlude one other), and have meaningful labels to ease data interpretation and communication. The map must match the typical viewer's mental model of the domain.
4. Use graphic design (color, shape, size coding) and legend that can be understood by a large audience—map must empower users to form new hypotheses and get new answers.
5. Support interactivity, e.g., zoom, filter, details on demand [24]. Multi-level maps, e.g., two-levels comprising subdisciplines aggregated into disciplines, support multi-level studies.
6. Define a mapping process to classify new data and overlay it onto the map, e.g., journals based on journal names and other records, e.g., patents, funding data based on keywords. As users have a hard time with fractional associations/counting, each record should be associated with one or few subdisciplines.



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Desirable features for a map of science classification system (cont.):

7. The science map and classification system should be easy to update to capture the continuously evolving structure of science. Computational workflow should be well documented so that is easy to understand in principle and can be replicated by other experts. Updates should preserve the main structure of the map as much as possible.
8. Alignment and comparison of any new science map and classification with commonly used science classifications (e.g., classifications used by Thomson Reuters' databases, Elsevier's Scopus, the Library of Congress, Universal Decimal Classification) and the translation of major ontologies into different languages (Science-Metrix, [25]).



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Data: The updated map and classification adds six years (2005–2010) of WoS data and three years (2006–2008) from Scopus to the existing category structure—increasing the number of source titles to about 25,000.

Process:

For each of the 4,021 new journals, we counted the number of citations to/from papers published in that journal to/from each subdiscipline of the original map. This yielded for each journal an outgoing and incoming citation count for each subdiscipline of the original map. To account for the fact that some subdisciplines publish more papers than others and that, thus, the probability of citing and being cited by these subdisciplines is greater than for smaller ones, we normalized each of these citation counts by the total number of papers published among all journals assigned (even only fractionally) to that subdiscipline. The top subdiscipline citing/cited was then assigned to these new journals.

Multidisciplinary journals: PLOS ONE and SCHWEIZERISCHE MEDIZINISCHE WOCHENSCHRIFT (Swiss Medical Weekly) have the highest combined relative importance across sub-disciplines yet were assigned to one subdiscipline.

To further simplify the 2010 UCSD map, all multi-assigned journals were examined and only 34 were kept, among them *Science*, *Nature*, *the Lancet*, *British Medical Journal*, and *Journal of the American Medical Association*.



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Results:

A comparison of the original 5-year and the new 10-year maps and classification system show (i) an increase in the total number of journals that can be mapped by 9,409 journals (social sciences had a 80% increase, humanities a 119% increase, medical (32%) and natural science (74%)), (ii) a simplification of the map by assigning all but five highly interdisciplinary journals to exactly one discipline, (iii) a more even distribution of journals over the 554 subdisciplines and 13 disciplines when calculating the coefficient of variation, and (iv) a better reflection of journal clusters when compared with paper-level citation data. When evaluating the map with a listing of desirable features for maps of science, the updated map is shown to have higher mapping accuracy, easier understandability as fewer journals are multiply classified, and higher usability for the generation of data overlays, among others.

To our knowledge, this is the first time that a widely used map of science was updated



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

#Journals	5-Year Map	10-Year Map	Difference
WoS	9,499	13,520	4,021
Scopus	14,789	22,253	7,464
WoS & Scopus	15,849	25,258	9,409

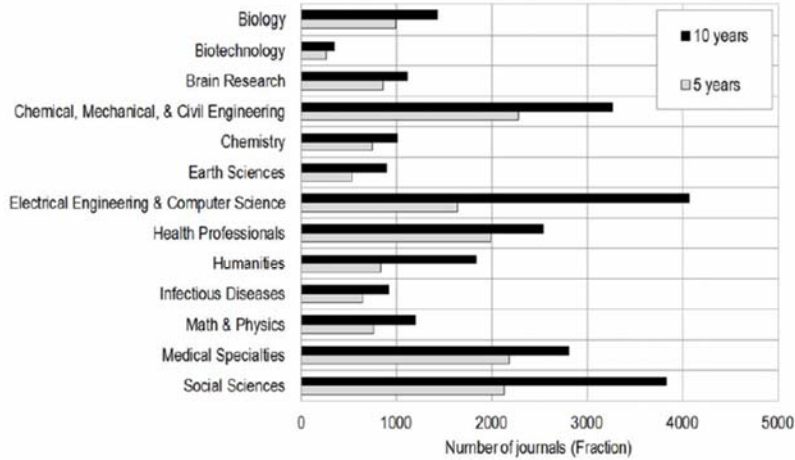
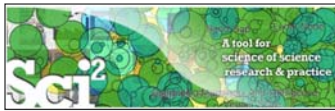


Figure 4. Number of journals per discipline for 5-year (grey) and 10-year (black) UCSD science map. doi:10.1371/journal.pone.0039464.g004



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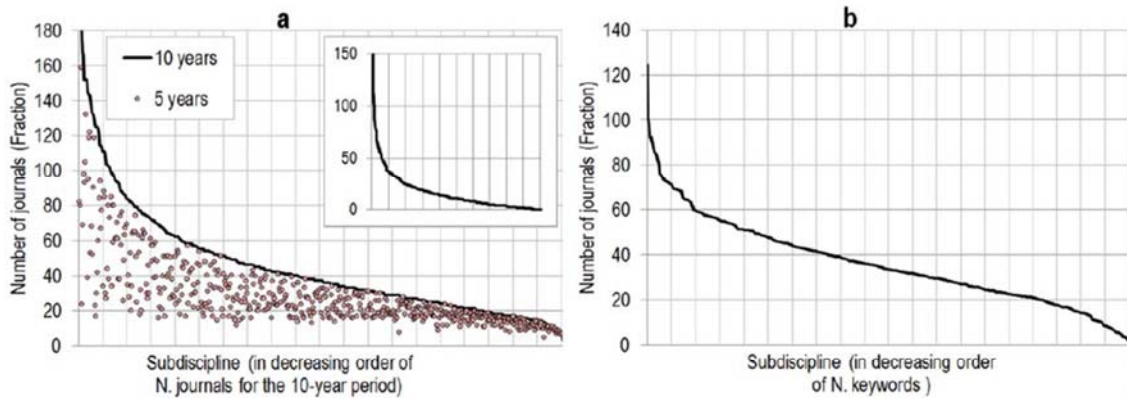
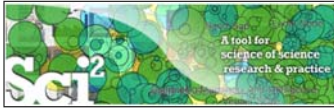


Figure 5. Number of journals per subspecialty for 5-year (grey/red circles) and 10-year (black line) UCSD science map. Inset: distribution of the gain in number of journals for each subspecialty (a). Number of (fractionally assigned) terms per 554 subspecialties (b). doi:10.1371/journal.pone.0039464.g005



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Deployment: The UCSD map of science data is available at <http://sci.cns.iu.edu/ucsdmap/>

Data

The 2010 UCSD map of science and classification system covering 10 years (2001-2010) of Web of Science data and 8 years (2001-2008) of Scopus data with subdiscipline assignments by SciTech Strategies.

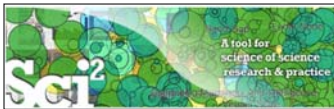
1. Data as [MS AccessDB](#) and as [MS Excel](#) file (identical info as MS AccessDB) as well as [data dictionary](#) and [database schema](#).
2. [Network .net file](#) to visually render science map. Also provided as [.net file](#) with discipline nodes and names.

Usage Conditions

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Please cite as: Börner, Katy, Richard Klavans, Michael Patek, Angela Zoss, Joseph R. Biberstine, Robert Light, Vincent Larivière, and Kevin W. Boyack (2012) Design and Update of a Classification System: The UCSD Map of Science. *PLoS ONE* 7(7): e39464. [doi:10.1371/journal.pone.0039464](https://doi.org/10.1371/journal.pone.0039464)



Full Update (10 years of Scopus and WoS)

by Börner, Klavans, Patek, Zoss, Biberstine, Light, Larivière, Boyack

Data: The 2010 UCSD map of science and classification system covers ten years (2001-2010) of data from Thomson Reuters' Web of Science and eight years (2001-2008) of Elsevier's Scopus, specifically the fractional assignment of about 25,000 journal names to 554 subdisciplines grouped into 13 disciplines of science.

