

## Envisioning Science and Technology: Maps and Tools

**Katy Börner**

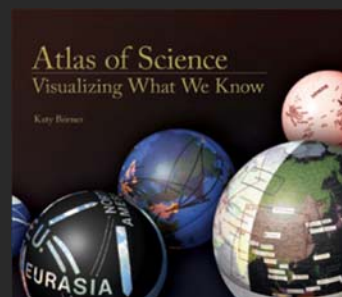
Cyberinfrastructure for Network Science Center, Director  
Information Visualization Laboratory, Director  
School of Library and Information Science  
Indiana University, Bloomington, IN, USA  
[katy@indiana.edu](mailto:katy@indiana.edu)



With special thanks to the members at the Cyberinfrastructure for Network Science Center; the Sci2 and NWB teams; and the VIVO Collaboration

*Keynote talk at NACIS Conference  
Portland, Oregon*

*October 19, 2012*



## Science Maps

- Compared to Geospatial Maps
- Design and Deployment
- Examples

## Early Maps of the World

VERSUS

## Early Maps of Science

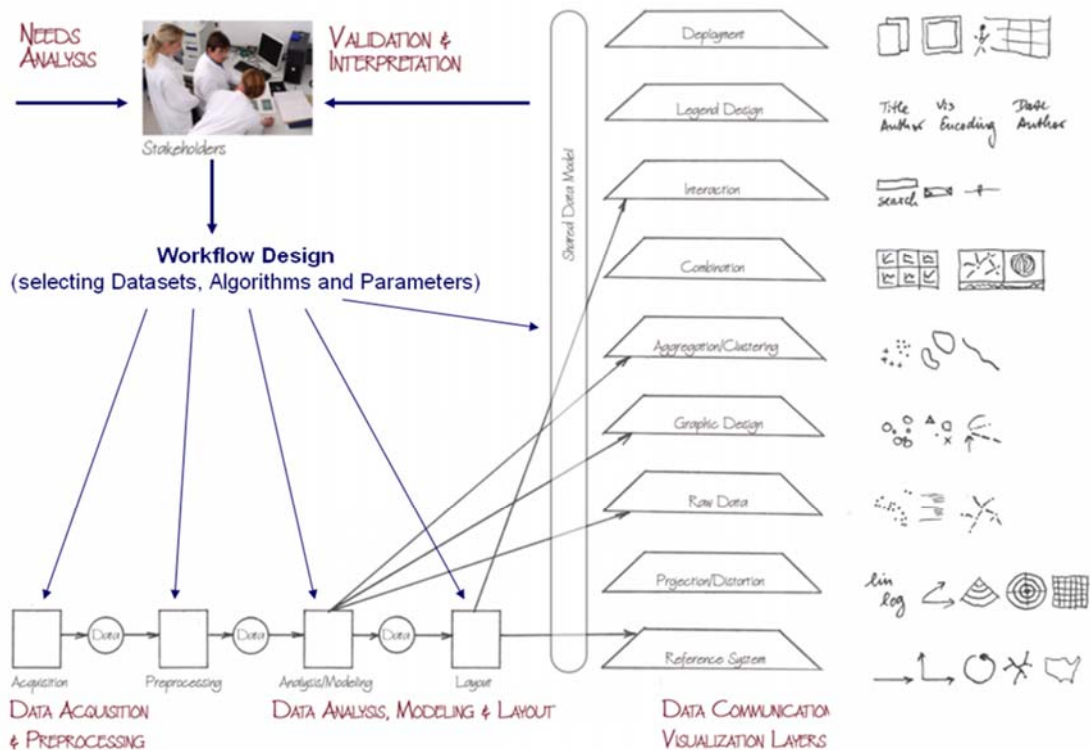


3D  
 Physically-based  
 Accuracy is measurable  
 Trade-offs have more to do with granularity  
 2-D projections are very accurate at local levels  
 Centuries of experience  
**Geo-maps can be a template for other data**

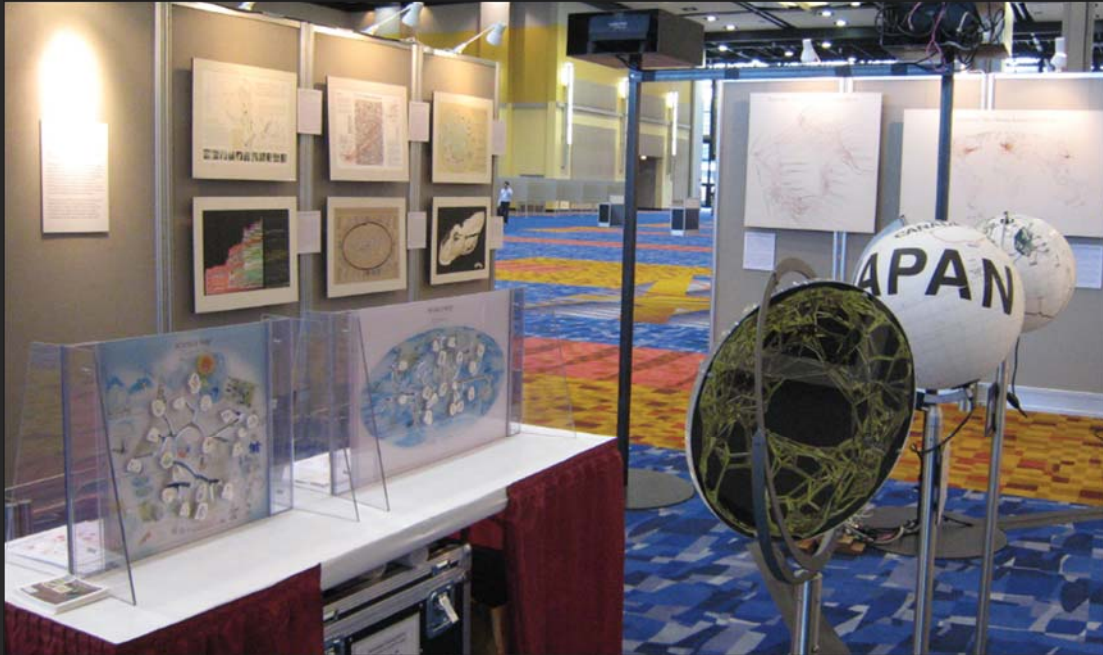
n-D  
 Abstract space  
 Accuracy is difficult  
 Trade-offs indirectly affect accuracy  
 2-D projections neglect a great deal of data  
 Decades of experience  
**Science maps can be a template for other data**

*Kevin W. Boyack, UCGIS Summer Meeting, June, 2009*

**Needs-Driven Workflow Design** using a modular data acquisition/analysis/ modeling/ visualization pipeline as well as modular visualization layers.



Places & Spaces: Mapping Science Exhibit (<http://scimaps.org>)



*After eight years, there now exist 80 out of 100 maps.*



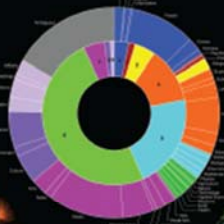
Mapping Science Exhibit at MEDIA X, Wallenberg Hall, Stanford University, 2009  
<http://mediax.stanford.edu>, <http://scaleindependentibought.typepad.com/photos/scimaps>



# DESIGN VS. EMERGENCE: VISUALIZATION OF KNOWLEDGE ORDERS

## WIKIPEDIA'S CATEGORY STRUCTURE

The Wikipedia category structure is a complex, hierarchical network of categories. It is a tree structure where each node represents a category and the edges represent the relationships between them. The structure is highly interconnected, with many categories having multiple sub-categories and being part of multiple parent categories.

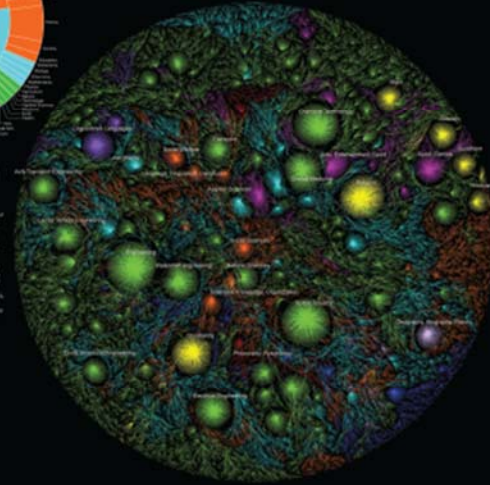


## CATEGORY DISTRIBUTION OF WIKIPEDIA & UDC

This figure shows the distribution of Wikipedia's top categories across the UDC classes. The length of each bar represents the number of Wikipedia categories that fall into that UDC class. The bars are color-coded to match the Wikipedia categories. The chart shows that Wikipedia categories are distributed across all UDC classes, but are most concentrated in the 'Arts and Humanities' and 'Science' classes.

## UNIVERSAL DECIMAL CLASSIFICATION

The UDC is a hierarchical classification system for knowledge. It is a tree structure where each node represents a class and the edges represent the relationships between them. The structure is highly interconnected, with many classes having multiple sub-classes and being part of multiple parent classes.



## WIKIPEDIA TO UDC: BAR CHART

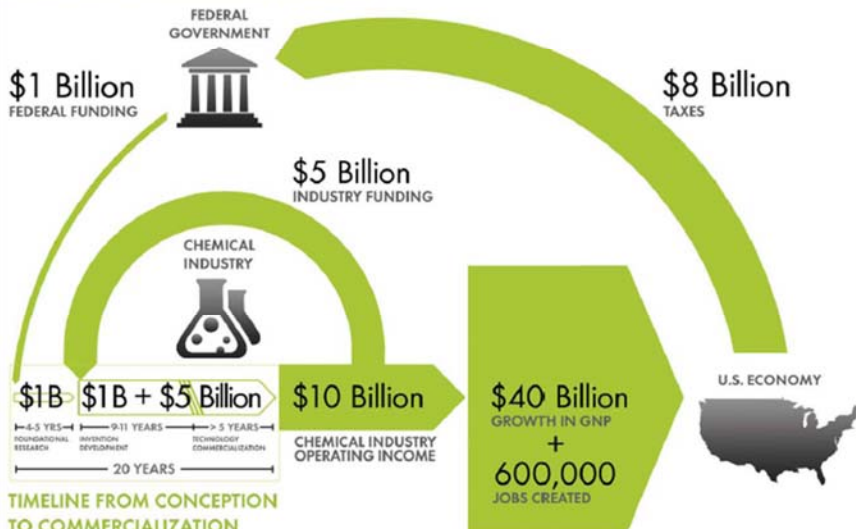
This bar chart shows the distribution of Wikipedia's top categories across the UDC classes. The length of each bar represents the number of Wikipedia categories that fall into that UDC class. The bars are color-coded to match the Wikipedia categories. The chart shows that Wikipedia categories are distributed across all UDC classes, but are most concentrated in the 'Arts and Humanities' and 'Science' classes.

Almila Akdag Salah, Cheng Gao, Krzysztof Suchacki, and Andrea Schärnhorst (2011) Design vs. Emergence: Visualization of Knowledge Orders.

# Chemical Research & Development Powers the U.S. Innovation Engine

Macroeconomic Implications of Public and Private R&D Investments in Chemical Sciences

