Atlas of Science: Envisioning Scholarly Data

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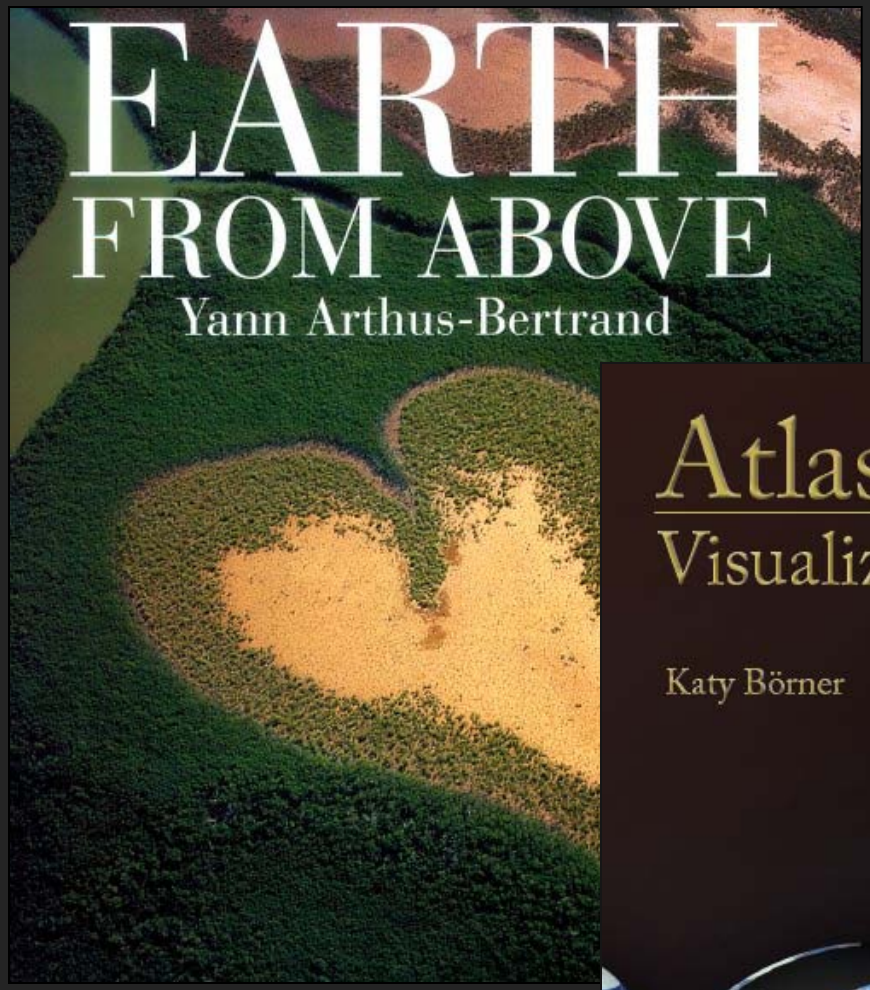
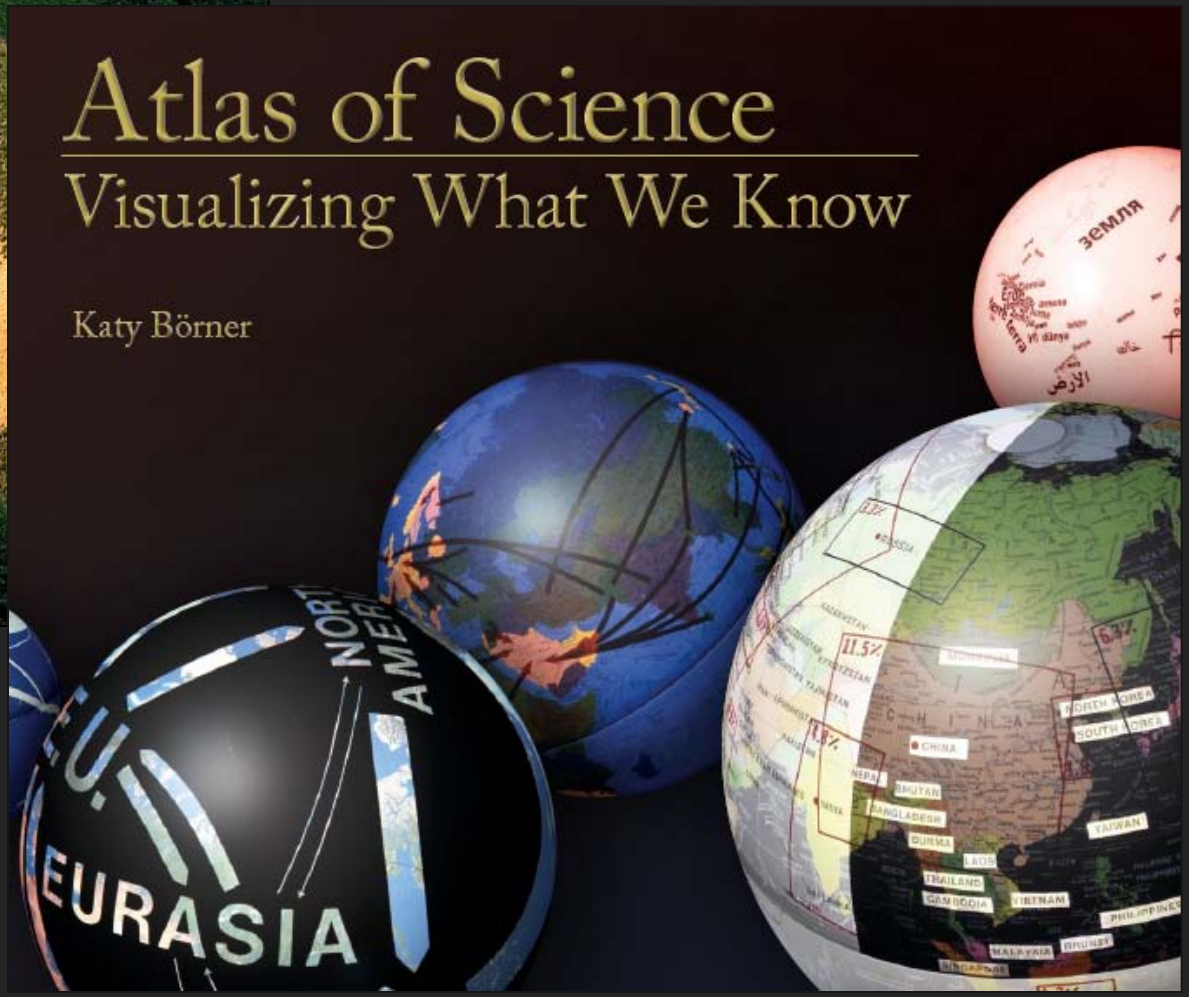
With special thanks to the members at the Cyberinfrastructure for Network Science Center, the Mapping Science exhibit map makers, the exhibit advisory board, and the VIVO Collaboration.