The counts for major record types are given here:

1. 13 disciplines with labels and color codes
2. 554 subdisciplines with x, y positions and size
3. 15,849 journals captured by 5-year map
4. 25,258 journals captured by 10-year map
5. 13,520 journal names used by Thomson Reuters
6. 22,253 journal names used by Scopus
7. 21,630 Scopus journal ID numbers
8. 19,988 ISSN numbers
9. 66,759 terms

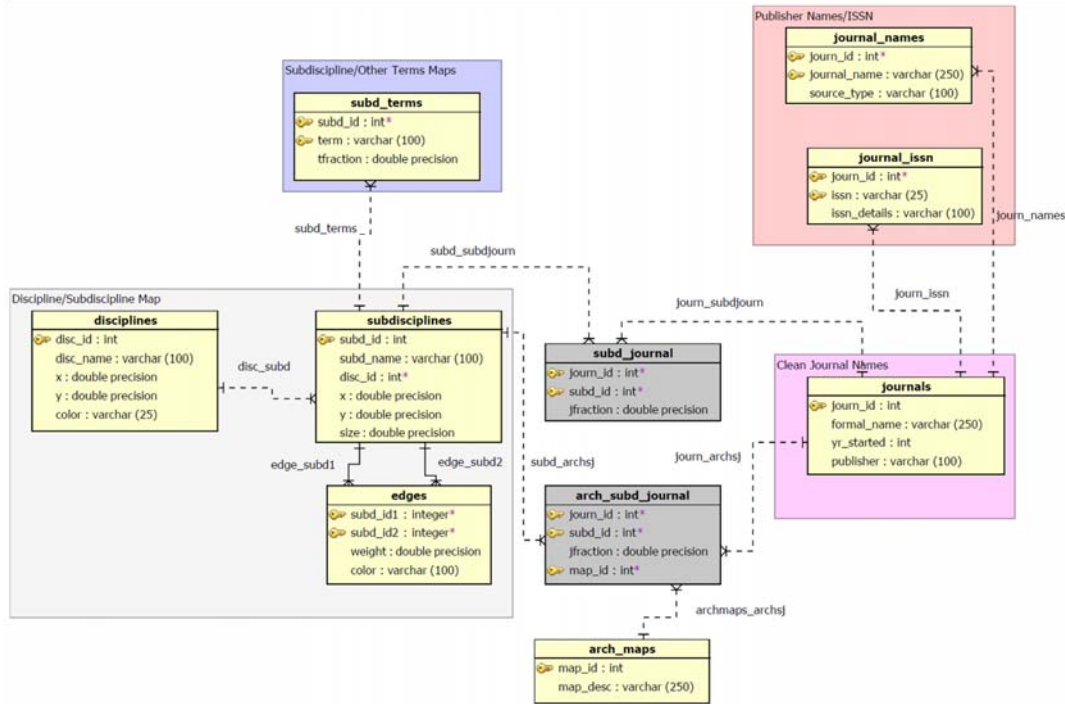
See Data Dictionary in Supplement 2 in

<http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0039464>

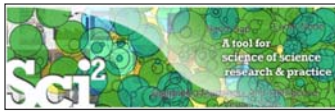


Full Update (10 years of Scopus and WoS)

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UCSD map table schema <http://sci.cns.iu.edu/ucsdmap/data/UCSDmapDBSchema.pdf>



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Note: There are no standards on how to render .net files!

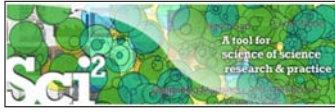
Some define the zero point on the top left (e.g., GUESS), while others define the bottom left point as 0,0 (e.g., Gephi, Pajek). This only becomes important when rendering a dataset that has a predefined left and right, top and bottom such as the UCSD map of science. Simply multiply all node's y-position with -1 to solve this issue.



Validation:

How good is the (UCSD) map of science?

- ❖ Comparing the Accuracies of Nine Text-Based Similarity Approaches
- ❖ Consensus Map
- ❖ User Studies



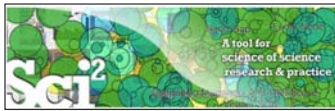
Comparing the Accuracies of Nine Text-Based Similarity Approaches

We used a corpus of 2.15 million recent (2004-2008) records from MEDLINE, and generated nine different document-document similarity matrices from information extracted from their bibliographic records, including titles, abstracts and subject headings.

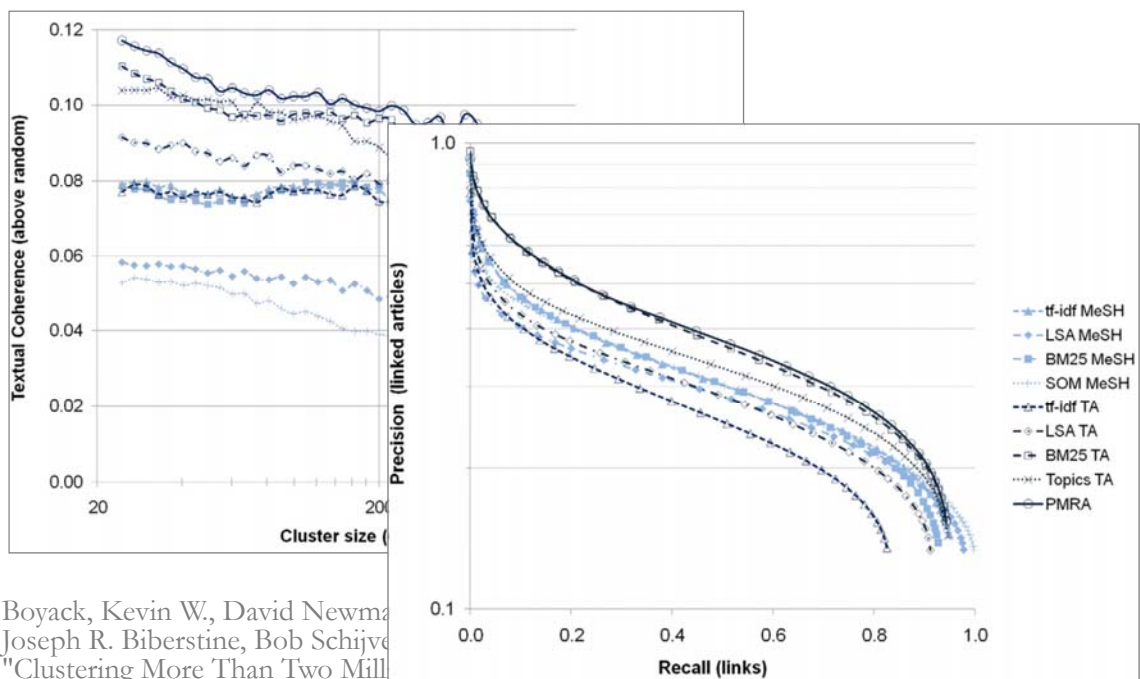
Similarity approach	Data source	
	MeSH terms	Title/abstract words
tf-idf cosine	tf-idf MeSH (Indiana U.)	tf-idf TA (Indiana U.)
Latent semantic analysis	LSA MeSH (Indiana U.)	LSA TA (Indiana U.)
Topic modeling		Topics TA (UC Irvine)
Self-organizing map	SOM MeSH (SDSU/Indiana U.)	
Poisson-based	BM25 MeSH (Collexis)	BM25 TA (Collexis) PMRA (UC Irvine/SciTech)

Cluster results from the nine similarity approaches were compared using (1) within-cluster textual coherence based on the Jensen-Shannon divergence, and (2) two concentration measures based on grant-to-article linkages indexed in MEDLINE.

Boyack, Kevin W., David Newman, Russell Jackson Duhon, Richard Klavans, Michael Patek, Joseph R. Biberstine, Bob Schijvenaars, Andre Skupin, Nianli Ma, and Katy Börner. 2011. "Clustering More Than Two Million Biomedical Publications: Comparing the Accuracies of Nine Text-Based Similarity Approaches". *PLoS ONE* 6(3): 1-11.