## INVESTMENT IN CHEMICAL SCIENCE R&D



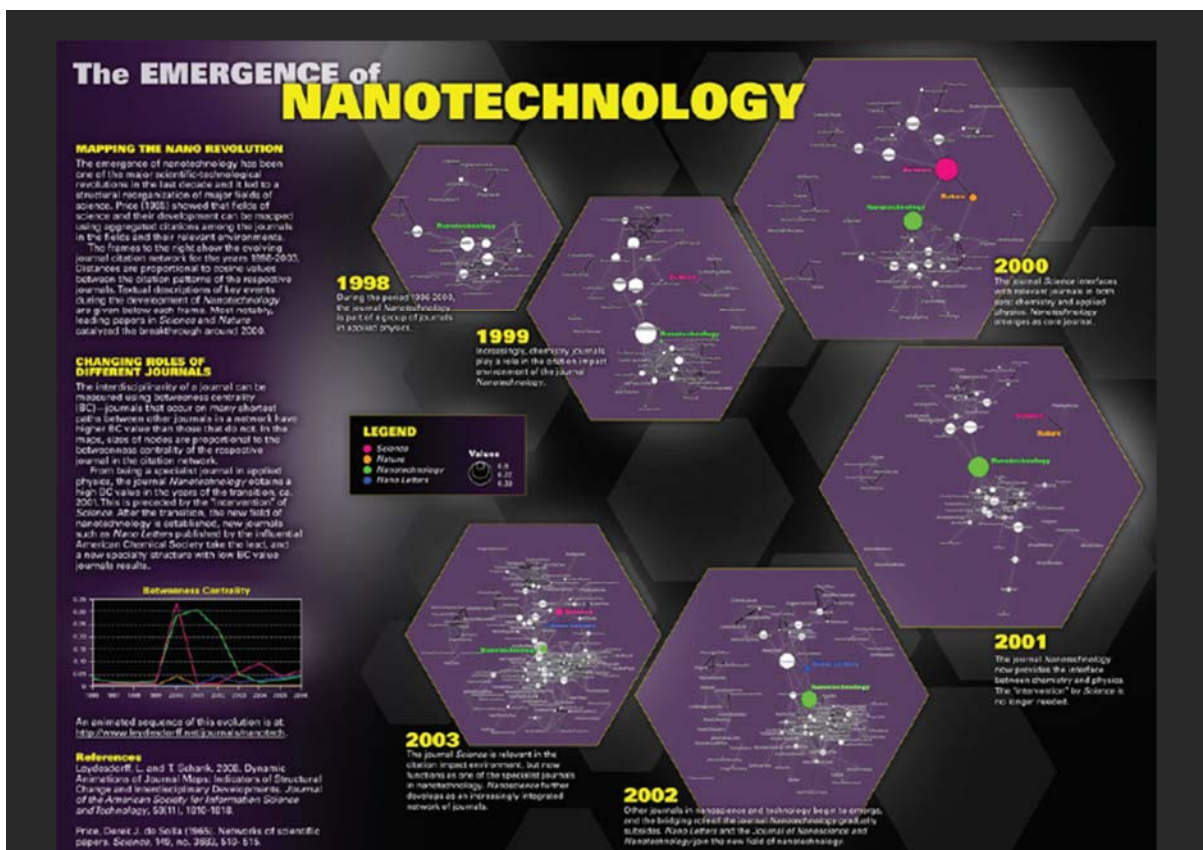
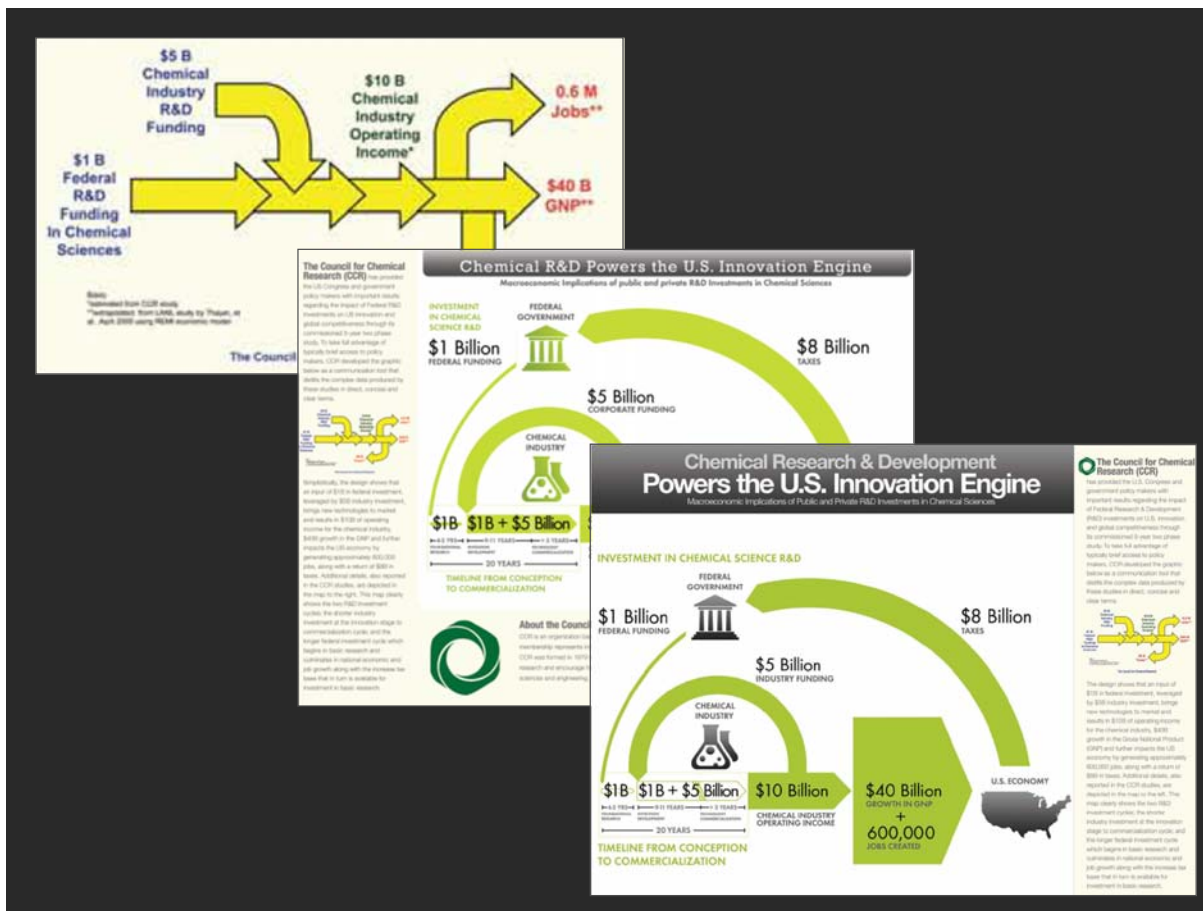
## The Council for Chemical Research (CCR)

has provided the U.S. Congress and government policy makers with important results regarding the impact of Federal Research & Development (R&D) investments on U.S. innovation and global competitiveness through its commissioned 5-year two phase study. To take full advantage of typically brief access to policy makers, CCR developed the graphic below as a communication tool that details the complex data produced by these studies in direct, concise and clear terms.



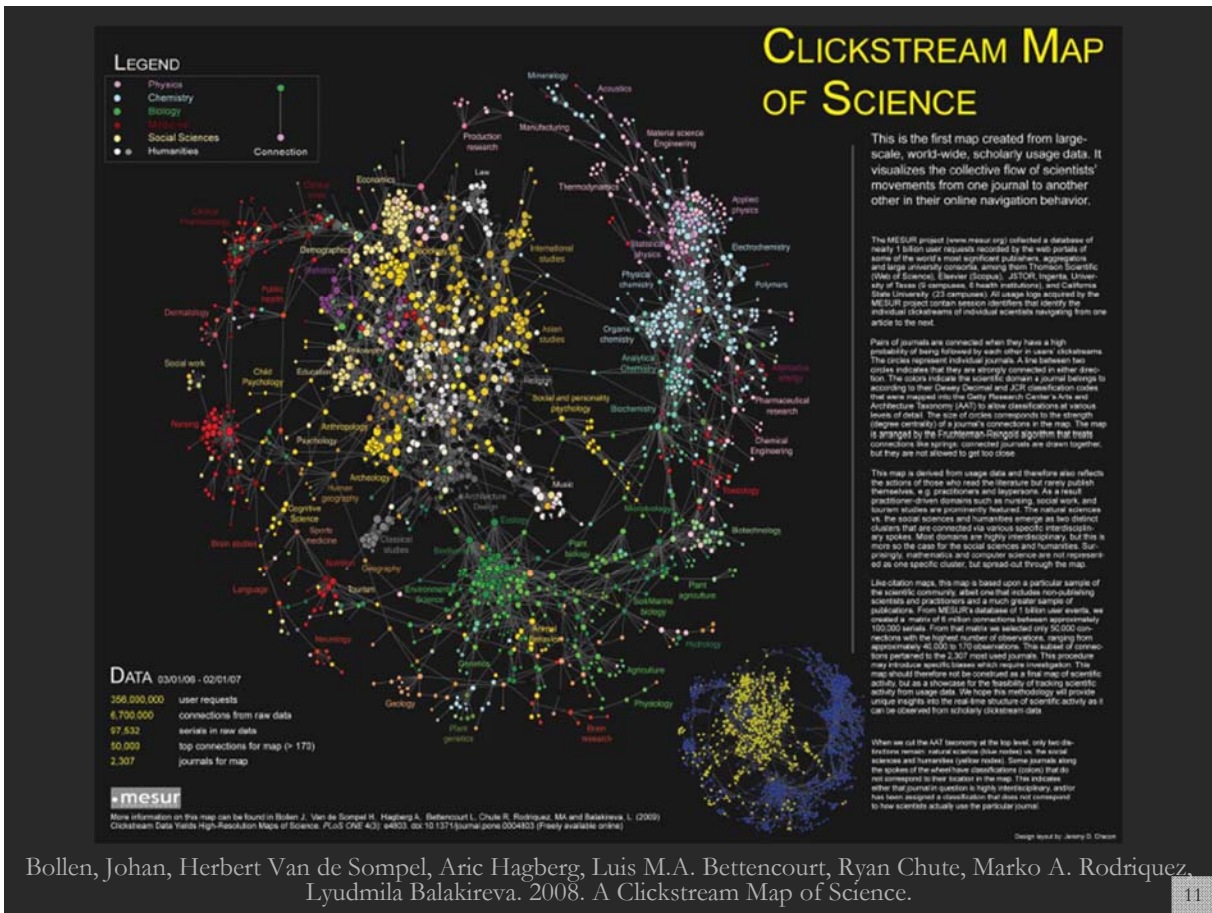
The design shows that an input of \$1B in federal investment, leveraged by \$5B industry investment, brings new technologies to market and results in \$10B of operating income for the chemical industry, \$40B growth in the Gross National Product (GNP) and further impacts the US economy by generating approximately 600,000 jobs, along with a return of \$8B in taxes. Additional details, also reported in the CCR studies, are depicted in the map to the left. This map clearly shows the two R&D investment cycles: the shorter industry investment at the innovation stage to commercialization cycle; and the longer federal investment cycle which begins in basic research and culminates in national economic and job growth along with the increase tax base that in turn is available for investment in basic research.

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

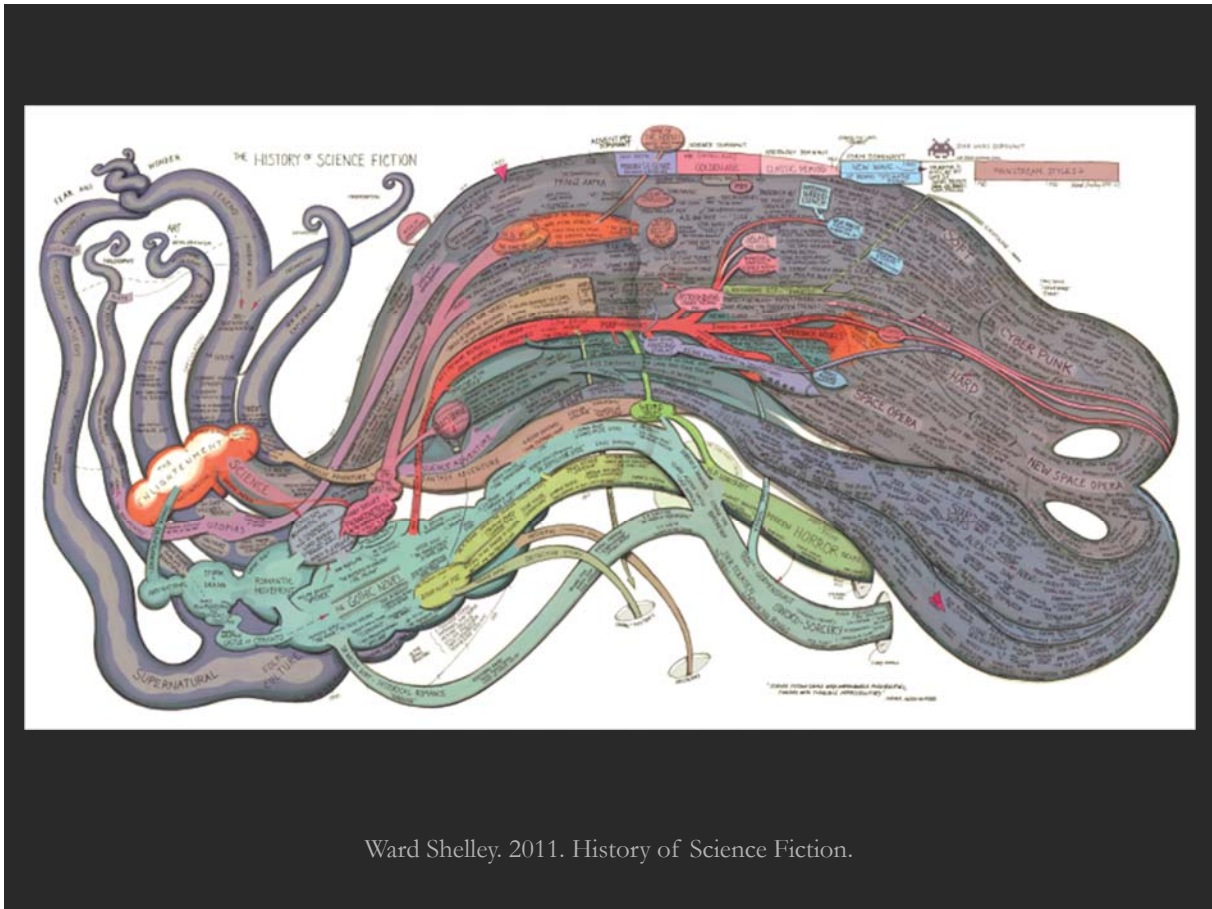


Loyt Leydesdorff, Thomas Schank and the Journal of the American Society for Information Science and Technology. 2010. The Emergence of Nanoscience & Technology.