HUBbub 2011: The HUBzero Conference (http://hubzero.org/hubbub2011)
April 6, 2011

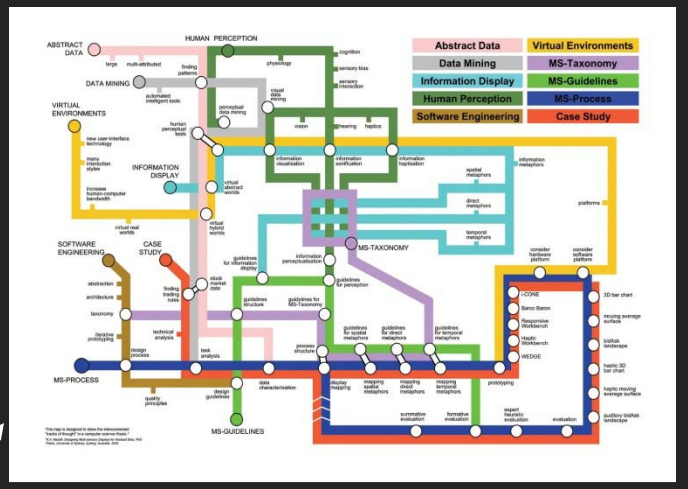

EARTH
FROM ABOVE
Yann Arthus-Bertrand


Atlas of Science
Visualizing What We Know
Katy Börner
EURASIA

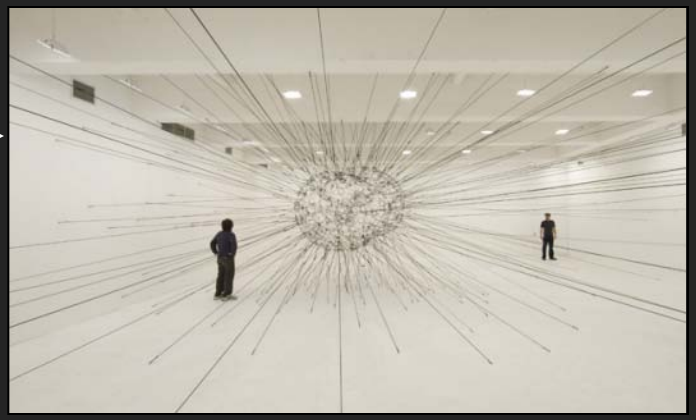
Take terra bytes of data

Take terra bytes of data

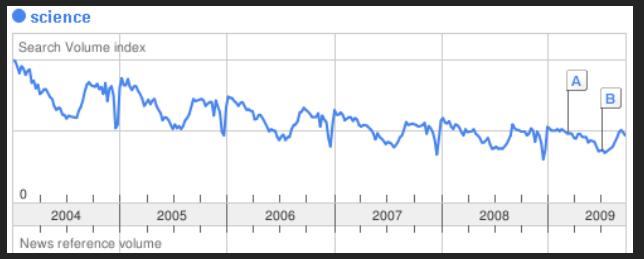
Black Box



Find your way

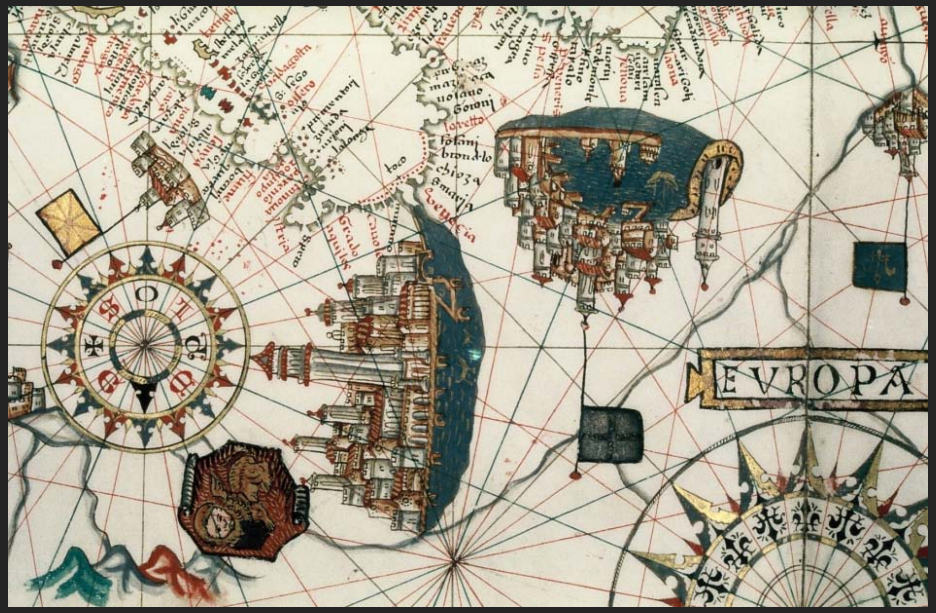


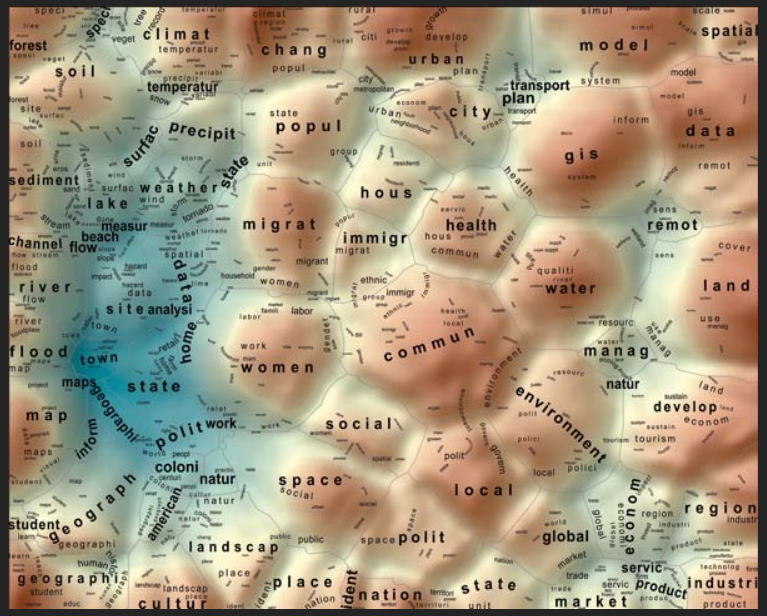
Find collaborators, friends



Identify trends

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

Mapping Science Exhibit – 10 Iterations in 10 years

http://scimaps.org

The Power of Maps (2005)

The Power of Reference Systems (2006)

The Power of Forecasts (2007)

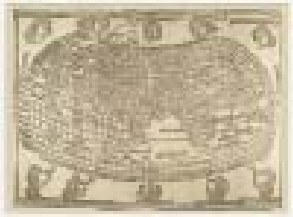
Science Maps for Economic Decision Makers (2008)