Comparing the Accuracies of Nine Text-Based Similarity Approaches



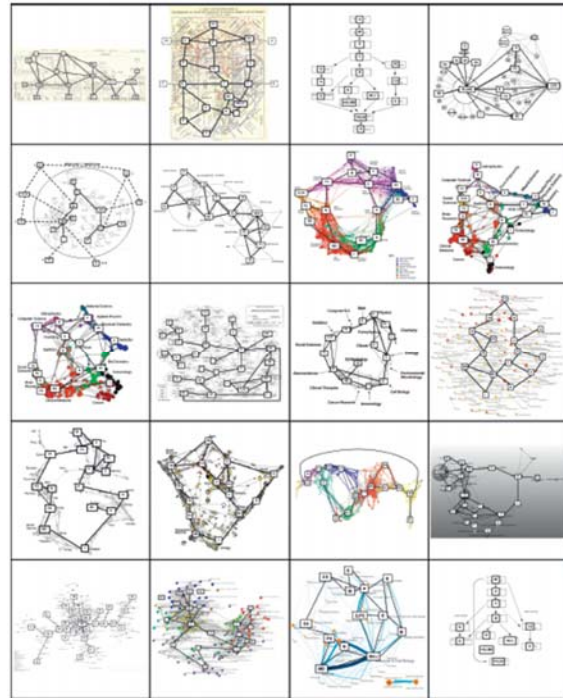
Boyack, Kevin W., David Newman, Russell Jackson Duhon, Richard Klavans, Michael Patek, Joseph R. Biberstine, Bob Schijvenaars, Andre Skupin, Nianli Ma, and Katy Börner. 2011. "Clustering More Than Two Million Biomedical Publications: Comparing the Accuracies of Nine Text-Based Similarity Approaches". *PLoS ONE* 6(3): 1-11.



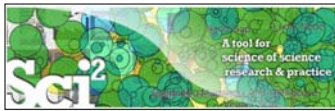
Consensus Map

20 maps of science were examined and found to have a high level of correspondence.

Source map	Year	Type
KB06-SC	2006	Paper
Backbone	2004	Jnl
UCSD	2007	Jnl
Ellingham	1948	Expert
KB-Para	2005	Paper
Bernal	1939	Expert
Scimago-I	2004	Categ
KB06-TS	2006	Paper
B03-ST	2005	Jnl
BBK02-S	2004	Jnl
Rosvall	2007	Jnl
Small99	1999	Paper
Balaban-II	2007	Pre-req
K02	2002	Jnl
L-R	2007	Categ
Balaban-I	2007	Expert
Small85	1985	Paper
Small74	1974	Paper
B-Z	1999	Jnl
Scimago-II	2007	Categ



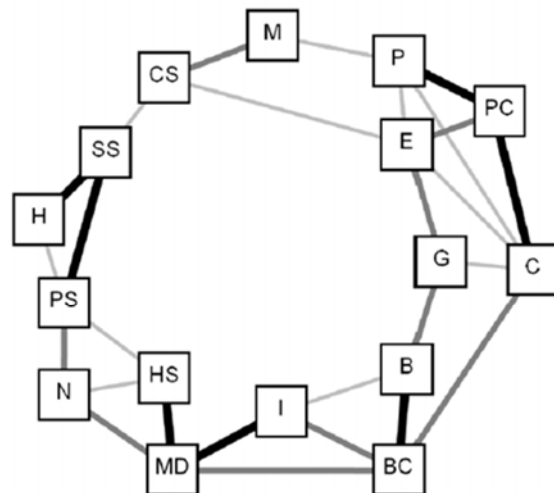
Klavans, R., & Boyack, K. W. (2009). Toward a consensus map of science. *Journal of the American Society for Information Science and Technology*, 60(3), 455-476.



Consensus Map

20 maps of science were examined and found to have a high level of correspondence.

- M – Mathematics
- CS – Computer science
- P – Physics
- PC – Physical chemistry
- C – Chemistry
- E – Engineering
- G – Earth sciences (geoscience)
- BC – Biochemistry
- B – Biology
- I – Infectious disease
- MD – Medical specialties
- HS – Health services
- N – Brain research (neuroscience)
- PS – Psychology/psychiatry
- SS – Social sciences
- H – Humanities



Line size/color = % of maps

- Thick black line** 90% or more
- Medium grey line** 70% - 90%
- Thin grey line** 50% - 70%

Klavans, R., & Boyack, K. W. (2009). Toward a consensus map of science. *Journal of the American Society for Information Science and Technology*, 60(3), 455-476.



Science Basemaps: Consensus Map

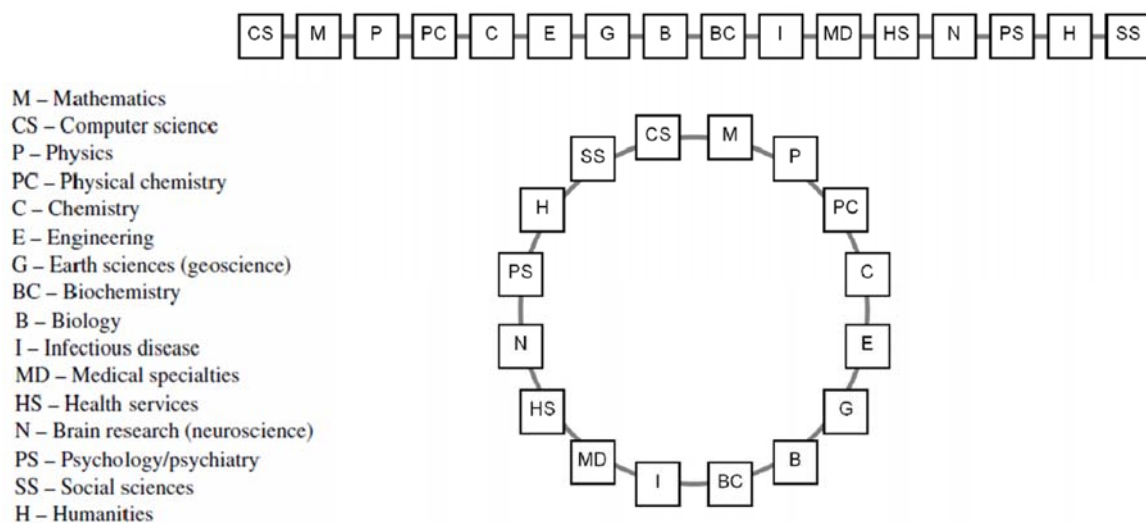


FIG. 6. One-dimensional consensus maps of science, Euclidean (top) and Riemannian (bottom).

Klavans, R., & Boyack, K. W. (2009). Toward a consensus map of science. *Journal of the American Society for Information Science and Technology*, 60(3), 455-476.



User Studies

Compare accuracies of cluster solutions of a large corpus of 2,153,769 recent articles from the biomedical literature (2004-2008) using four similarity approaches: co-citation analysis, bibliographic coupling, direct citation, and a bibliographic coupling-based citation-text hybrid approach.

Accuracies are compared using two metrics – within-cluster textual coherence as defined by the Jensen-Shannon divergence, and a new concentration factor based on the grant-to-article linkages indexed in MEDLINE.