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. 11



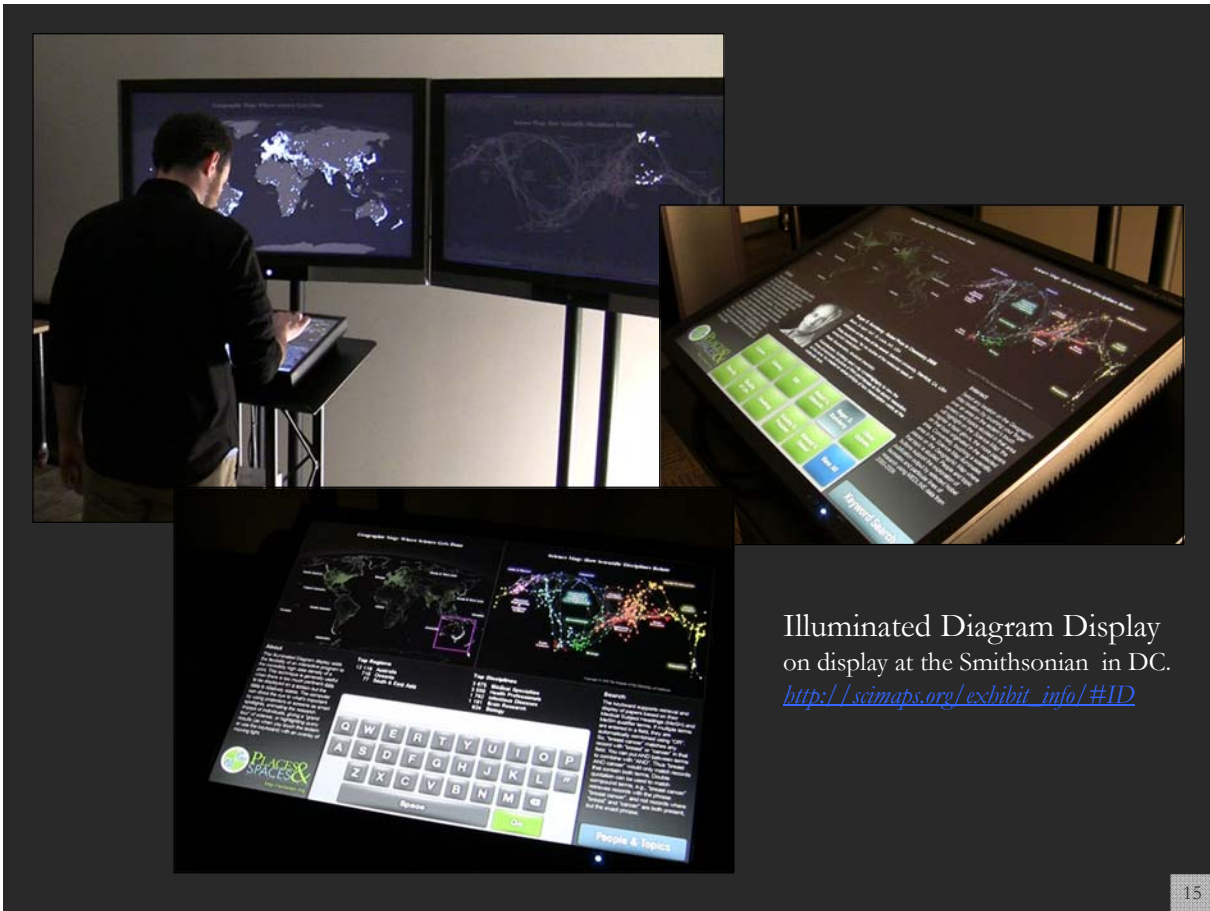
Ward Shelley. 2011. History of Science Fiction.



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







Illuminated Diagram Display on display at the Smithsonian in DC. [http://scimaps.org/exhibit\\_info/#ID](http://scimaps.org/exhibit_info/#ID)

### Geographic Map: Where Science Gets Done

### Science Map: How Scientific Disciplines Relate

#### 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

<http://scimaps.org>

People & Topics



### Geographic Map: Where Science Gets Done

### Science Map: How Scientific Disciplines Relate

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#### 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.

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

#### Keyword Search

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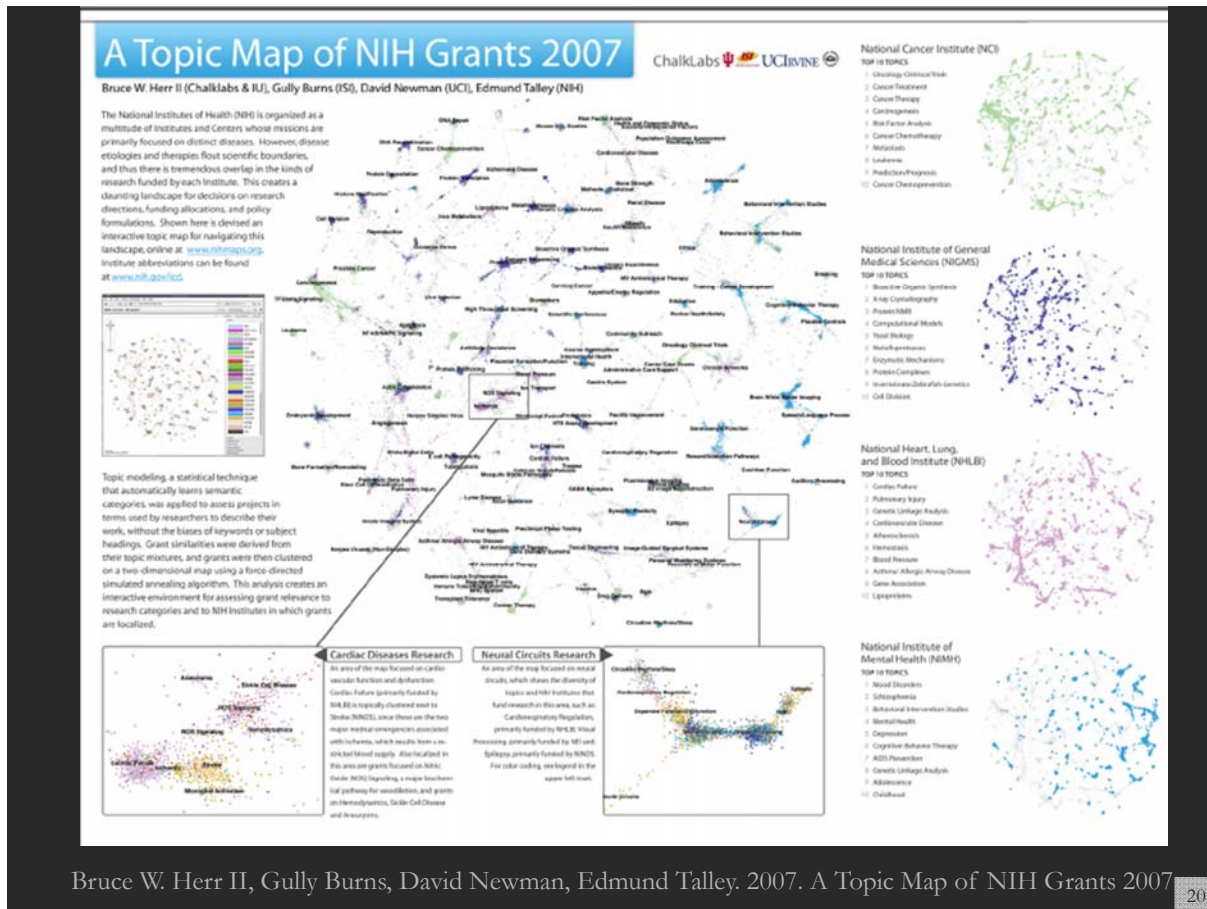
12-Tokyo-Worldprocessor

Ingo Gunther's Worldprocessor globe design now on display at the Giant Geo Cosmos OLED Display at the Museum of Emerging Science and Innovation in Tokyo, Japan

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# Online Interactive Maps

- NIH Topic Map
- VIVO International Researcher Network
- Sustainability Research Map
- Gene Therapy Research Map



Bruce W. Herr II, Gully Burns, David Newman, Edmund Talley. 2007. A Topic Map of NIH Grants 2007



# NIH TOPIC MAPS

## A Topic Database of NIH-Funded Grants

NIH Map Viewer Show Topic Browser ? Export Data Methods Feedback

2009 add delete AND Topic Words cancer breast cancers cancer\_risk cancer\_p 20 0/0 Search Clear Search

Pointer Select  
Markers On  
Labels IRG

Settings

**Institutes (9)**  

NIH Inst	# Grants	Count	+
NCI	116		
NCRR	10		
NIHES	5		
NCMHD	1		
NIA	-		

**Topics**  

%	Title Words	+
25.9	breast, cancer, cancer_risk, women, cancer_sui	
3.86	risk, risk_factors, cancer, prospective, women,	
3.76	genome_wide_association, loci, genome_wide,	
3.70	genetic, genetics, genes, gene_environment, i	

**Grants (137)**  

C NIH Inst	Grant	+
NCRR	3P20RR011792-10S2 6914 OBESITY, INSULIN RESISTANCE, IGF'S, AND BREAST CANCER RISK IN AFRICAN AMERICANS PI: CUI, YONG	
NCI	3R01CA120562-03S1 Commonly Used Medications and Breast Cancer Recurrence PI: BOUDREAU, DENISE M	
NCI	5R01CA120562-03 Commonly Used Medications and Breast Cancer Recurrence PI: BOUDREAU, DENISE M	
NCI	5R01CA093772-06 Long-term Survivorship in Older Women with Early Stage Breast	

Powered by ChalkLabs

<https://app.nihmaps.org>

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# NIH TOPIC MAPS

## A Topic Database of NIH-Funded Grants

NIH Topic Browser Show Map Viewer ? Export Data Methods Feedback

Topics by NIH Institute Topics by Category  
 2009 add delete AND Exact Text cancer Search Clear Search

**2009 Grants (137)**

Col	NIH Inst	Project/Subproj	Title	Investigator(s)	# 1 Topic	# 1 Topic Word	+
	NCRR	3P20RR011792-10S2 6914	OBESITY, INSULIN RESISTANCE, IGF'S, AND BREAST CANCER RISK IN AFRICAN AMERICANS	CUI, YONG	686 (50%)	cancer brea...	
	NCI	3R01CA120562-03S1	Commonly Used Medications and Breast Cancer Recurrence	BOUDREAU, DENISE M	686 (42%)	cancer brea...	
	NCI	5R01CA120562-03	Commonly Used Medications and Breast Cancer Recurrence	BOUDREAU, DENISE M	686 (42%)	cancer brea...	
	NCI	5R01CA093772-06	Long-term Survivorship in Older Women with Early Stage Breast Cancer	SILLIMAN, REBECCA A	686 (42%)	cancer brea...	
	NCI	5R01CA064277-11	Shanghai Breast Cancer Study	ZHENG, WEI	686 (41%)	cancer brea...	

**Institutes (9)**  

NIH Inst	# Grants	Count	+
NCI	116		
NCRR	10		
NIHES	5		
NCMHD	1		
NIA	1		
NCCAM	1		
NICHHD	1		
NINR	1		
NHGRI	1		

**Topics**  

%	Topic	Topic Words	Title Words	+
25.91	686	cancer breast cancers cancer_risk cancer_patients	breast, cancer, car	
3.86	437	risk risk_factors cases cohort prospective high_ris	risk, risk_factors,	
3.76	544	snps snp genome_wide_association cases genes	genome_wide_ass	
3.70	173	genetic genes risk susceptibility polymorphisms	genetic, genetics,	
2.62	252	treatment patients management patient outcom	management, tre	
1.64	235	conference meeting workshop symposium scienti	th, conference, sy	
1.63	351	community implementation community_based he	community, preve	
1.54	325	million disease treatment united_states public_h	disease, treatmen	
1.51	580	training candidate career skills applicant program	treatment, depres	

**Similar Grants** Show Top 100 on Map  

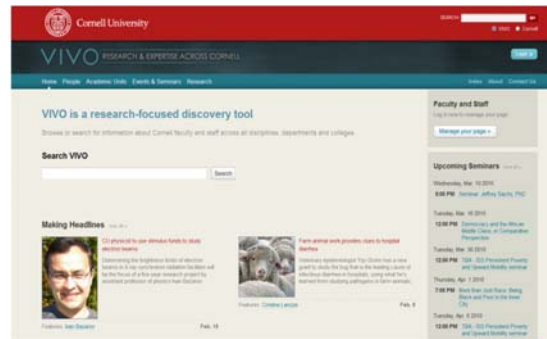
Similar	C NIH Inst	Grant	+
6.51	NCI	1R01CA129639-01A2 Genome-Wide Association Study of Radiation Exposure and Bilateral Breast Cancer PI: BERNSTEIN, JONINE LISA	
6.46	NCI	1K07CA136758-01A1 Genetic variants in the PI3K pathway in mammographic density and breast cancer PI: THOMPSON, CHERYL L.	
6.31	NCI	5P50CA116199-05 UTMADACC SPORE in Breast Cancer PI: HORTOBAGYI, GABRIEL N	
6.02	NCI	2R01CA050385-21A1 Risk Factors for Breast Cancer in Younger Nurses PI: WILLETT, WALTER C.	
4.6	NCI	5R01CA127617-02 Who Cares For Older Breast Cancer Survivors And How Does It Affect Quality? PI: MANDELBLATT, JEANNE	

<https://app.nihmaps.org>

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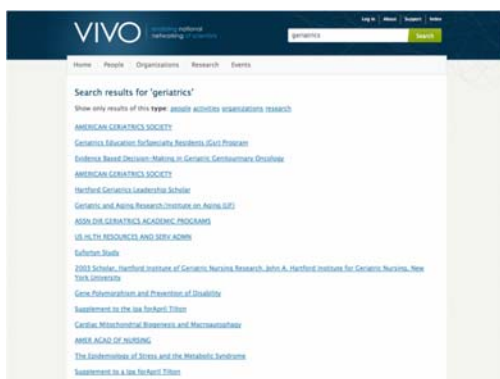
## VIVO: A Semantic Approach to Creating a National Network of Researchers (<http://vivoweb.org>)