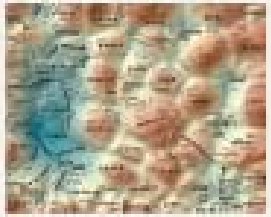
Science Maps for Science Policy Makers (2009)

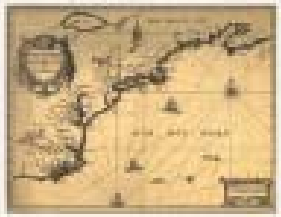
Science Maps for Scholars (2010)
Science Maps as Visual Interfaces to Digital Libraries (2011)
Science Maps for Kids (2012)
Science Forecasts (2013)
How to Lie with Science Maps (2014)

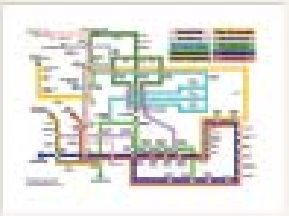
Exhibit has been shown in 72 venues on four continents. Currently at
- NSF, 10th Floor, 4201 Wilson Boulevard, Arlington, VA
- Center of Advanced European Studies and Research, Bonn, Germany
- University of Michigan, Ann Arbor, MI

The Power of Maps 2005

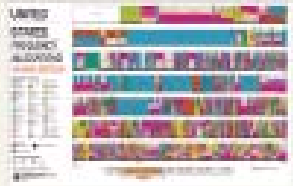


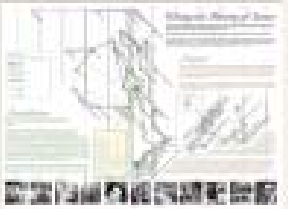
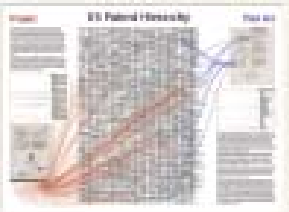
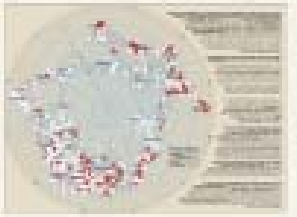


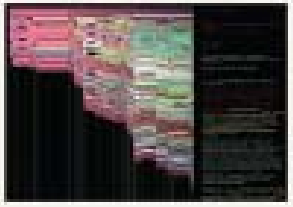
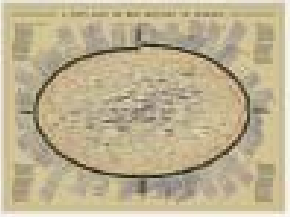