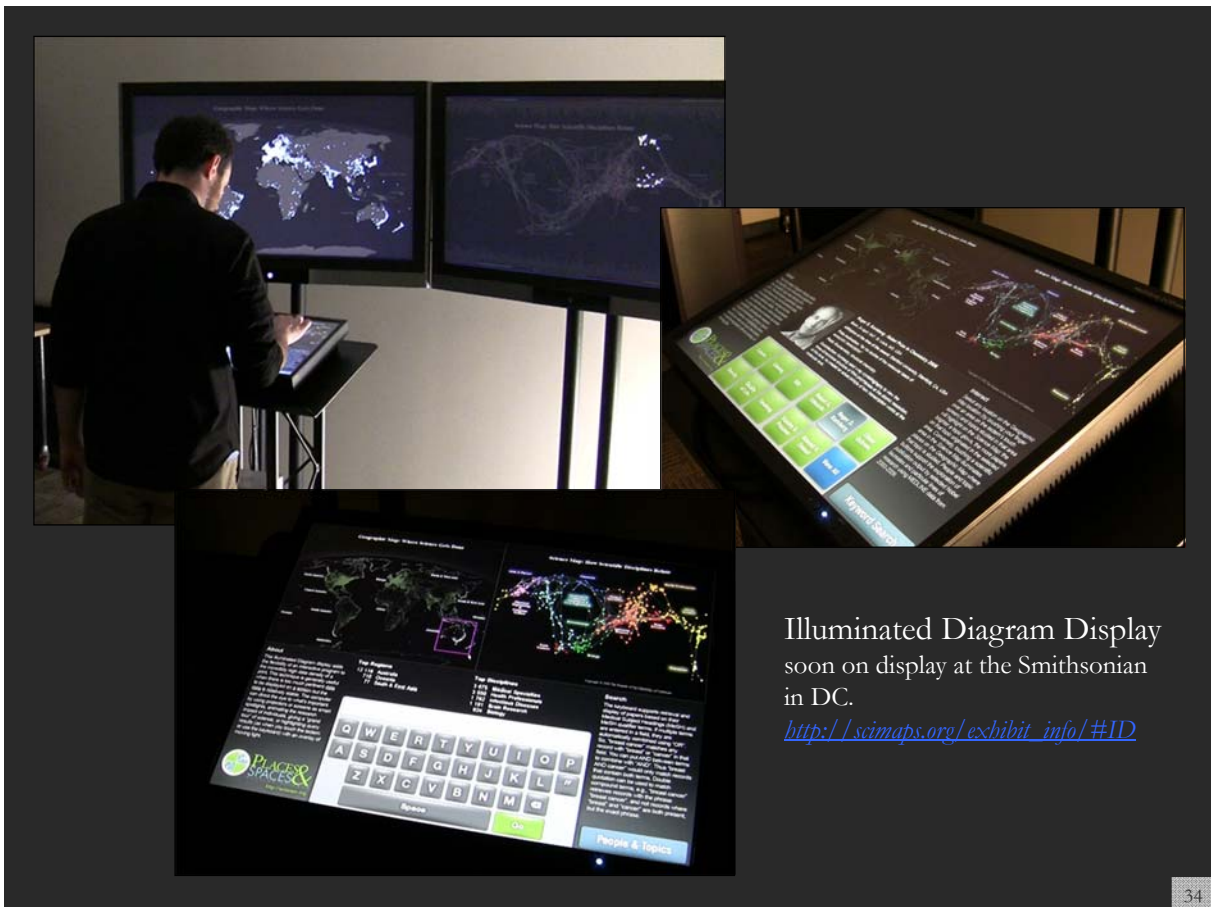
Experts found the partitioning of our micro-structural model to be compelling at the research problem level.

Boyack, K. W., & Klavans, R. (2010). Co-citation analysis, bibliographic coupling, and direct citation: Which citation approach represents the research front most accurately? *Journal of the American Society for Information Science and Technology*, 61(12), 2389-2404.

Klavans, R., Boyack, K. W., and Small Henry (2012). Indicators and Precursors of 'Hot Science.' *17th International Conference on Science and Technology Indicators (STI), Montreal, Canada.*

**Application:
How to use the (UCSD) map of science?**

- ❖ **Illuminated Diagram**
- ❖ **VIVO**
- ❖ **MapSustain**
- ❖ **Sci2**



Geographic Map: Where Science Gets Done

Science Map: How Scientific Disciplines Relate

Copyright © 2008 The Regents of the University of California

About

This Illuminated Diagram display adds the flexibility of an interactive program to the incredibly high data density of a print. This technique is generally useful when there is too much pertinent data to be displayed on a screen but the data is relatively stable. The computer can direct the eye to what's important by using projectors or screens as smart spotlights, animating the research impact of individuals, giving a "grand tour" of science, or highlighting query results (as when you touch the lectern or use the keyboard) with an overlay of moving light.

Elinor Ostrom - Nobel Prize in Economic Sciences 2009
 Born: 7 August 1933, New York, NY, USA
 Affiliation at the time of the award: Indiana University, Bloomington, IN, USA, Arizona State University, Tempe, AZ, USA
 Prize motivation: "for her analysis of economic governance, especially the commons"
 Field: Economic governance
 Contribution: Challenged the conventional wisdom by demonstrating how local property can be successfully managed by local commons without any regulation by central authorities or privatization.

Interact

Select any location on the Geographic Map location (by brushing your finger over an area on the lectern's touch screen) and topics studied in that area will highlight on the Science Map: the brighter a topic glows, the more papers on that topic originated in the selected area. Conversely, touching a scientific area in the Science Map illuminates places on the Geographic Map where that topic is studied. People and topic buttons support the exploration of publication output by selected Noble laureates and particular lines of research using MEDLINE data from 2000-2009.

Cancer	Cloning	HIV	Robert G. Edwards	Roger D. Kornberg	Elinor Ostrom
Obesity	Quality of Life	Smoking	Stanley B. Prusiner	Ahmed H. Zewail	View All

35

Geographic Map: Where Science Gets Done

Science Map: How Scientific Disciplines Relate

Copyright © 2008 The Regents of the University of California

About

This Illuminated Diagram display adds the flexibility of an interactive program to the incredibly high data density of a print. This technique is generally useful when there is too much pertinent data to be displayed on a screen but the data is relatively stable. The computer can direct the eye to what's important by using projectors or screens as smart spotlights, animating the research impact of individuals, giving a "grand tour" of science, or highlighting query results (as when you touch the lectern or use the keyboard) with an overlay of moving light.

Top Five Continents

- North America - 4,000 records
- South & East Asia - 3,589
- Australia - 2,431
- Africa - 2,208
- South America - 1,562

Top Five Scientific Disciplines

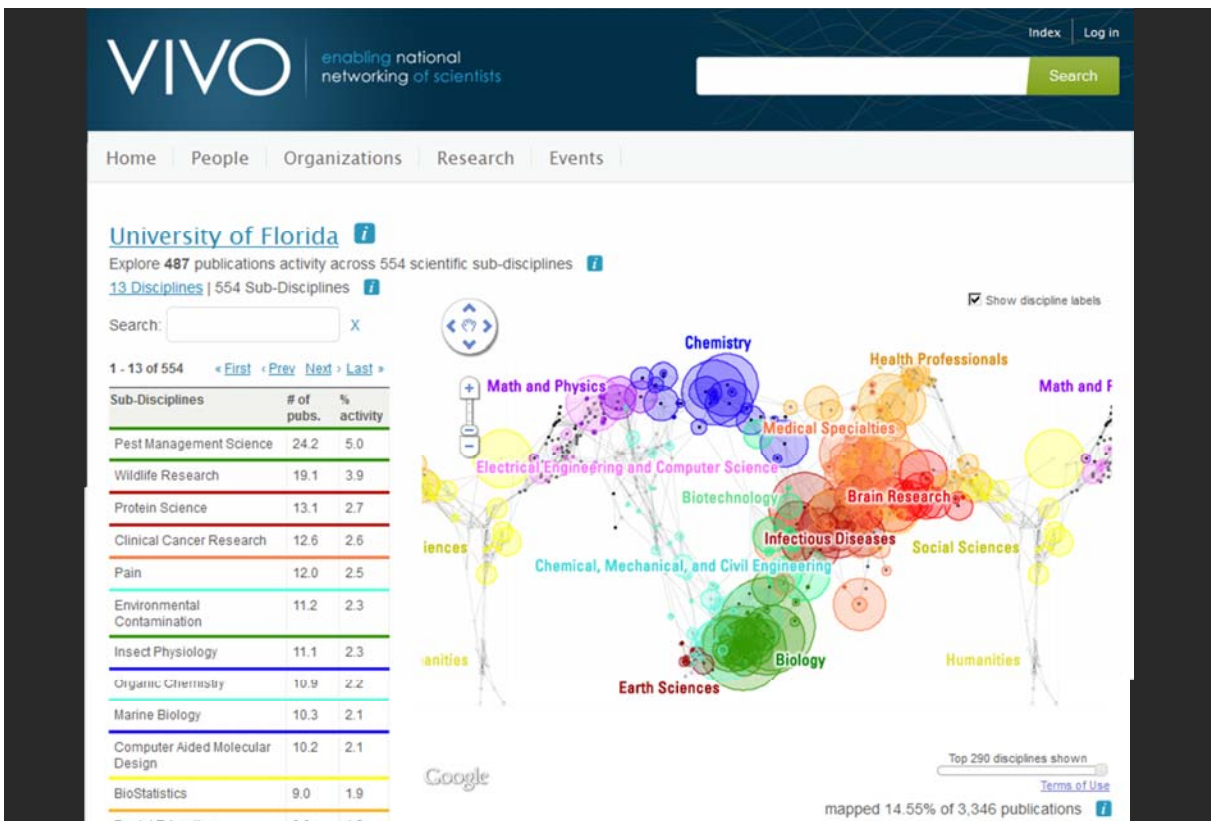
- Math & Physics - 4,000 records
- Health Professions - 3,589
- Social Sciences - 2,431
- Aeronautical, Chemical, Mechanical & Civil Engineering - 2,208
- Humanities - 1,562