- 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

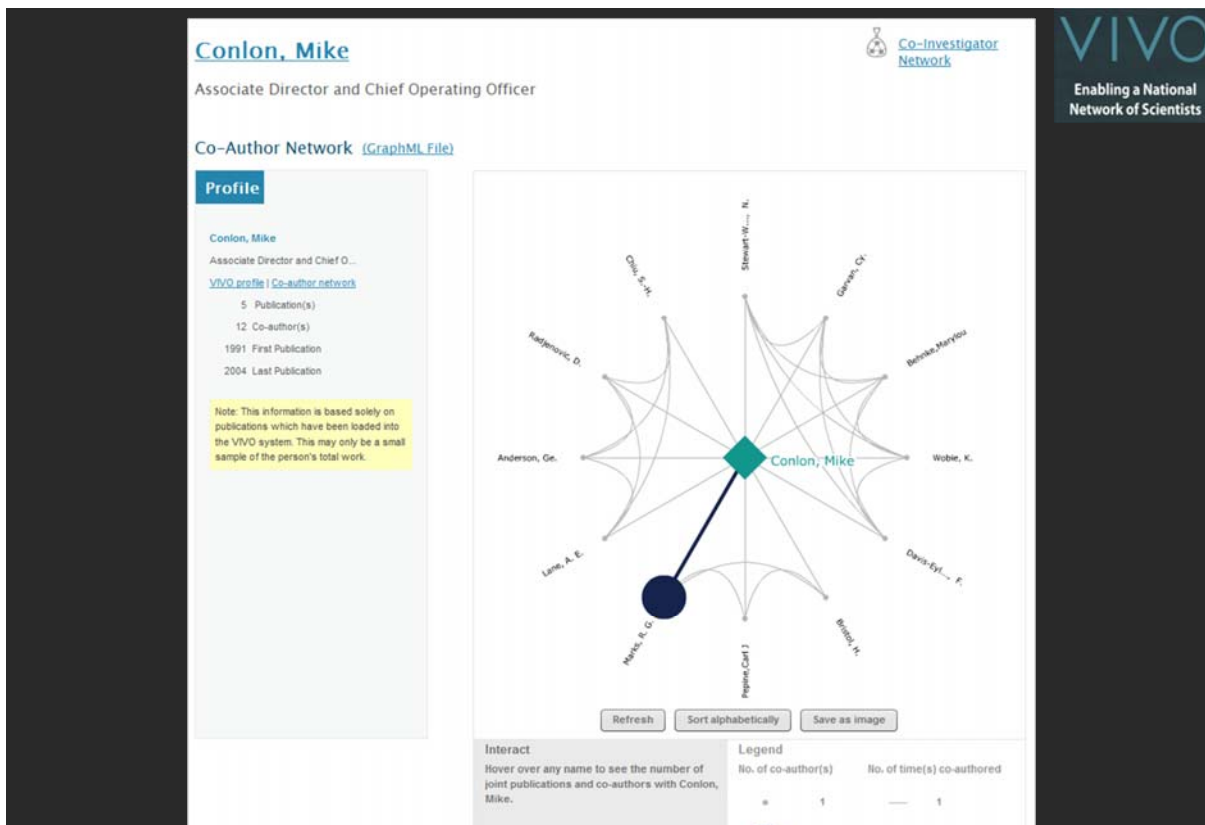
1 - 13 of 554

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? 27



**Geospatial Analysis (Where)** A geospatial map of the US is used to show where what science is performed by whom. 28



VIVO On-The-Go

Overview, Interactivity,  
Details on Demand

come to  
commonly  
used devices  
and environments



MAPSustain  
Mapping Sustainability Research



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>

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.

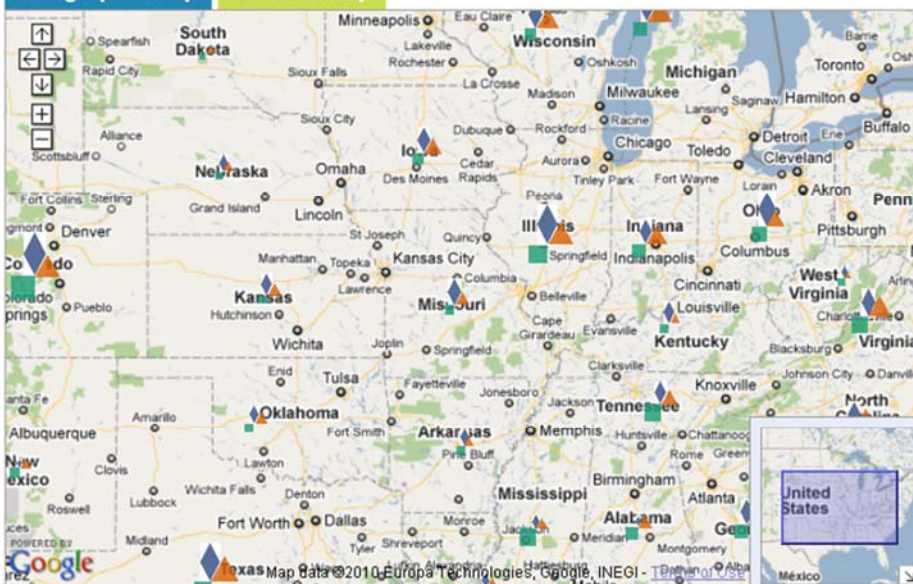
US Department of Agriculture (USDA) awards made available by a staff member of the Office of Scientific and Technical Information from the US Department of Energy (DOE).

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.

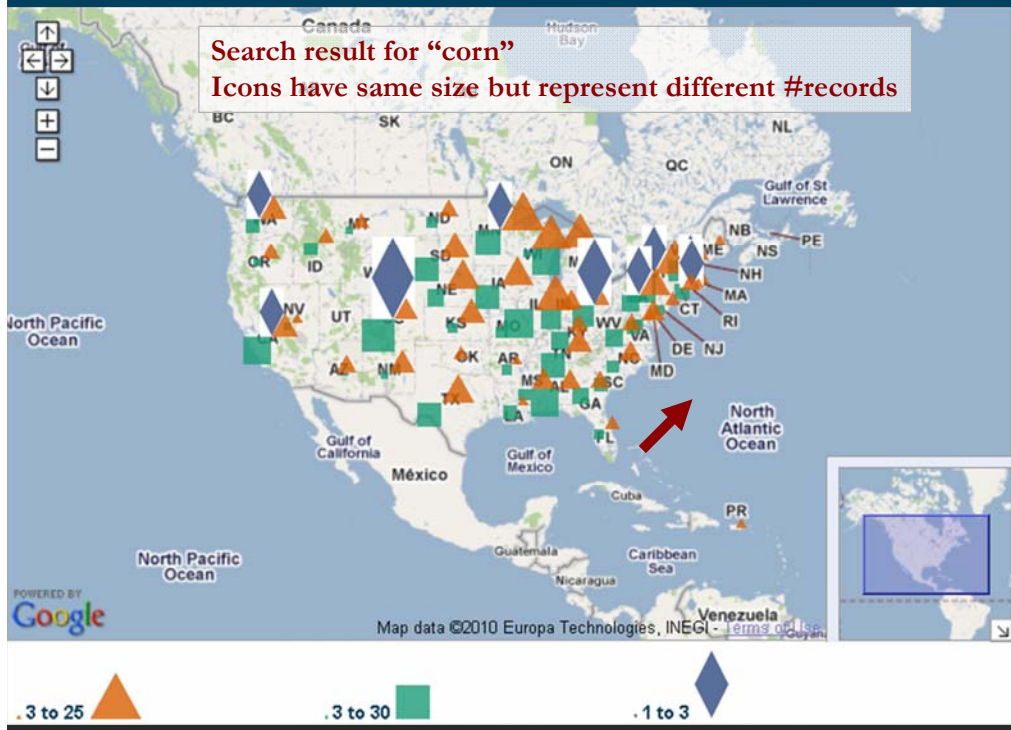
The geographic map at state level.

Geographic Map Science Map



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](#)

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

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

DOE Scientific and Technical Information

DOE • OSTI

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

Done

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

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**MAPSustain**  
Mapping Sustainability Research

Geographic Map Science Map

Color B & W

Engineering and Computer Science

Chemical, Mechanical, and Nuclear Engineering

Math and Physics

Chemistry

Health Professionals

Medical Specialties

Brain Research

Social Sciences

Biology

Earth Sciences

Humanities

Biotechnology

Infectious Diseases

Other Engineering

Biotechnology

Earth Sciences

Biology

Medical Specialties

Brain Research

Health Professionals

Social Sciences

Humanities

Biotechnology

Earth Sciences

Biology

Medical Specialties

Brain Research

Health Professionals

Social Sciences

Humanities

Math & Physics

Chemistry

Computer Science & EE

Other Engineering

Biotechnology

Earth Sciences

Biology

Medical Specialties

Brain Research

Health Professionals

Social Sciences

Humanities

Biography funding: 2112 records  
 NSF: 1617  
 NIH: 114  
 USDA: 381

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Maps Detail Data Ab

> Biology

NIH  
2009

- Label-Free And Simultaneous Detection Of Multiple Bacterial Pathogens And Virulen
- Mechanism Of Psp Mediated Adhesion
- Label-Free And Simultaneous Detection Of Multiple Bacterial Pathogens And Virulen
- Novel Mechanism Of Uranium Reduction Via Microbial Nanowires
- Nano-Scale Mechanisms Of Metal(Loid) Rhizostabilization In Desert Mine Tailings
- Label-Free And Simultaneous Detection Of Multiple Bacterial Pathogens And Virulen
- Mechanism Of Psp Mediated Adhesion

2008

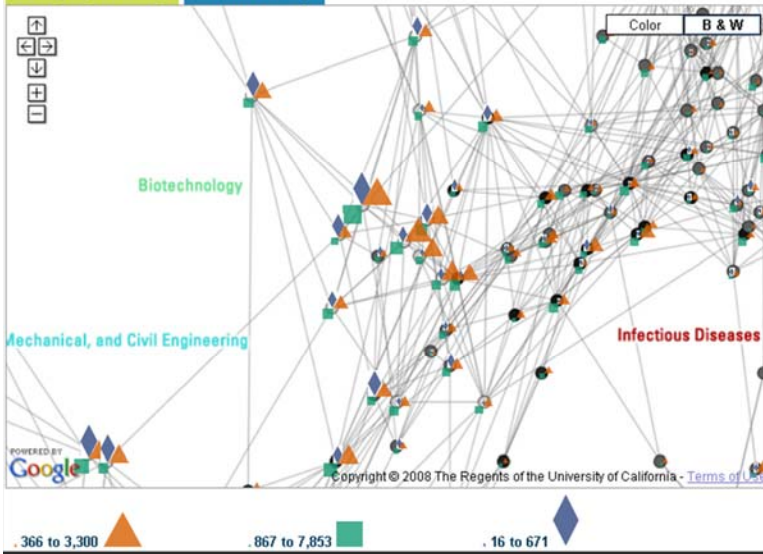
- The Effect Of Inter-Species Interactions On The Virulence Of Streptococcus Mutans
- Cookstove Replacement For Prevention Of Ari And Low Birthweight In Nepal
- Diverse Drug Lead Compounds From Bacterial Symbionts In Tropical Marine Mollusks
- Remote Sensing Of Wildfire Smoke Exposures To Assess Health Effects
- Cookstove Replacement For Prevention Of Ari And Low Birthweight In Nepal

366 to 3,300 .867 to 7,853 .16 to 671

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

36





> Chemistry

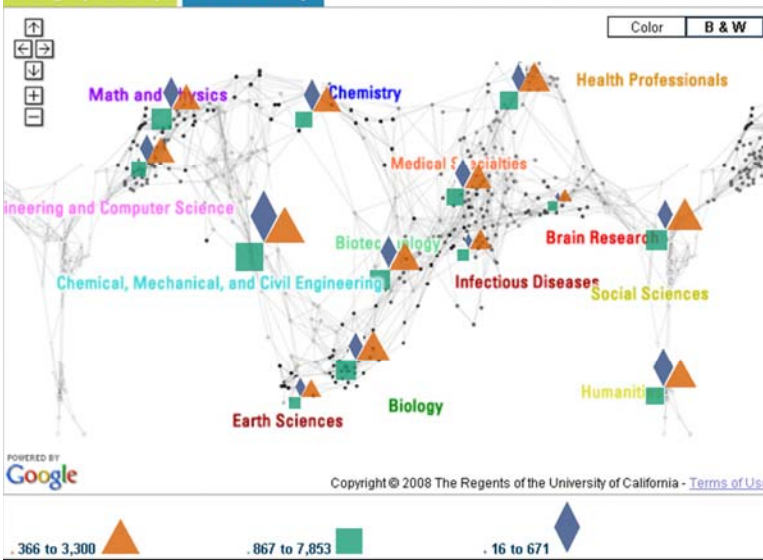
USPTO  
2009

- [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](#)

The science map at 554 sub-disciplines level.