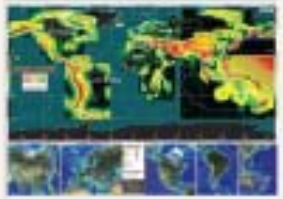
The Power of Reference Systems 2006



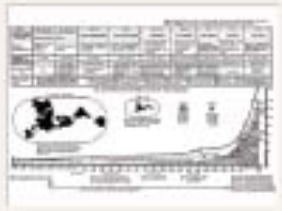




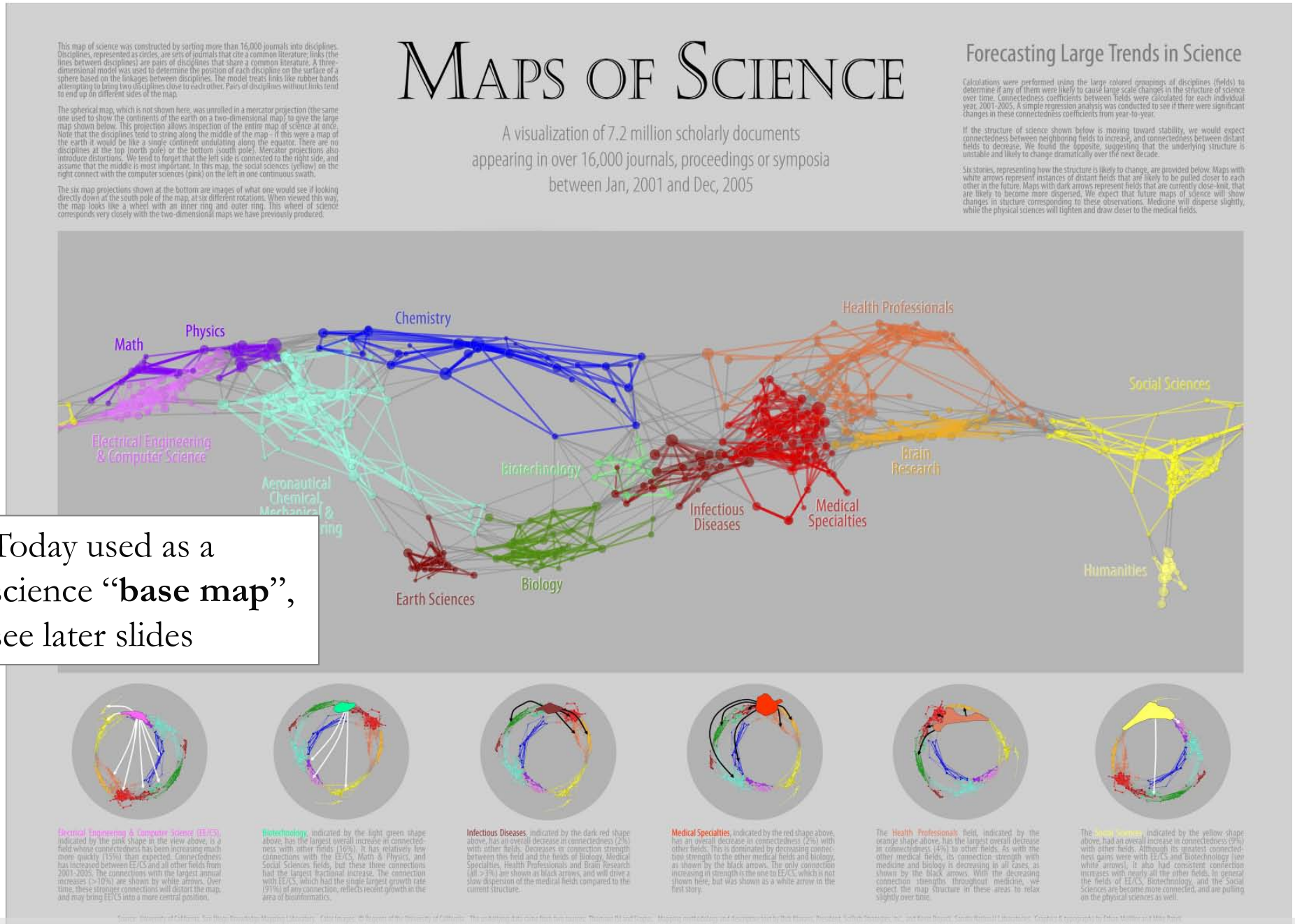



The Power of Forecasts 2007



Science Maps for Economic Decision Makers 2008



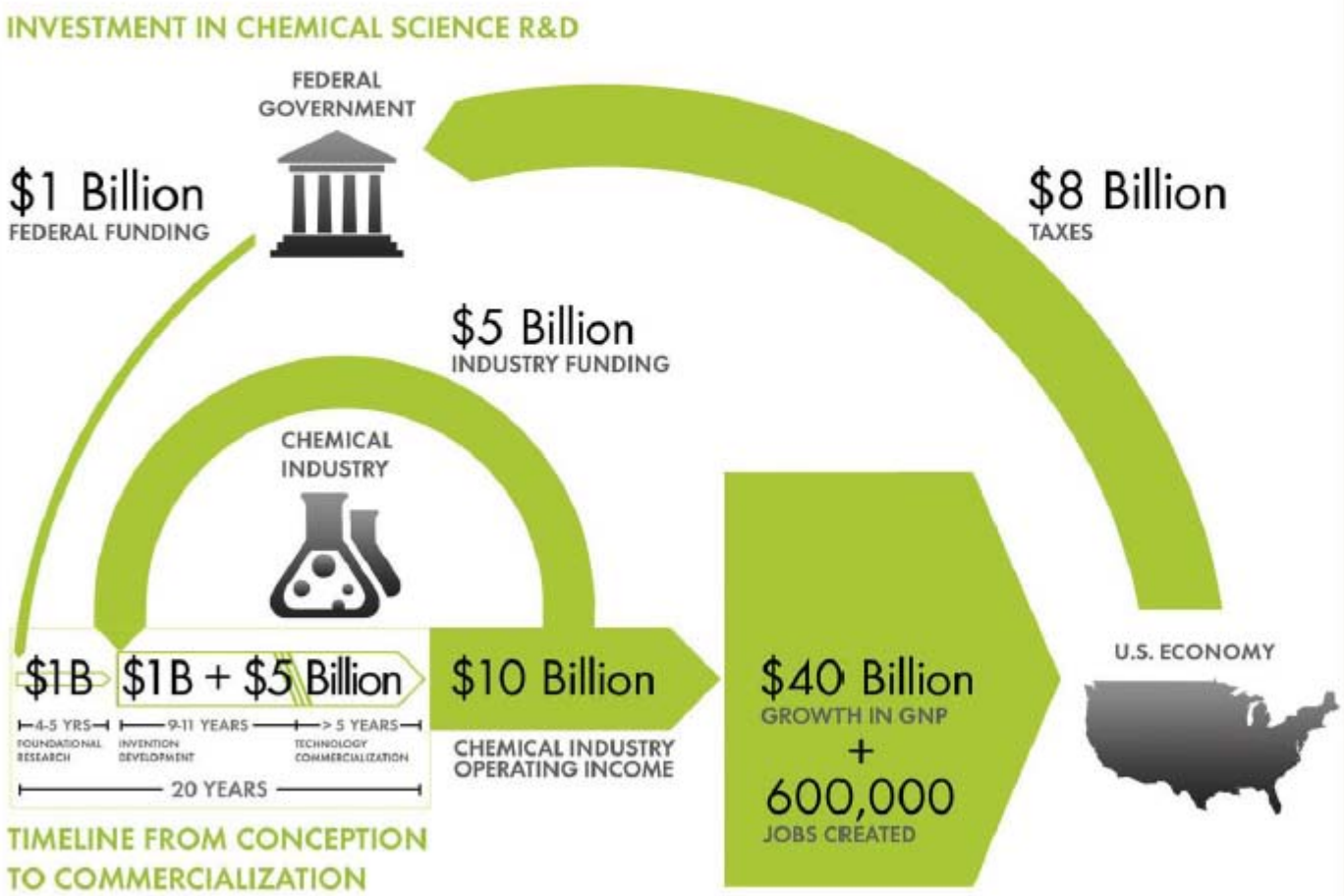


Today used as a science "**base map**", see later slides

Richard Klavans & Kevin W. Boyack. 2007. Maps of Science: Forecasting Large Trends in Science