Search

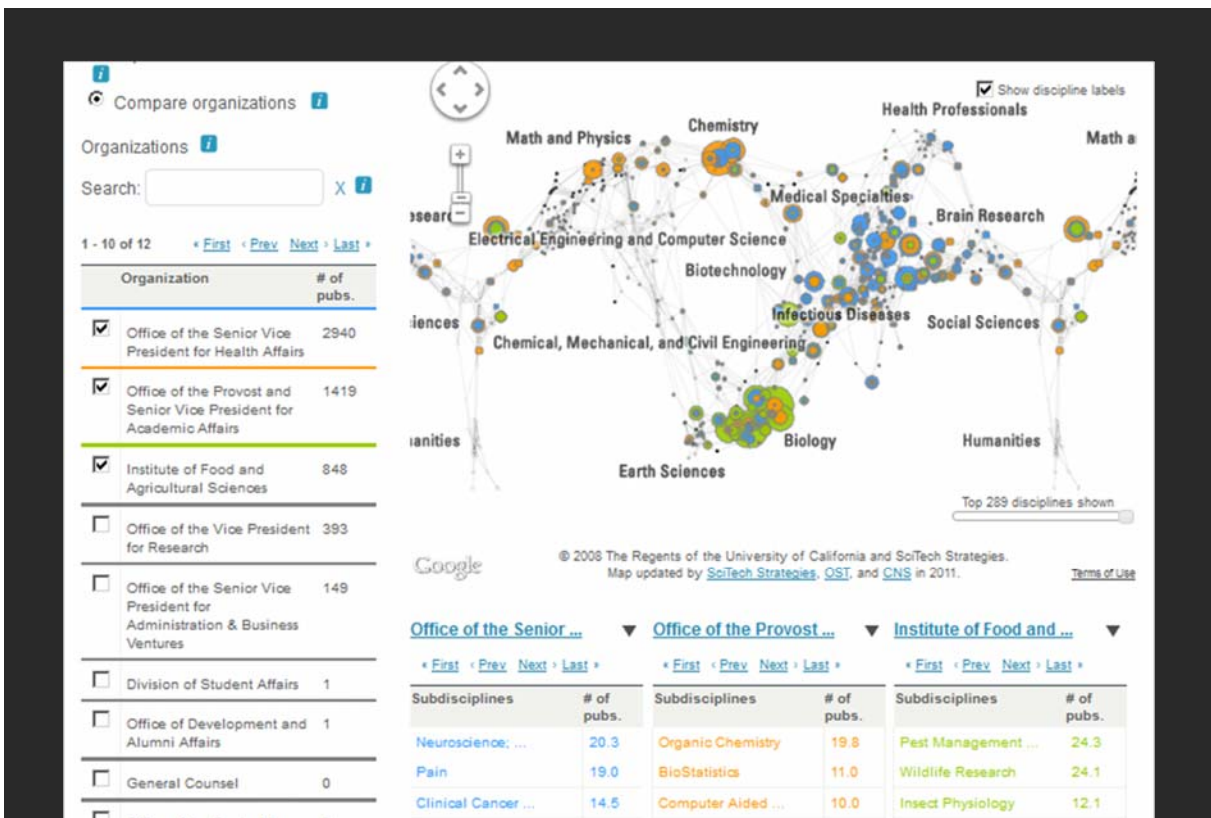
The keyboard supports retrieval and display of papers based on their Medical Subject Headings (MeSH) and MeSH qualifier terms. If multiple terms are entered in a field, they are automatically combined using "OR". So, "breast cancer" matches any record with "breast" or "cancer" in that field. You can put AND between terms to combine with "AND". Thus "breast AND cancer" would only match records that contain both terms. Double quotation can be used to match compound terms, e.g., "breast cancer" retrieves records with the phrase "breast cancer", and not records where "breast" and "cancer" are both present, but the exact phrase.

Q	W	E	R	T	Y	U	I	O	P
A	S	D	F	G	H	J	K	L	"
Z	X	C	V	B	N	M			
Space									Go

36



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

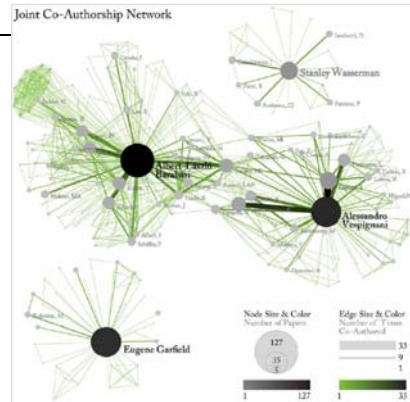
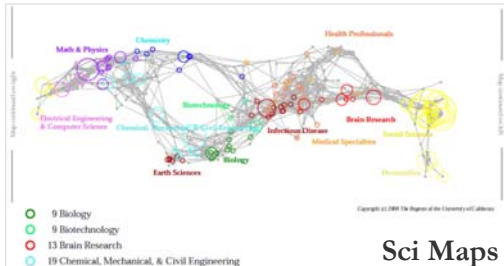


Topical Analysis (What) Science map overlays will show where a person, department, or university publishes most in the world of science. (in work)

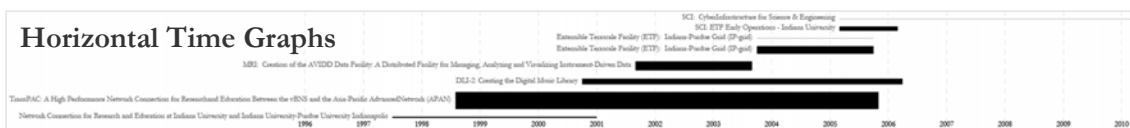


Sci² Tool – “Open Code for S&T Assessment”

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



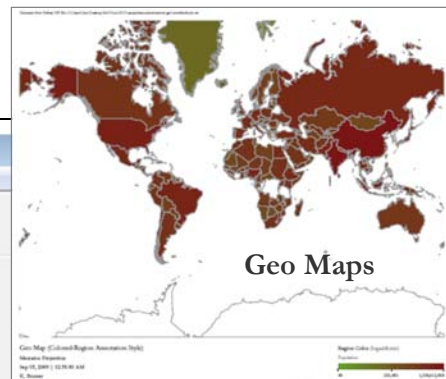
Horizontal Time Graphs



Börner, Katy, Huang, Weixia (Bonnie), Linnemeier, Micah, Dubon, Russell Jackson, Phillips, Patrick, Ma, Nianli, Zoss, Angela, Guo, Hanning & Price, Mark. (2009). *Reti-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 Vis cont.



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>).