> 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](#)
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- [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](#)

Math & Physics	Biotechnology	Medical Specialties
Chemistry	Earth Sciences	Brain Research
Computer Science & EE	Biology	Health Professionals
Other Engineering	Infectious Diseases	Social Sciences
		Humanities






About/Contact/Search

- ▶ Information
- ▶ Gene Therapy Data Maps
- ▶ Archiving Services
- ▶ Insertion Site Analysis
- ▶ Pharm/Tox Resources
- ▶ Clinical Trial Testing
- ▶ Reagent Repository
- ▶ Educational Resources
- ▶ My NGVB


**LOG IN**

user name:

password:

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[Can't remember your password?](#)

## Gene Therapy Geographic Data Map



Funding     Publications     Patents     Clinical Trials  
 NIH             Medicine             USPTO  
 NSF

From year 1972 to year 2011

Search by:

**Maryland**

TRIALS 2011

- [Phase III Study Of Metastatic Cancer That Expresses Mage-A3/12 Using Lymphodepleting Conditioning Followed By Infusion Of Anti-Mage-A3/12 Tcr-Gene Engineered Lymphocytes](#)
- [Phase III Study Of Metastatic Cancer That Expresses Nv-Eso-1 Using Lymphodepleting Conditioning Followed By Infusion Of Gene Engineered Lymphocytes Cotransduced With Genes Encoding Il-12 And Anti-Nv Eso-1 Tcr](#)
- [A Phase III Study Of The Safety And](#)

ClinicalTrials.gov
A service of the U.S. National Institutes of Health
Home Search Study Topics Glossary

Full Text View
Tabular View
No Study Results Posted
Related Studies

### MAGE-A3/12 Metastatic Cancer Treatment With Anti-MAGE-A3/12 TCR-Gene Engineered Lymphocytes

This study has been suspended.

First Received on January 7, 2011. Last Updated on March 14, 2012 [History of Changes](#)

Sponsor:	<a href="#">National Cancer Institute (NCI)</a>
Information provided by:	National Institutes of Health Clinical Center (CC)
ClinicalTrials.gov Identifier:	NCT01273181

**Purpose**

**Background:**

- MAGE-A3/12 is a type of protein commonly found on certain types of cancer cells, particularly in metastatic cancer. Researchers have developed a process to take lymphocytes (white blood cells) from cancer patients, modify them in the laboratory to target cancer cells that contain MAGE-A3/12, and return them to the patient to help attack and kill the cancer cells. These modified white blood cells are an experimental treatment, but researchers are interested in determining their safety and effectiveness as a possible treatment for cancers that involve MAGE-A3/12.

**Objectives:**

- To evaluate the safety and effectiveness of anti-MAGE-A3/12 lymphocytes as a treatment for metastatic cancers that have not responded to standard treatment.

**Eligibility:**

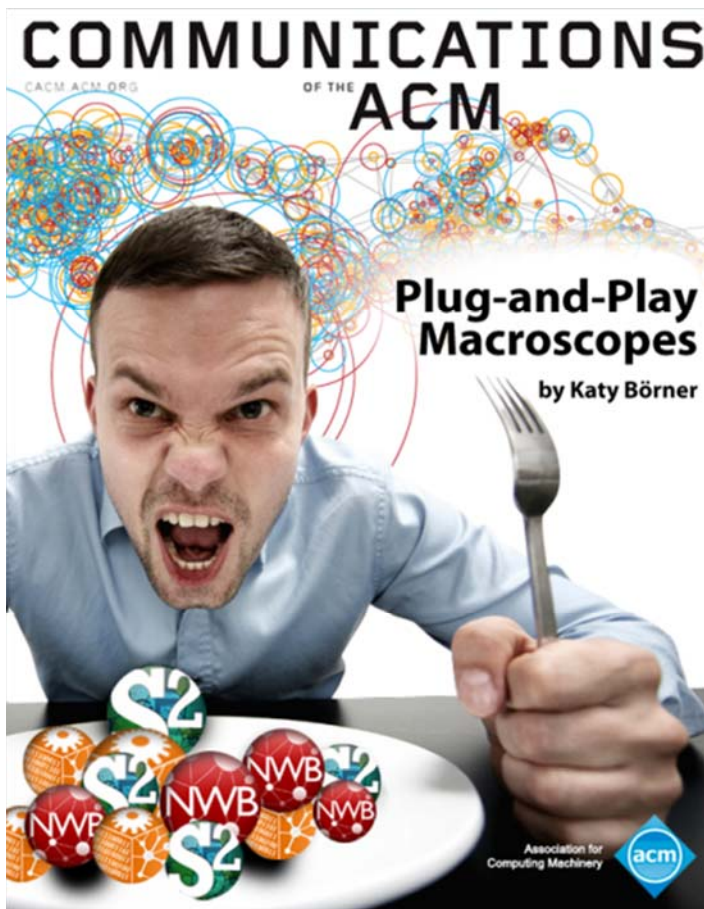
- Individuals at least 18 years of age who have been diagnosed with metastatic melanoma, renal cell cancer, or another type of metastatic cancer that has not responded to standard treatment.

**Design:**

- Participants will be screened with a full medical history and physical examination, as well as blood and urine tests, tumor samples, and imaging studies.
- Participants will have leukapheresis to collect enough white blood cells for modification in the laboratory.
- Seven days before the start of anti-MAGE-A3/12 treatment, participants will have chemotherapy with cyclophosphamide and fludarabine to suppress the immune system in preparation for the treatment.

## Science of Science (Sci2) Tool

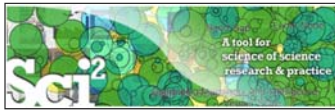
- Use your own data
- Run your own analysis
- Identify overlap, gaps and emerging areas
- Interpret results to improve decision making



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

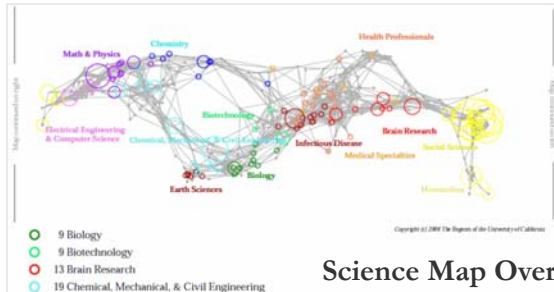
Video and paper are at  
<http://www.scivee.tv/node/27704>



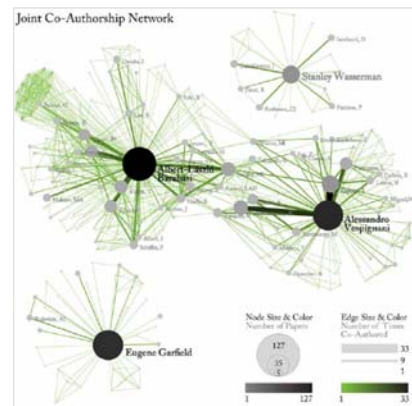


## Science of Science (Sci<sup>2</sup>) Tool – Open Code for S&T Assessment

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



Science Map Overlays



Network Visualizations



Börner, Katy. (2011). *Plug-and-Play Macroscopes*. *Communications of the ACM*, 54(3), 60-69. Video and paper are at <http://www.scivee.tv/node/27704>

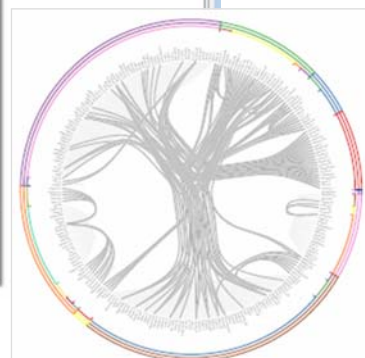
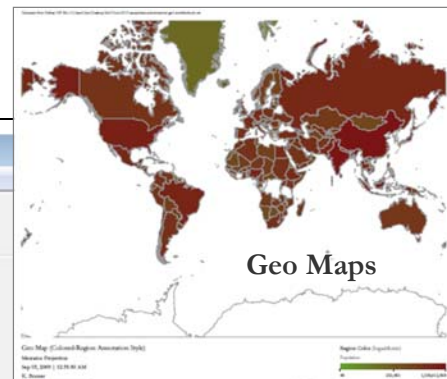


## Sci<sup>2</sup> Tool cont.

Visualization menu options:

- 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

Algorithm Name	Date	Time	% Con
Extract Co-Author Netw...	09/03/2009	00:15:20 AM	100%
Load and Clean ISI File	09/03/2009	00:15:05 AM	100%



Circular Hierarchy

**Sci<sup>2</sup> 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.in.edu>  
<http://sci2.wiki.cns.in.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.



## Science of Science (Sci<sup>2</sup>) Tool – Usage

The Sci<sup>2</sup> Tool is used by the

- National Science Foundation,
- National Institutes of Health,
- US Department of Agriculture, and
- National Oceanic and Atmospheric Administration



Tool registrations come from 73 countries and professions such as



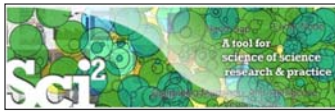




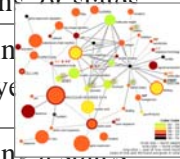
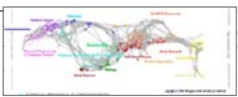
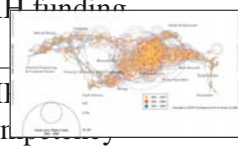

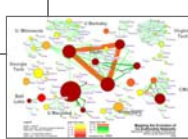
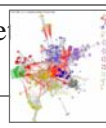
## Sci² Tool – Type of Analysis vs. Level of Analysis

	<i>Micro/Individual (1-100 records)</i>	<i>Meso/Local (101–10,000 records)</i>	<i>Macro/Global (10,000 &lt; records)</i>
<b>Statistical Analysis/Profiling</b>	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
<b>Temporal Analysis (When)</b>	Funding portfolio of one individual	Mapping topic bursts in 20-years of PNAS	113 Years of Physics Research
<b>Geospatial Analysis (Where)</b>	Career trajectory of one individual	Mapping a states intellectual landscape	PNAS publications
<b>Topical Analysis (What)</b>	Base knowledge from which one grant draws.	Knowledge flows in Chemistry research	VxOrd/Topic maps of NIH funding
<b>Network Analysis (With Whom?)</b>	NSF Co-PI network of one individual	Co-author network	NIH's core competency

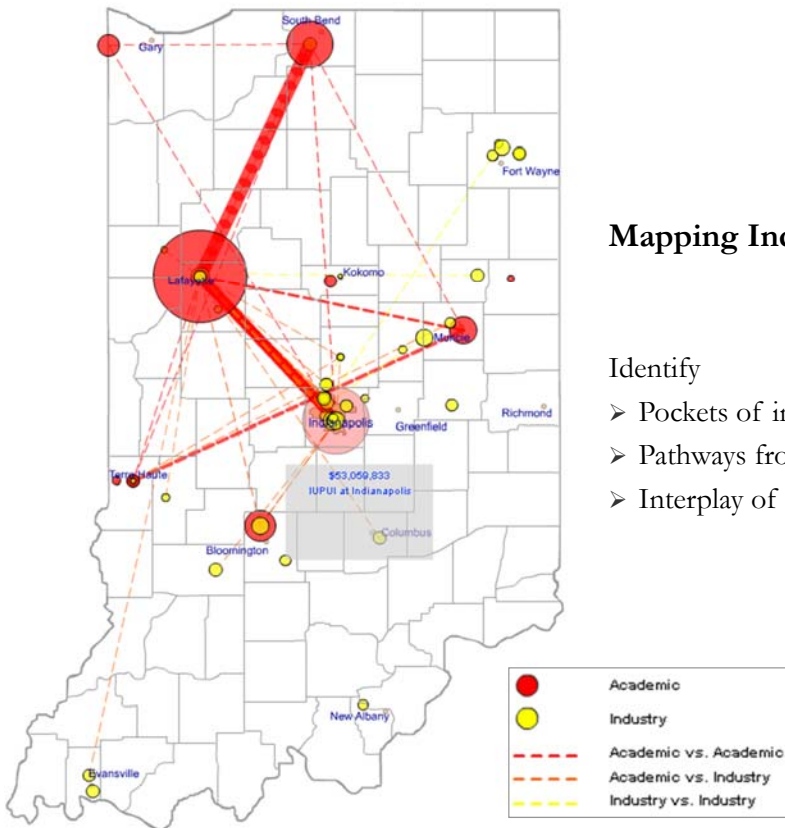
49



## Sci² Tool – Type of Analysis vs. Level of Analysis

	<i>Micro/Individual (1-100 records)</i>	<i>Meso/Local (101–10,000 records)</i>	<i>Macro/Global (10,000 &lt; records)</i>
<b>Statistical Analysis/Profiling</b>	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NSF, all of USA, all of science.
<b>Temporal Analysis (When)</b>	Funding portfolio of one individual	Mapping in 20-ye 	113 Years of Physics Research
<b>Geospatial Analysis (Where)</b>	Career trajectory of one individual	Mapping a states intellectual landscape	PNAS publications
<b>Topical Analysis (What)</b>	 from draws.	Knowledge flows in Chemistry research	VxOrd/Topic maps of NIH funding 
<b>Network Analysis (With Whom?)</b>	NSF Co-PI network of  lual 	Co-author ne 	NIH core competency