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

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



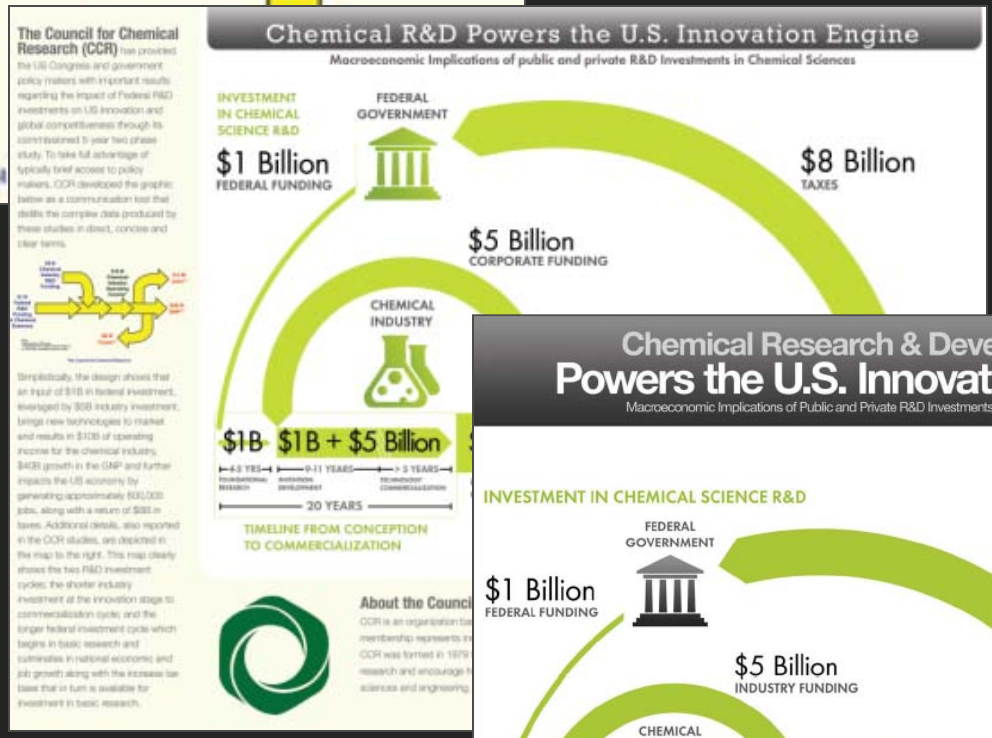
The Council for Chemical Research (CCR)

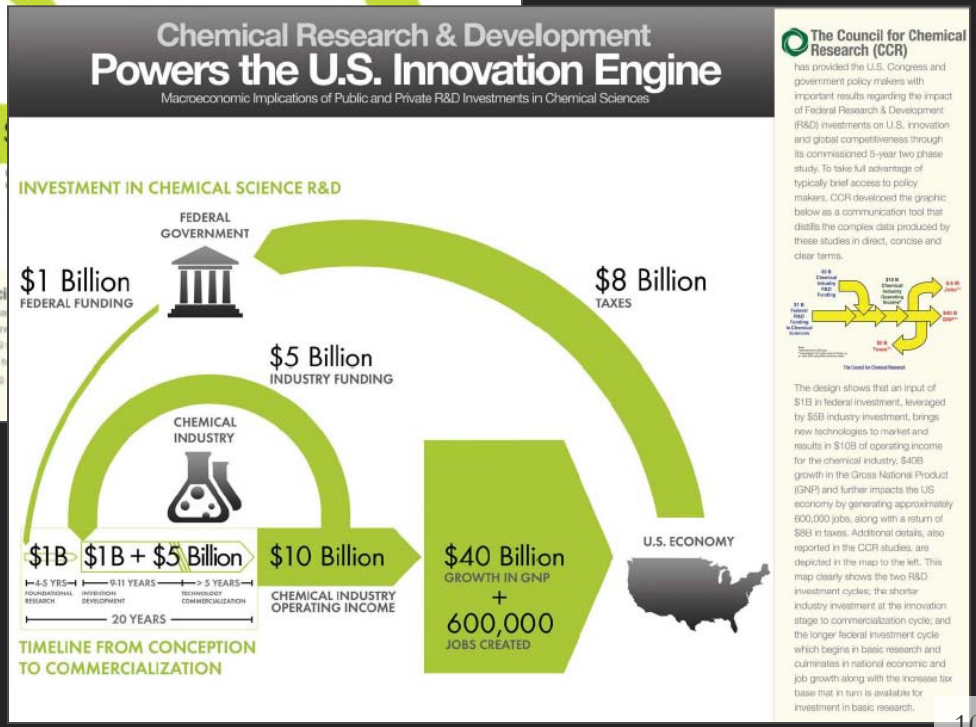
has provided the U.S. Congress and government policy makers with important results regarding the impact of Federal Research & Development (R&D) investments on U.S. innovation and global competitiveness through its commissioned 5-year two phase study. To take full advantage of typically brief access to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

$5 B
Chemical
Industry
R&D
Funding
$1 B
Federal
R&D
Funding
In Chemical
Sciences
$10 B
Chemical
Industry
Operating
Income*
0.6 M
Jobs**
$40 B
GNP**