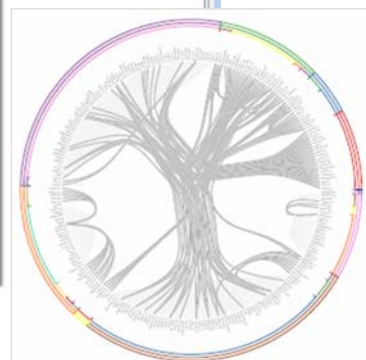
The primary investigators are Katy Börner, In SciTech Strategies Inc. The Sci² tool was developed by J. Duhon, Patrick A. Phillips, Chintan Tank, a Cyberinfrastructure Shell (<http://cishell.org>) for Network Science Center (<http://cns.slis.indiana.edu>). Many algorithm plugins were derived from the Network Workbench Tool (<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 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%

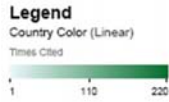




New Visualizations

Geospatial Visualization (Choropleth Map)

Generated from CSV file: Preprocessed-usptoInfluenza-8383730930137543104.csv
Jun 05, 2012 | 05:45:00 PM EDT

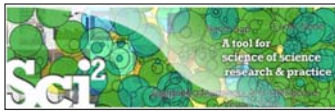


How to Read this Map

This choropleth map shows 200 countries of the world using the equal-area Eckert IV projection. Each country may be color coded in proportion to a numerical value. Minimum and maximum data values are given in the legend.

CNS (cns.iu.edu)

41



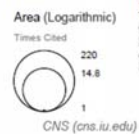
New Visualizations

Geospatial Visualization (Proportional Symbol Map)

Generated from CSV file: C:\sci2\sampledata\geolusptoInfluenza.csv
Jun 14, 2012 | 05:56:39 PM EDT



Legend

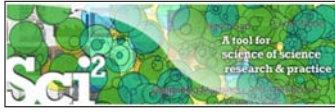


How to Read this Map

This proportional symbol map shows 209 countries of the world using the equal-area Eckert IV projection. Each dataset record is represented by a circle centered at its geolocation. The area, interior color, and exterior color of each circle may represent numeric attribute values. Minimum and maximum data values are given in the legend.

CNS (cns.iu.edu)

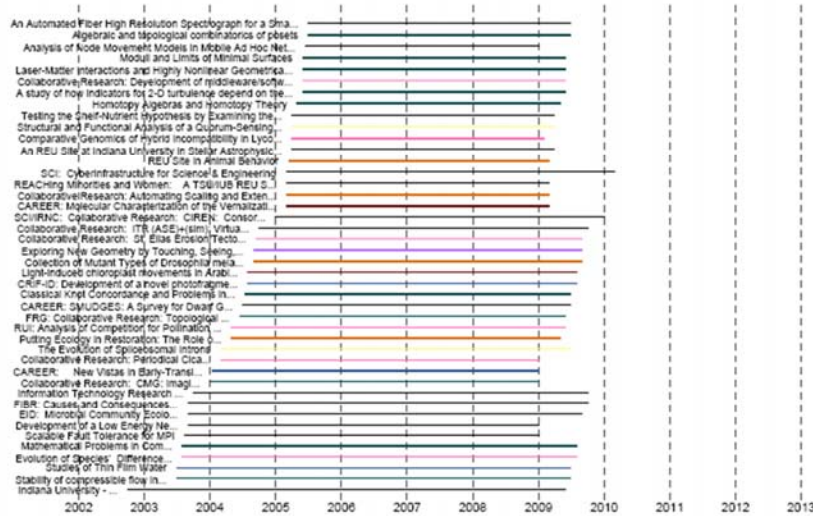
42



New Visualizations

Temporal Visualization

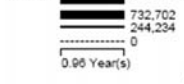
Generated from NSF csv file: C:\Users\katy\Desktop\TOOLS\Sci2-2012.06.04-KNAW\sampled\datascientometrics\isf\indiana.nsf
June 05, 2012 | 4:50 PM EDT



Legend

Area size: Award Number
Minimum = 220,560
Maximum = 952,643
Text label: Title
Color: NSF Organization
See end of PDF for color legend.

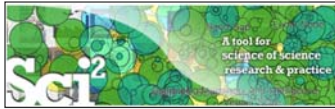
Area



How To Read This Map

This temporal bar graph visualization represents each record as a horizontal bar with a specific start and end date and a text label on its left side. The area of each bar encodes a numerical attribute value, e.g., total amount of funding. Bars may be colored to present categorical attribute values of records.

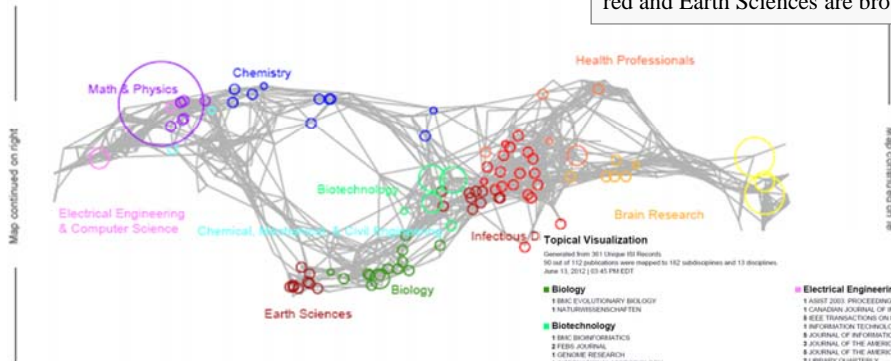
CNS (cns.iu.edu)



New Visualizations

Topical Visualization

Generated from 361 Unique ISI Records of 4 NetSci Researchers
14 out of 109 publications were mapped to 94 subdisciplines and 12 disciplines.
June 05, 2012 | 05:39 PM EDT



Legend

Circle area: Fractional Journal Count
Unclassified = 96
Minimum = 0
Maximum = 25
Color: Discipline
See end of PDF for color legend.

Area



How To Read This Map

The UCSD map are aggregated in color and is labeled unique subdiscipline and assigned record:

- Chemistry**
 - 1 CURRENT SCIENCE
- Earth Sciences**
 - 1 JOURNAL OF CHEMICAL INFORMATION AND COMPUTER SCIENCES
 - 1 JOURNAL OF THE ROYAL INSTITUTE OF SCIENCE
 - 1 PURE AND APPLIED CHEMISTRY
- Electrical Engineering & Computer Science**
 - 1 1987 2001 PROCEEDINGS OF THE 8TH ANNUAL MEETING...
 - 1 CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE RE...
 - 1 IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
 - 1 INFORMATION TECHNOLOGY AND LIBRARIES
 - 1 JOURNAL OF INFORMATION SCIENCE
 - 1 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
 - 1 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE QUARTERLY
 - 1 LIBRI
 - 1 PROCEEDINGS OF THE AMERICAN SOCIETY FOR INFORMATION SC...
- Health Professionals**
 - 1 ANNALS OF BIOMEDICAL ENGINEERING
 - 1 BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION
 - 1 CANADIAN MEDICAL JOURNAL
 - 1 JOURNAL OF APPLIED PHYSIOLOGY
 - 1 JOURNAL OF PUBLIC HEALTH DENTISTRY
 - 1 METHODS OF INFORMATION IN MEDICINE
 - 1 PLASTIC AND RECONSTRUCTIVE SURGERY
 - 1 TEAR MEDICINE
 - 1 UNFALLCHIRURG
 - 1 WISNER-KLUBSCHE WOCHENSCHRIFT
- Humanities**
 - 1 BULLETIN OF THE ATOMIC SCIENTISTS
- Infectious Diseases**
 - 1 FEBS MICROBIOLOGY LETTERS
 - 1 JOURNAL OF BACTERIOLOGY
- Math & Physics**
 - 1 ADVANCES IN APPLIED PROBABILITY

CNS (cns.iu.edu)

CNS (cns.iu.edu)

Data: WoS and Scopus paper level data for 2001–2010, about 25,000 separate journals, proceedings, and series.
Similarity Metric: Combination of bibliographic coupling and keyword vectors.
Number of Disciplines: 554 journal clusters further aggregated into 13 main scientific disciplines that are labeled and color coded in a metaphorical way, e.g., Medicine is blood red and Earth Sciences are brown as soil.