50



## Mapping Indiana's Intellectual Space

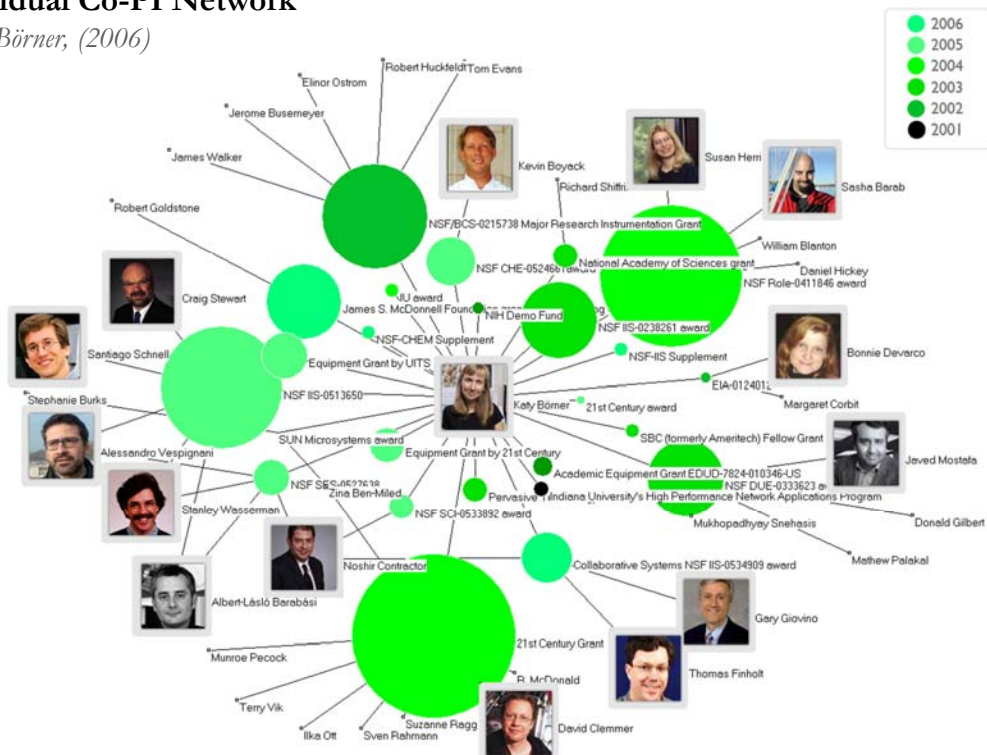
Identify

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

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## Individual Co-PI Network

Ke & Börner, (2006)

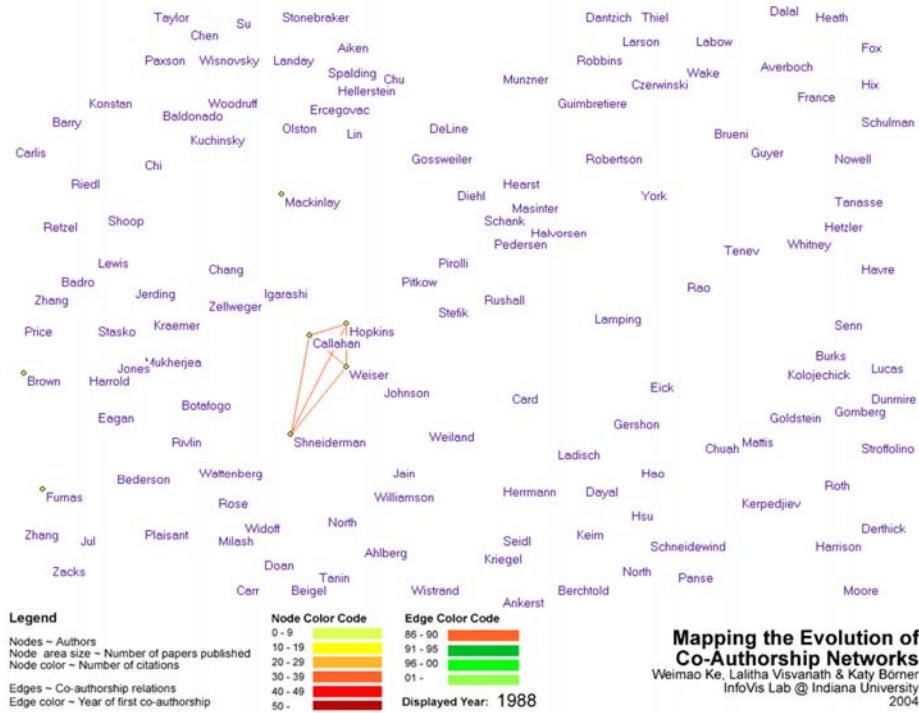


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# Mapping the Evolution of Co-Authorship Networks

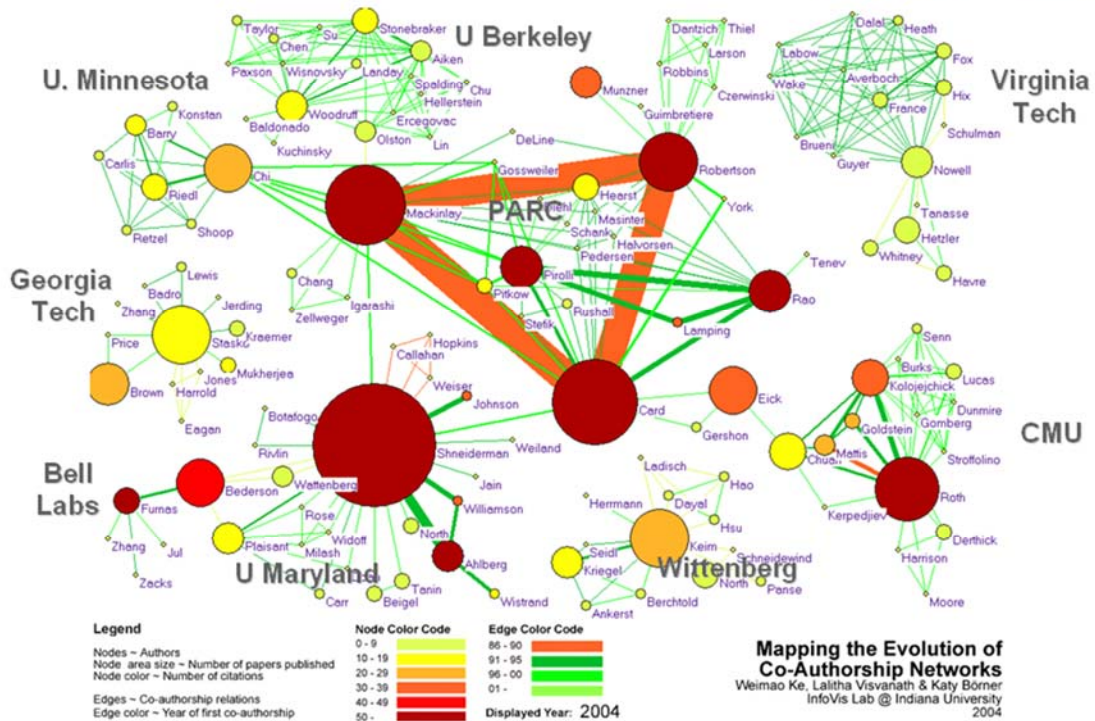
Ke, Visvanath & Börner, (2004) Won 1st price at the IEEE InfoVis Contest.



53

# Mapping the Evolution of Co-Authorship Networks

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



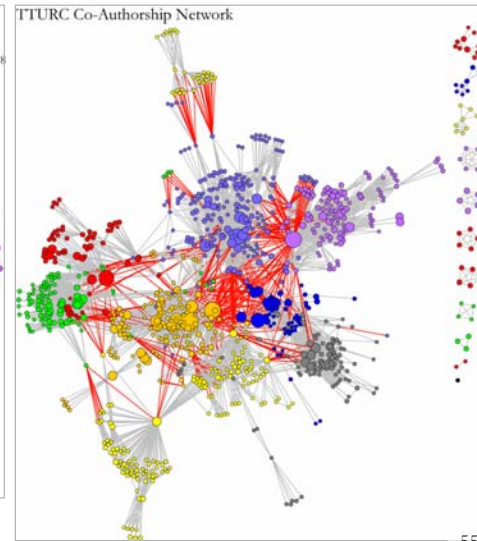
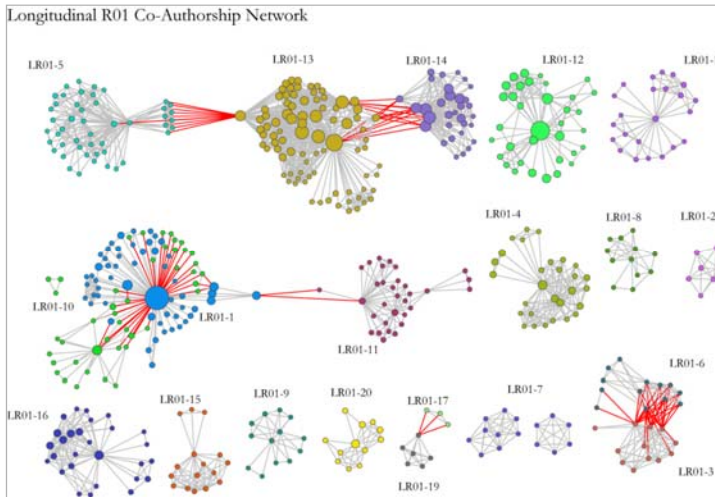
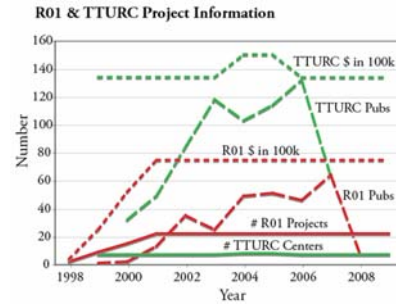
54

## Mapping Transdisciplinary Tobacco Use Research Centers Publications

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

Zoss & Börner, *forthcoming*.

Supported by NIH/NCI Contract HHSN261200800812



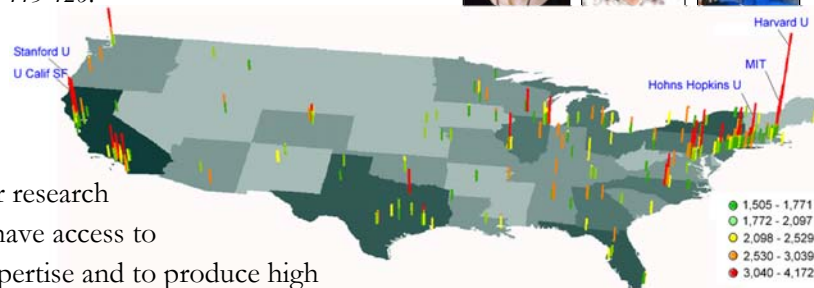
## Spatio-Temporal Information Production and Consumption of Major U.S. Research Institutions

Börner, Katy, Penumarthy, Shashikant, Meiss, Mark and Ke, Weimao. (2006) *Mapping the Diffusion of Scholarly Knowledge Among Major U.S. Research Institutions. Scientometrics. 68(3), pp. 415-426.*



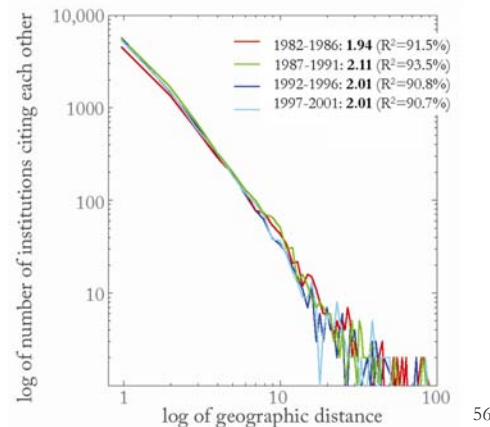
### Research questions:

- Does space still matter in the Internet age?
- Does one still have to study and work at major research institutions in order to have access to high quality data and expertise and to produce high quality research?
- Does the Internet lead to more global citation patterns, i.e., more citation links between papers produced at geographically distant research institutions?



### Contributions:

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

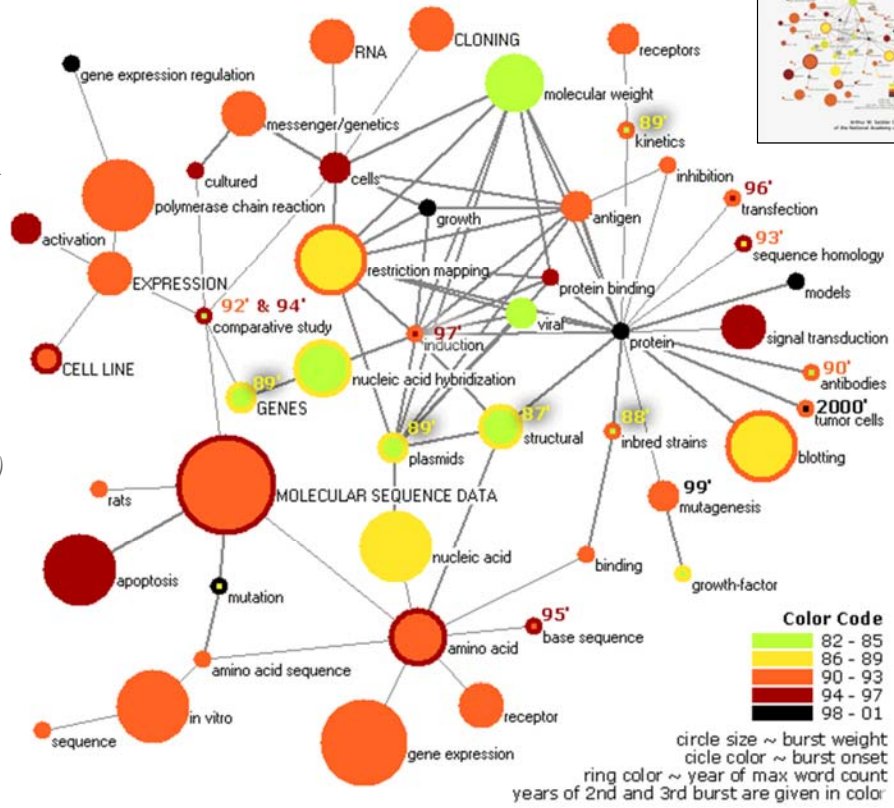




# Mapping Topic Bursts

Co-word space of the top 50 highly frequent and bursty words used in the top 10% most highly cited PNAS publications in 1982-2001.