Chemical R&D Powers the U.S. Innovation Engine
Macroeconomic Implications of public and private R&D Investments in Chemical Sciences
INVESTMENT
IN CHEMICAL
SCIENCE R&D
FEDERAL
GOVERNMENT
$1 Billion
FEDERAL FUNDING
$8 Billion
TAXES
$5 Billion
CORPORATE FUNDING
CHEMICAL
INDUSTRY
$1B
$1B + $5 Billion
4-5 YRS
9-11 YEARS
> 5 YEARS
20 YEARS
TIMELINE FROM CONCEPTION
TO COMMERCIALIZATION
The Council for Chemical Research (CCR)


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
FEDERAL
GOVERNMENT
$1 Billion
FEDERAL FUNDING
$8 Billion
TAXES
$5 Billion
INDUSTRY FUNDING
CHEMICAL
INDUSTRY
$1B
$1B + $5 Billion
$10 Billion
4-5 YRS
9-11 YEARS
> 5 YEARS
20 YEARS
CHEMICAL INDUSTRY
OPERATING INCOME
$40 Billion
GROWTH IN GNP
+
600,000
JOBS CREATED
U.S. ECONOMY
TIMELINE FROM CONCEPTION
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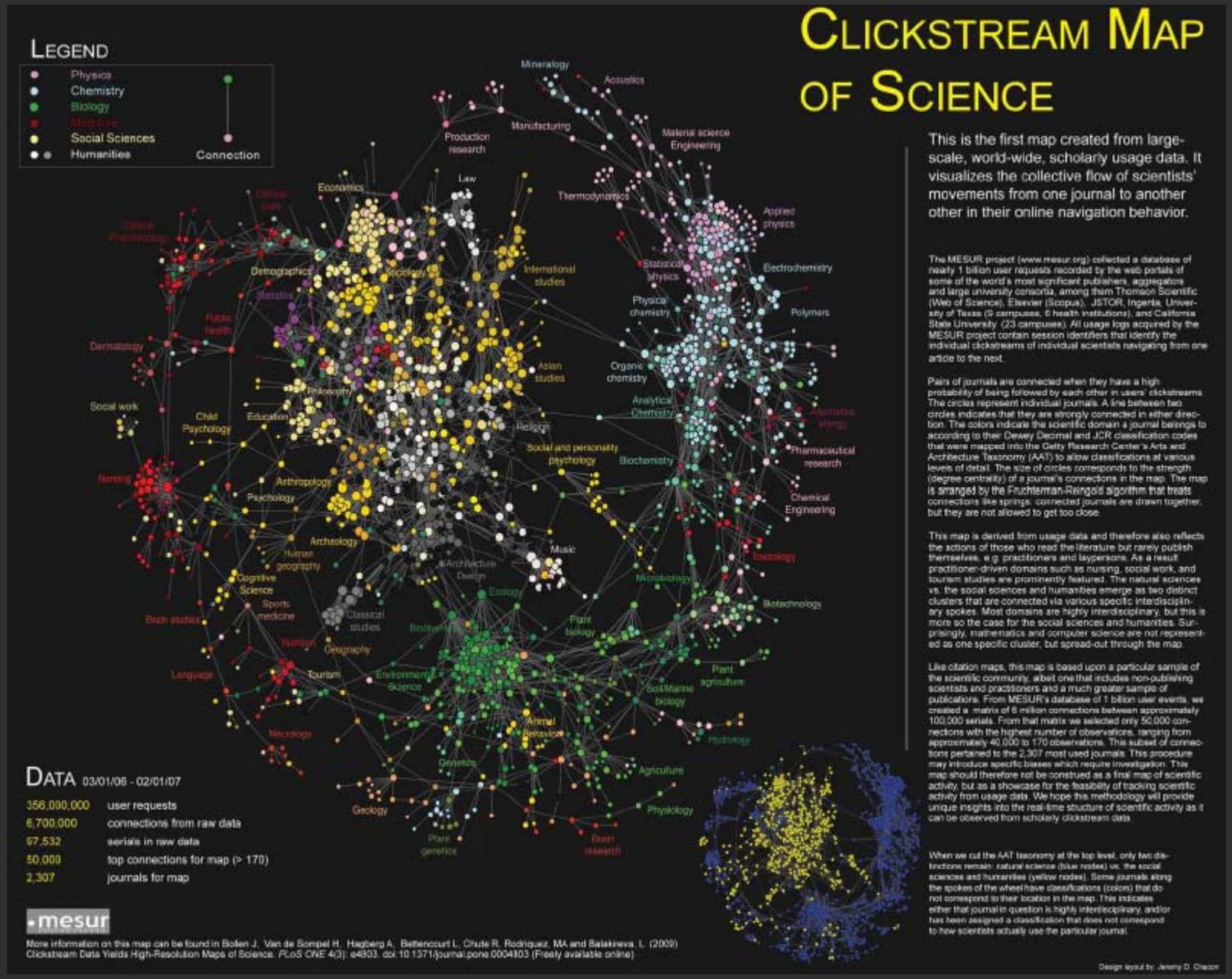