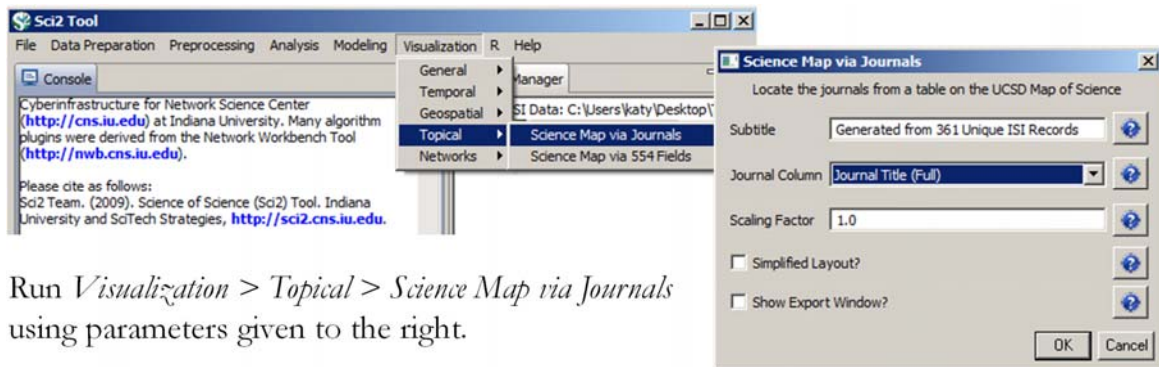
DIY Science Maps using the Sci2 Tool

Download Sci2 Tool v1.0 Alpha (June 13, 2012) from <http://sci2.cns.iu.edu>

Unpack into a /sci2 directory. Run /sci2/sci2.exe

Sci2 Manual is at <http://sci2.wiki.cns.iu.edu>

Load an ISI (*.isi), Bibtext (*.bib), Endnote Export Format (*.enw), Scopus csv (*.scopus) file such as /sci2/sampleddata/scientometrics/isi/FourNetSciResearchers.isi



Run *Visualization > Topical > Science Map via Journals* using parameters given to the right.

Postscript file will appear in *Data Manager*. Save and open with a Postscript Viewer.

45

Topical Visualization

Generated from 361 Unique ISI Records
90 out of 112 publications were mapped to 182 subdisciplines and 13 disciplines.
June 24, 2012 | 04:04 PM EDT



2008 The Regents of the University of California and SciTech Strategies.
Map updated by SciTech Strategies, OST, and CNS in 2011.

Legend

Circle area: Fractional Journal Count
Unclassified = 22
Minimum = 0
Maximum = 98
Color: Discipline
See end of PDF for color legend.

Area



How To Read This Map

The UCSD map of science depicts a network of 554 subdiscipline nodes that are aggregated to 13 main disciplines of science. Each discipline has a distinct color and is labeled. Overlaid are circles, each representing all records per unique subdiscipline. Circle area is proportional to the number of fractionally assigned records. Minimum and maximum data values are given in the legend.

CNS (cns.iu.edu)

Topical Visualization

Generated from 361 Unique ISI Records
90 out of 112 publications were mapped to 182 subdisciplines and 13 disciplines.
June 24, 2012 | 04:04 PM EDT

■ Biology

- 1 BMC EVOLUTIONARY BIOLOGY
- 1 NATURWISSENSCHAFTEN

■ Biotechnology

- 1 BMC BIOINFORMATICS
- 2 FEBS JOURNAL
- 1 GENOME RESEARCH
- 1 INTERNATIONAL MICROBIOLOGY
- 1 NATURE BIOTECHNOLOGY
- 3 NATURE GENETICS
- 1 NATURE REVIEWS GENETICS
- 1 NUCLEIC ACIDS RESEARCH
- 2 PROTEOMICS

■ Brain Research

- 5 JOURNAL OF MATHEMATICAL PSYCHOLOGY

■ Chemical, Mechanical, & Civil Engineering

- 1 JOURNAL OF CERAMIC PROCESSING RESEARCH
- 2 MATERIALS SCIENCE AND ENGINEERING A-STRUCTURAL MATERIA...
- 1 PHYSICS WORLD
- 1 SCIENTIFIC AMERICAN

■ Chemistry

- 1 COMPUTER PHYSICS COMMUNICATIONS
- 2 JOURNAL OF CHEMICAL INFORMATION AND COMPUTER SCIENCES
- 1 JOURNAL OF THE INDIAN INSTITUTE OF SCIENCE
- 1 PURE AND APPLIED CHEMISTRY

■ Earth Sciences

- 1 CURRENT SCIENCE

■ Electrical Engineering & Computer Science

- 1 ASIST 2003: PROCEEDINGS OF THE 66TH ASIST ANNUAL MEETING...
- 1 CANADIAN JOURNAL OF INFORMATION AND LIBRARY SCIENCE-REV...
- 5 IEEE TRANSACTIONS ON PROFESSIONAL COMMUNICATION
- 1 INFORMATION TECHNOLOGY AND LIBRARIES
- 5 JOURNAL OF INFORMATION SCIENCE
- 3 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
- 5 JOURNAL OF THE AMERICAN SOCIETY FOR INFORMATION SCIENC...
- 2 LIBRARY QUARTERLY
- 1 LIBRI
- 1 PROCEEDINGS OF THE AMERICAN SOCIETY FOR INFORMATION SC...

■ Health Professionals

- 1 ANNALS OF BIOMEDICAL ENGINEERING
- 1 BULLETIN OF THE MEDICAL LIBRARY ASSOCIATION
- 1 CROATIAN MEDICAL JOURNAL
- 2 JOURNAL OF APPLIED PHYSIOLOGY
- 1 JOURNAL OF PUBLIC HEALTH DENTISTRY
- 1 METHODS OF INFORMATION IN MEDICINE
- 1 PLASTIC AND RECONSTRUCTIVE SURGERY
- 1 TEXAS MEDICINE
- 1 UNFALLCHIRURG
- 1 WIENER KLINISCHE WOCHENSCHRIFT

■ Humanities

- 1 BULLETIN OF THE ATOMIC SCIENTISTS

■ Infectious Diseases

- 1 FEMS MICROBIOLOGY LETTERS
- 1 JOURNAL OF BACTERIOLOGY

■ Math & Physics

- 1 ADVANCES IN APPLIED PROBABILITY

CNS (cns.iu.edu)

Topical Visualization

Generated from 361 Unique ISI Records
90 out of 112 publications were mapped to 182 subdisciplines and 13 disciplines.
June 24, 2012 | 04:04 PM EDT

■ Math & Physics

- 10 APPLIED PHYSICS LETTERS
- 1 BRAZILIAN JOURNAL OF PHYSICS
- 3 CHAOS SOLITONS & FRACTALS
- 1 COMPLEXITY
- 1 COMPUTATIONAL MATERIALS SCIENCE
- 11 EUROPEAN PHYSICAL JOURNAL B
- 12 EUROPHYSICS LETTERS
- 2 INTERNATIONAL JOURNAL OF MODERN PHYSICS B
- 6 JOURNAL OF PHYSICS A-MATHEMATICAL AND GENERAL
- 1 JOURNAL OF STATISTICAL MECHANICS-THEORY AND EXPERIMENT
- 1 JOURNAL OF STATISTICAL PHYSICS
- 1 JOURNAL OF THE KOREAN PHYSICAL SOCIETY
- 1 MATERIALS SCIENCE AND ENGINEERING B-SOLID STATE MATERIAL...
- 3 NATURE PHYSICS
- 3 NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH SEC...
- 12 PHYSICA A
- 5 PHYSICAL REVIEW A
- 2 PHYSICAL REVIEW B
- 45 PHYSICAL REVIEW LETTERS
- 2 REVIEWS OF MODERN PHYSICS

■ Medical Specialties

- 1 ANNALS OF INTERNAL MEDICINE
- 1 REVISTA DE INVESTIGACION CLINICA

■ Social Sciences

- 1 ADMINISTRATIVE SCIENCE QUARTERLY
- 1 AMERICAN BEHAVIORAL SCIENTIST
- 1 AMERICAN SOCIOLOGICAL REVIEW
- 1 ANNALS OF THE AMERICAN ACADEMY OF POLITICAL AND SOCIAL S...
- 1 ARBOR-CIENCIA PENSAMIENTO Y CULTURA
- 3 BRITISH JOURNAL OF MATHEMATICAL & STATISTICAL PSYCHOLOGY
- 1 JOURNAL OF CLASSIFICATION