*Mane & Börner. (2004) PNAS, 101(Suppl. 1): 5287-5290.*



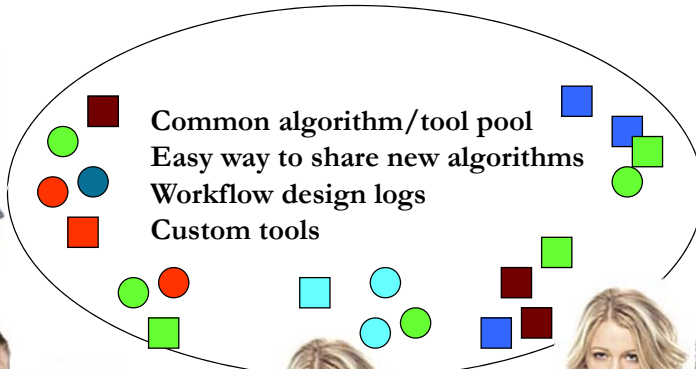
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## OSGi/CIShell-Powered Tools Support Algorithm Sharing



EpiC



TexTrend



Converters



Sci2



NWB

- IS
- CS
- Bio
- SNA
- Phys

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## CIShell – Integrate New Algorithms

### About the Cyberinfrastructure Shell

The Cyberinfrastructure Shell (CIShell) is an open source, community-driven platform for the integration and utilization of datasets, algorithms, tools, and computing resources. Algorithm integration support is built in for Java and most other programming languages. Being Java based, it will run on almost all platforms. The software and specification is released under an Apache 2.0 License.

CIShell is the basis of [Network Workbench](#), [TexTrend](#), [SciF](#) and the upcoming [EpiC](#) tool.

CIShell supports remote execution of algorithms. A standard web service definition is in development that will allow pools of algorithms to transparently be used in a peer-to-peer, client-server, or web front-end fashion.

### CIShell Features

#### A framework for easy integration of new and existing algorithms written in any programming language

Using CIShell, an algorithm writer can fully concentrate on creating their own algorithm in whatever language they are comfortable with. Simple tools are provided to then take their algorithm and

### Learn More...

- [CIShell Papers](#)
- [CIShell Powered Tools](#)
- [Algorithms](#)
- [Plugins \(coming soon\)](#)
- [Misc. Tool Documentation](#)
- CIShell Web Services (coming soon)
- [Screenshots](#)

### Getting Started...

- [Documentation & Developer Resources](#)
- [Download](#)

### Getting Involved...

- [Contact Us](#)

CIShell Developer Guide is at <http://cishell.wiki.cns.iu.edu>

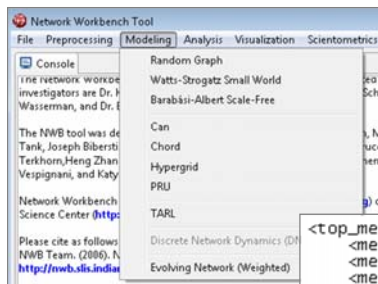
Additional Sci2 Plugins are at <http://sci2.wiki.cns.iu.edu/3.2+Additional+Plugins>

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## CIShell – Customize Menu

- The file *'yourtooldirectory/configuration/default\_menu.xml'* encodes the structure of the menu system.
- In NWB Tool, the Modeling menu (left) is encoded by the following piece of xml code:



```
<?xml version="1.0" encoding="UTF-8" ?>
<top_menu name="Modeling">
  <menu pid="edu.iu.nwb.modeling.erdosrandomgraph"/>
  <menu pid="edu.iu.nwb.modeling.smallworld"/>
  <menu pid="edu.iu.nwb.modeling.barabasiAlbert"/>
  <menu type="break"/>
  <menu pid="edu.iu.iv.modeling.p2p.can.CanAlgorithm"/>
  <menu pid="edu.iu.iv.modeling.p2p.chord.ChordAlgorithm"/>
  <menu pid="edu.id.iv.modeling.p2p.hypergrid.Hypergrid"/>
  <menu pid="edu.iu.iv.modeling.p2p.pru.PruAlgorithm"/>
  <menu type="break"/>
  <menu pid="edu.iu.iv.modeling.tarl.TarlAlgorithm"/>
  <menu type="break"/>
  <menu pid="edu.iu.nwb.modeling.discretenetworkdynamics.DNDAlgorithm"/>
  <menu type="break"/>
  <menu pid="edu.iu.nwb.modeling.weighted.evolvingnetwork"/>
</top_menu>
```

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# Future Work

- Web Services
- Science Classification and Mapping Standards



## Sci<sup>2</sup> Tool Usage at National Institutes of Health

Sci2 Tool now supports Web services and serves as a visual interface to publically available NIH RePORT Expenditure and Results (RePORTER)/ RePORTER data provided by NIH.

The screenshot shows the Nete AV Analyzer | Visualizer interface. At the top, the logo 'NETE AV ANALYZER | VISUALIZER' is displayed. Below it, there are four main analysis categories: TEMPORAL ANALYSIS, GEOSPATIAL ANALYSIS, TOPICAL ANALYSIS, and NETWORK ANALYSIS. A smartphone is shown in the foreground, displaying a network graph. The interface also includes a 'DATA SETS' button and a 'WHEN' IIS TEMPORAL ANALYSIS section. Below the main interface, there are four text boxes explaining the types of questions each analysis type addresses: 'When' questions are commonly addressed via temporal analyses; 'Where' questions often involve the application of geospatial methods; 'What' questions require topical analyses; and 'With whom' questions are often answered via network studies. On the right side, there are four horizontal lines with the words 'WHEN', 'WHERE', 'WHAT', and 'WHOM' below them.





## Sci² Tool Usage at National Institutes of Health

### NETE A|V - Temporal Analysis

Find and select one or multiple PIs

1 CHOOSE A DATA SET    2 CHOOSE AN ANALYSIS    3 VISUALIZE

Choose the data set that you would like to visualize

Principal Investigators by Name

Principal Investigators by Organization

Organization :  Include Co-PIs

Select Select All / Deselect All	Name	Organization	Total Projects	Projects with Award Amounts	Profile Id
<input type="checkbox"/>	CEDAR, HOWARD	HEBREW UNIVERSITY OF JERUSALEM	6	6	1858057
<input type="checkbox"/>	YANAI, JOSEPH	HEBREW UNIVERSITY OF JERUSALEM	3	3	1869372
<input type="checkbox"/>	OLSON, SARA H	HEBREW UNIVERSITY OF JERUSALEM	6	6	1872521
<input type="checkbox"/>	MINKE, BARUCH	HEBREW UNIVERSITY OF JERUSALEM	1	1	1876962
<input type="checkbox"/>	SCHULDINER, SHIMON	HEBREW UNIVERSITY OF JERUSALEM	3	3	1901430

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## Sci² Tool Usage at National Institutes of Health

### NETE A|V - Temporal Analysis

Visualize portfolio of projects on the timescale

- Projects with award amounts
- Projects by IC funding
- Projects by PIs

1 CHOOSE A DATA SET    2 CHOOSE AN ANALYSIS    3 VISUALIZE

Choose an analysis that you would like to do:

All projects with award amounts

Top 20 projects by average award amount

All projects with award amounts by IC funding

All projects by PI

Start Fiscal Year:  End Fiscal Year:

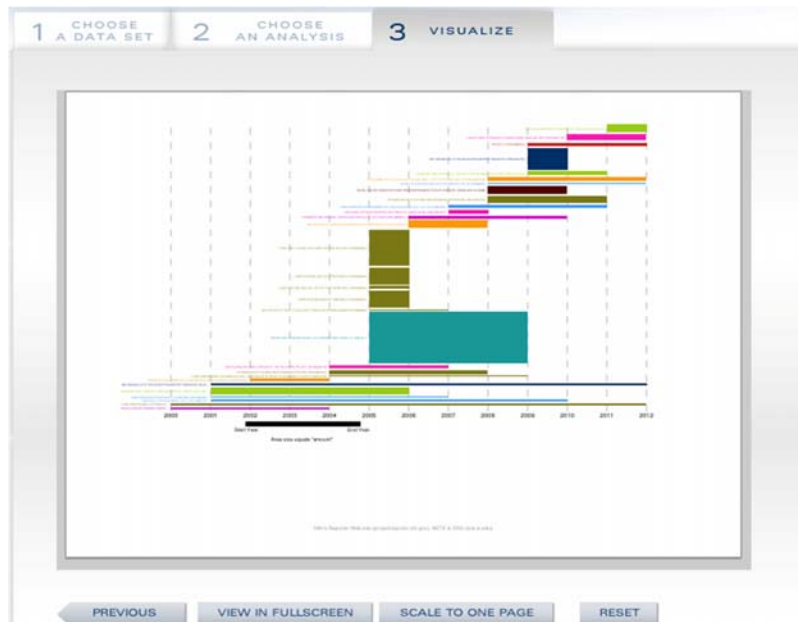
64



## Sci² Tool Usage at National Institutes of Health

### NETE A|V - Temporal Analysis – Projects with Award Amounts

Four-variable visualizations, e.g. time, amounts, PIs and projects

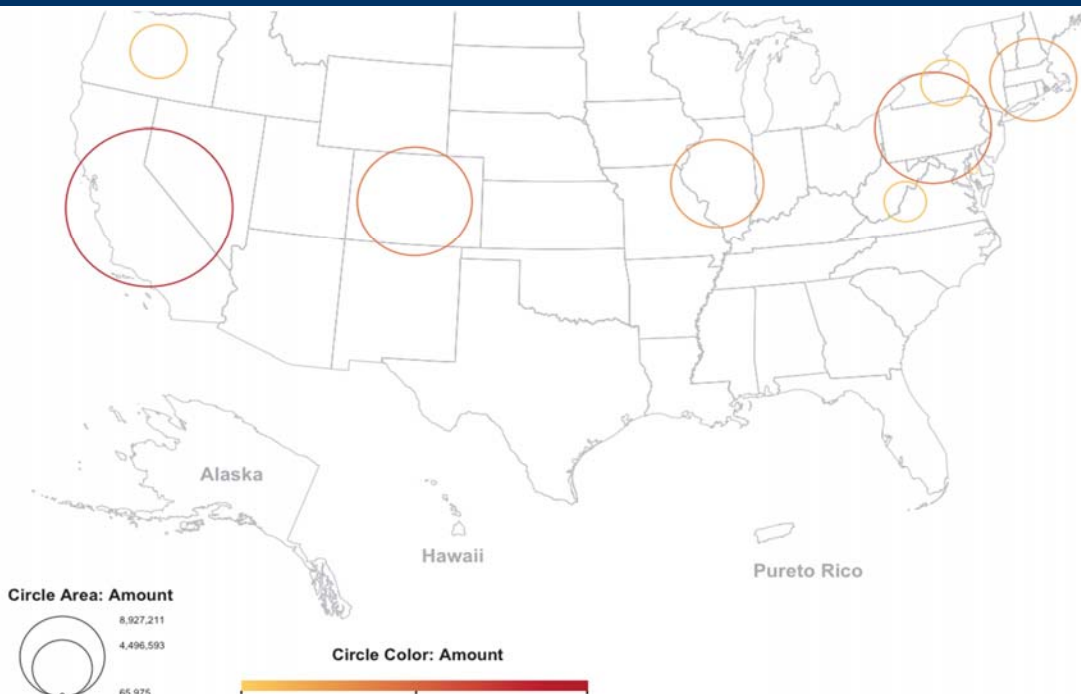


65



## Sci² Tool Usage at National Institutes of Health

### NETE A|V – Geospatial Analysis – Projects by External Organization

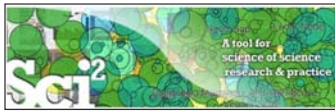
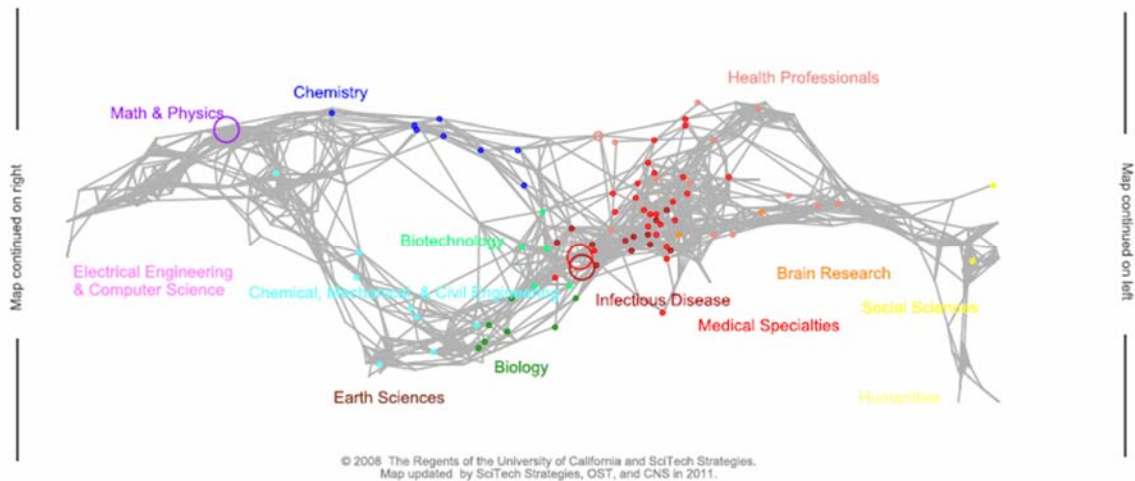