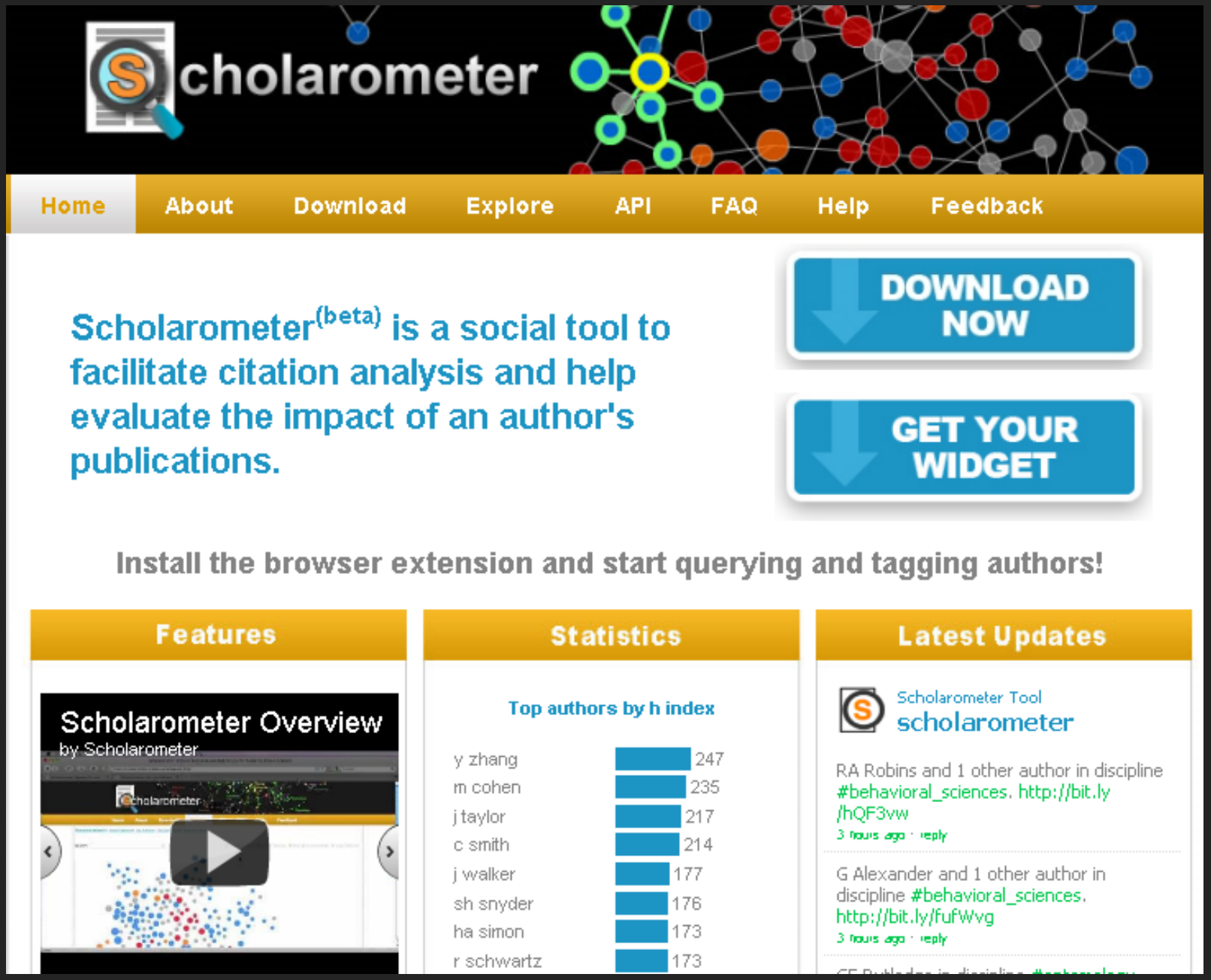
Bollen, Johan, Herbert Van de Sompel, Aric Hagberg, Luis M.A. Bettencourt, Ryan Chute, Marko A. Rodriquez, Lyudmila Balakireva. 2008. A Clickstream Map of Science.

Debut of 5th Iteration of the Mapping Science Exhibit at MEDIA X was in 2009 at Wallenberg Hall, Stanford University, *http://mediax.stanford.edu*, *http://scaleindependentthought.typepad.com/photos/scimaps*

INDIANA
UNIVERSITY
PLACES AND SPACES
EXHIBIT

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

Interactive S&T Maps



http://scholarometer.indiana.edu

Maps of Science - Windows Internet Explorer

http://mapofscience.com/

mapofscience.com

File Edit View Favorites Tools Help

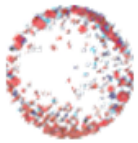
Convert Select

Favorites Suggested Sites Web Slice Gallery

Maps of Science

Page Safety Tools

MAPS OF SCIENCE



Overview | Detail | Disciplinary Maps | Competency Maps | Paradigm Maps | Posters | Education

BETTER MAPS • BETTER DECISIONS

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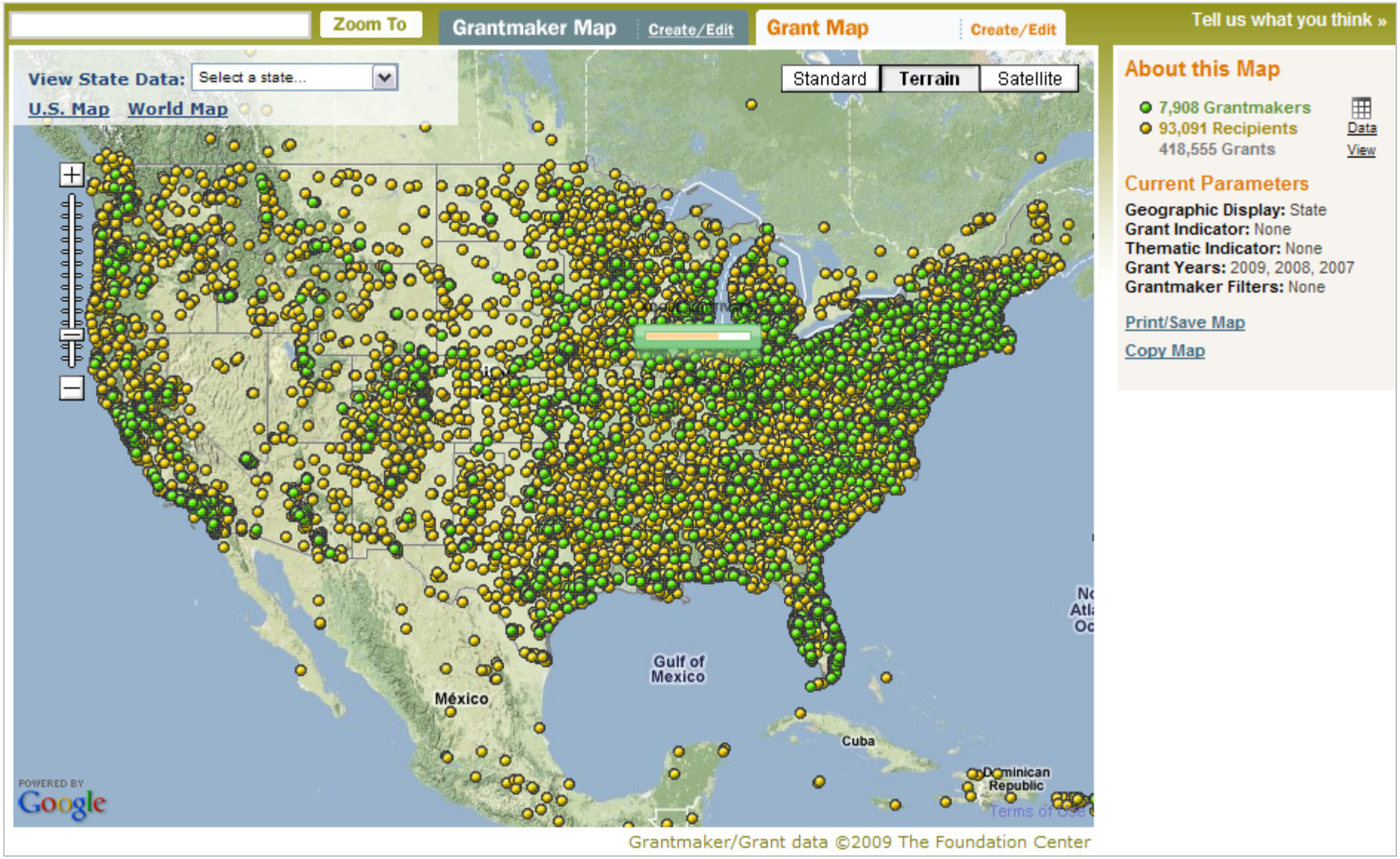
Done Internet