■ Social Sciences

- 2 JOURNAL OF MATHEMATICAL SOCIOLOGY
- 3 JOURNAL OF THE AMERICAN STATISTICAL ASSOCIATION
- 2 PSYCHOLOGICAL BULLETIN
- 5 PSYCHOMETRIKA
- 1 RECHERCHE
- 5 SCIENTOMETRICS
- 1 SOCIAL FORCES
- 6 SOCIAL NETWORKS
- 3 SOCIOLOGICAL METHODS & RESEARCH

Multiple Categories

- 1 BRITISH MEDICAL JOURNAL
- 2 JAMA-JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION
- 1 JOURNAL OF THEORETICAL BIOLOGY
- 18 NATURE
- 44 PHYSICAL REVIEW E
- 5 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE ...
- 6 SCIENCE

Unclassified

- 1 ALGORITHMS AND MODELS FOR THE WEB-GRAPHS, PROCEEDINGS
- 2 AMERICAN DOCUMENTATION
- 2 ASIST 2002: PROCEEDINGS OF THE 65TH ASIST ANNUAL MEETING, ...
- 1 BIOLOGIYA MORYA-MARINE BIOLOGY
- 1 BULLETIN OF THE AMERICAN SOCIETY FOR INFORMATION SCIENCE
- 1 CHEMIKER-ZEITUNG
- 3 CHEMTECH
- 1 COMBINATORIAL AND ALGORITHMIC ASPECTS OF NETWORKING
- 7 CURRENT COMMENTS
- 3 CURRENT CONTENTS/LIFE SCIENCES
- 1 FEDERATION PROCEEDINGS
- 5 FRACTALS-AN INTERDISCIPLINARY JOURNAL ON THE COMPLEX GE...
- 1 FRONTIERS OF LIBRARIANSHIP-SYRACUSE UNIVERSITY

CNS (cns.iu.edu)



Sci2 Tool Tutorials at IUB

There are five hands-on mini tutorials that teach network science analysis and visualization techniques and tools to a general audience.

Each is 1h each and the Fall tutorials comprise:

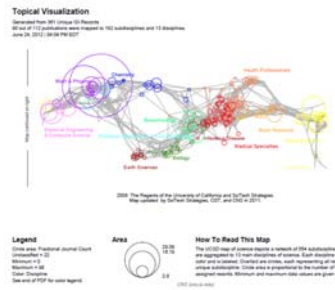
- ❖ Network Analysis using the Network Workbench (NWB) and the Science of Science Tool (Sci2)
- ❖ Network Visualization using Gephi
- ❖ Temporal Data Analysis: Burst detection and Evolving Networks using Sci2
- ❖ Topical Analysis and Visualization of (Network) Data using Sci2
- ❖ Advanced Network Analysis and Visualization: Hierarchical Networks using Sci2 and OSLOM

Please register at <http://www.surveymonkey.com/s/PGLL7VL> if you plan to attend.

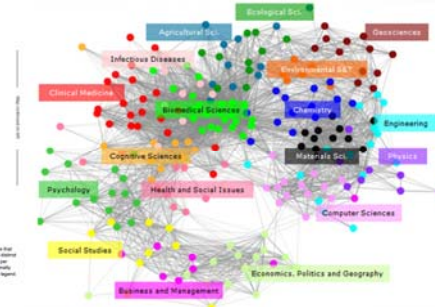
**Projection:
Planned R&D for the (UCSD) map of science.**



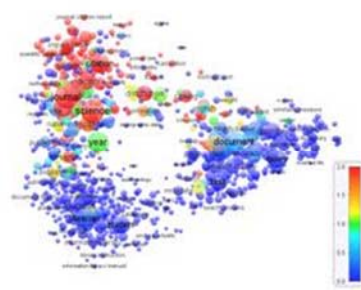
Currently Used Science Basemaps



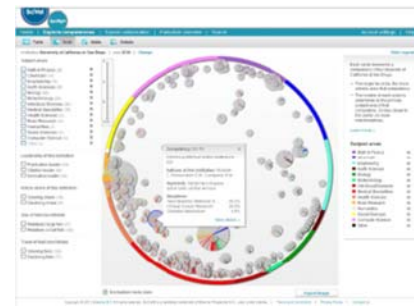
UCSD Map



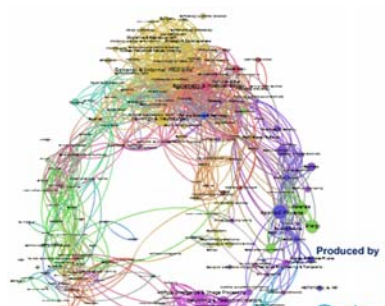
Loet et al science maps ISI categories



<http://vosviewer.com>



Elsevier's SciVal Map



Science-Metrix.com



NIH Map

<https://app.nihmaps.org>

51



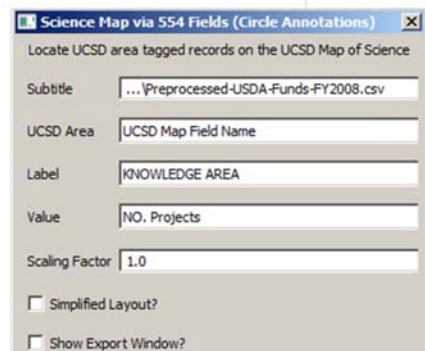
Align existing classifications/taxonomies/hierarchies to generate science map overlays

In addition to using [journal names](#) to

- Map career trajectories
- Identify evolving expertise areas
- Compare expertise profiles

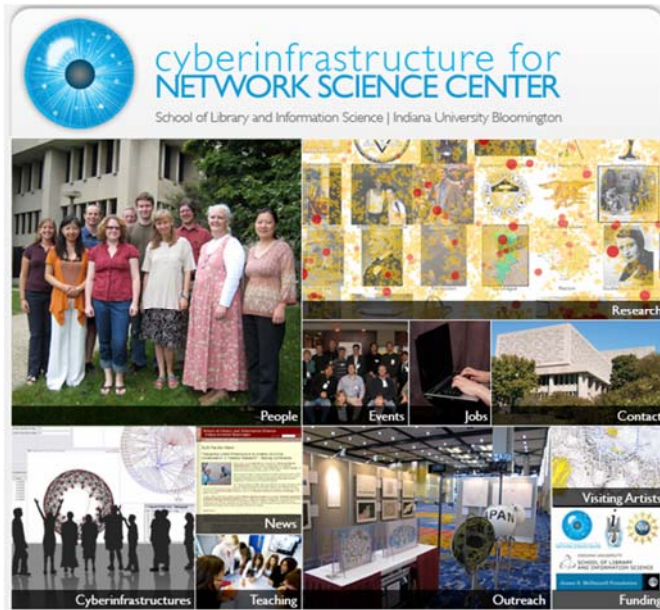
[Existing classifications](#) can be aligned and used to generate science map overlays.

B	C	D	E	F	G
KNOWLEDGE AREA	NO. Projects	USDA Staff Years	STATE APPR	TOTAL FUNDS	UCSD Map Field Name
101 Appraisal of Soil Resources					315
102 Soil, Plant, Water, Nutrient Relationships					227
103 Management of Saline and Sodic Soils and Salinity					158
104 Protect Soil from Harmful Effects of Natural Elements					120
111 Conservation and Efficient Use of Water					245
112 Watershed Protection and Management					245
121 Management of Range Resources					520
122 Management and Control of Forest and Range Fires					520
123 Management and Sustainability of Forest Resources					231
124 Urban Forestry					231
125 Agroforestry					231



Run *Visualization > Topical > Science Map via 554 Fields* using parameters given to the right. Postscript file will appear in *Data Manager*. Save and open with a Postscript Viewer.

52



All papers, maps, tools, talks, press are linked from <http://cns.iu.edu>

CNS Facebook: <http://www.facebook.com/cnscenter>

Mapping Science Exhibit Facebook: <http://www.facebook.com/mappingscience>