66



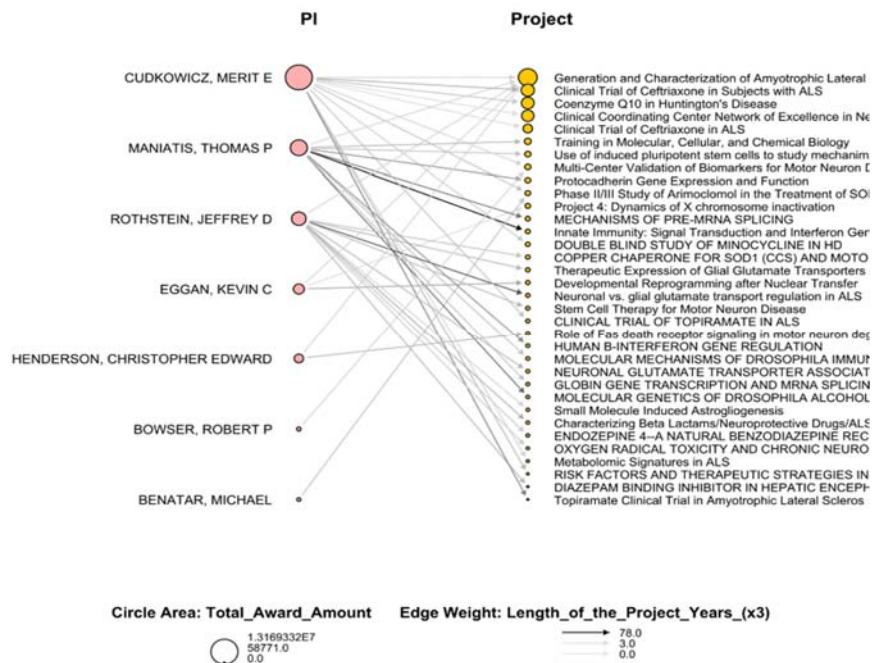
## Sci² Tool Usage at National Institutes of Health

### NETE A|V – Topical Analysis – Publications in a Project Portfolio

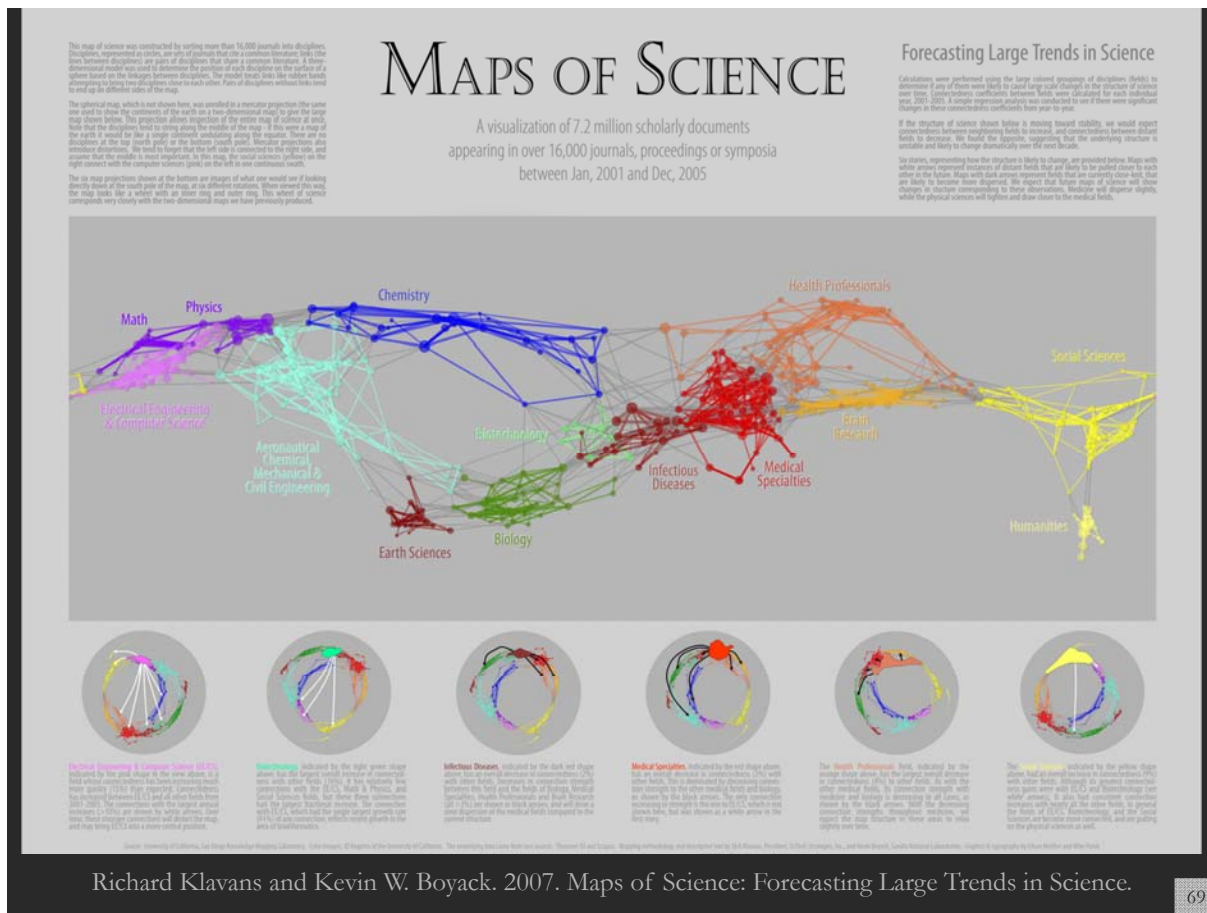


## Sci² Tool Usage at National Institutes of Health

### NETE A|V – Network Analysis – (Co-) PIs to Projects







## The UCSD Map of Science and Classification System

### 2007 Map:

**Data:** WoS and Scopus for 2001–2005, 7.2 million papers, >16,000 separate journals, proceedings, series

**Similarity Metric:** Combination of bibliographic coupling and keyword vectors

**Number of Disciplines:** 13; **Subdisciplines:** 554

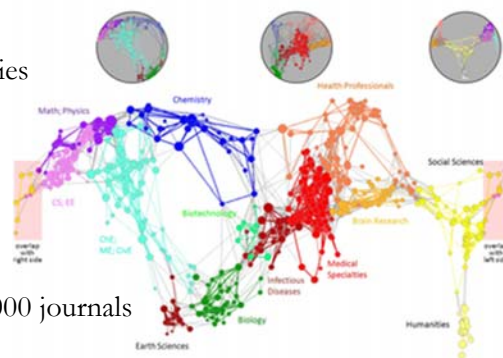
### 2010 Map:

**Data:** WoS and Scopus for 2001–2010; about 25,000 journals

**Number of Disciplines:** 13; **Subdisciplines:** 554

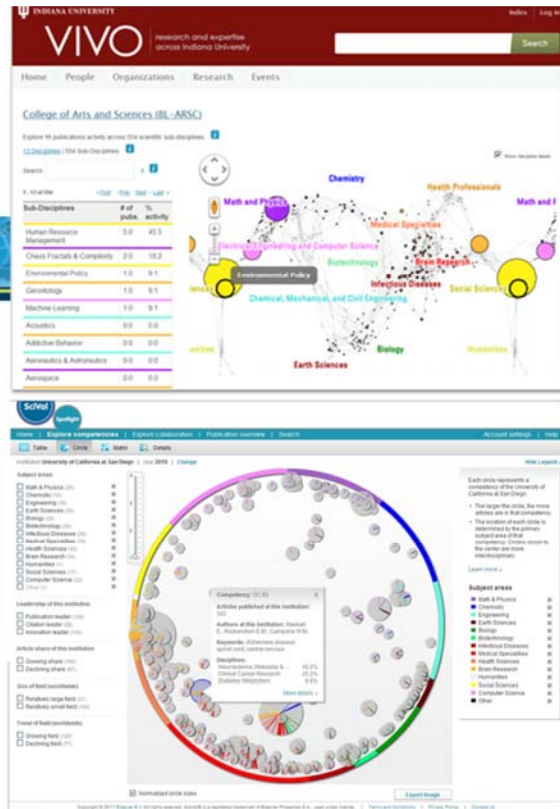
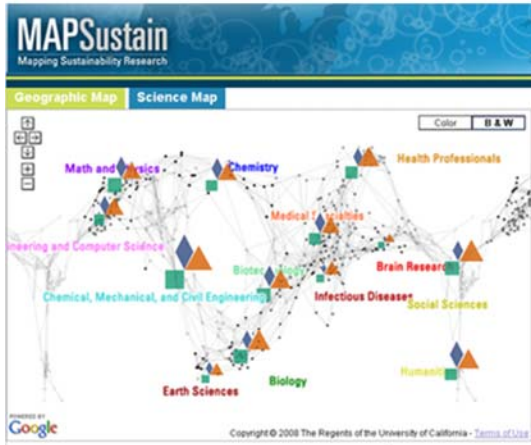
### Map Design and Usage:

Map places 554 subdisciplines on the surface of a sphere—those with papers that cite the same base knowledge are placed in closer proximity. The spheric layout is then flattened using a Mercator projection. Each node is labeled and has an extensive list of journal names and key phrases as metadata, which can be used to “science locate” journal publications as well as nonjournal data such as patents or grants.



Börner, Katy, Richard Klavans, et al. (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)

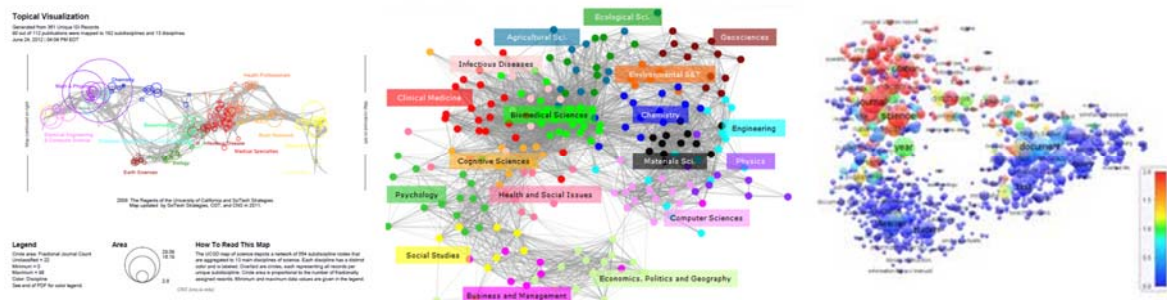
# UCSD Map of Science: Deployments



Börner, Katy, Richard Klavans, et al. (2012) Design and Update of a Classification System: The UCSD Map of Science. PLoS ONE 7(7): e39464. Data is at <http://sci.cns.in.edu/ucsdmap>



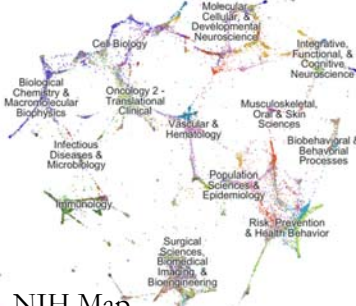
## Aligning Science Basemaps using the Sci2 Tool



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>

## References

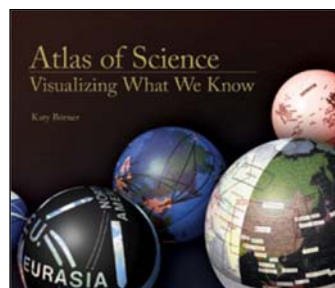
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[http://www.pnas.org/content/vol101/suppl\\_1/](http://www.pnas.org/content/vol101/suppl_1/)

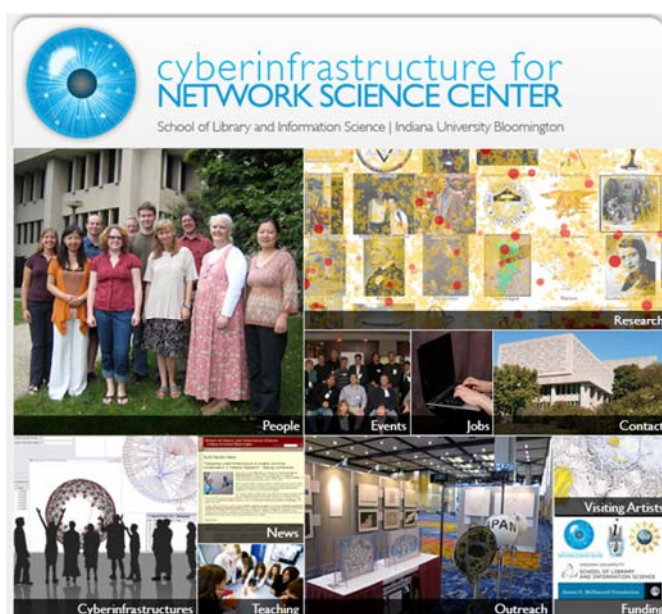
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Börner, Katy (2010) **Atlas of Science**. MIT Press.  
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Scharnhorst, Andrea, Börner, Katy, van den Besselaar, Peter (2012) **Models of Science Dynamics**. Springer Verlag.



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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>

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