http://mapofscience.com and SciVal by Elsevier

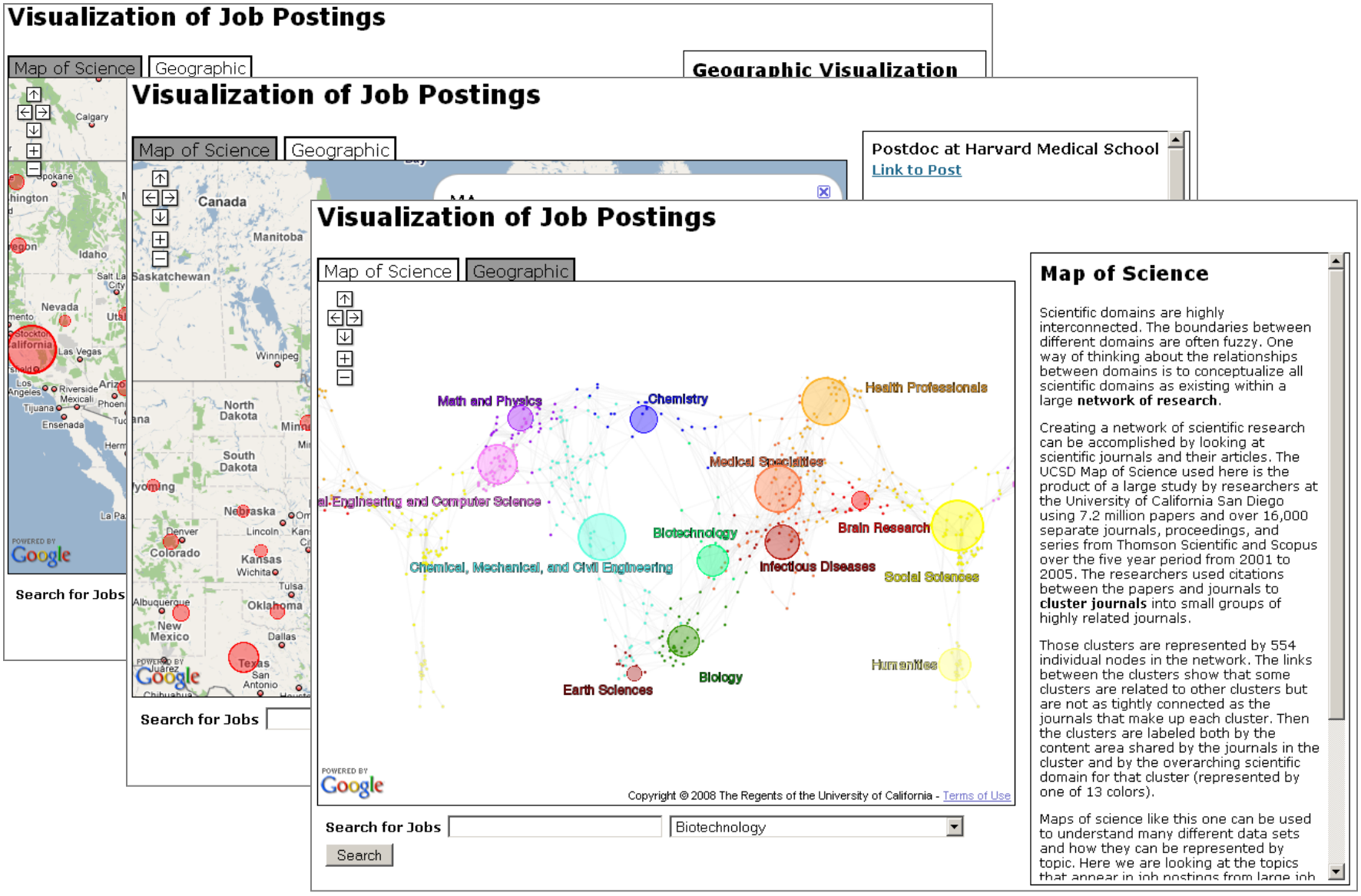
Interactive Maps of Science – Philanthropy



http://www.philanthropyinsight.org

Interactive World and Science Map of S&T Jobs

Angela Zoss, Michael Connover, Katy Börner (2010)



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.

☑ **Funding**
☑ NIH
☑ NSF
☑ USDA

Amount ◉ Count ○

☑ **Publications**
☑ DOE
☑ ISI
☑ Medline

Citations ◉ Count ○

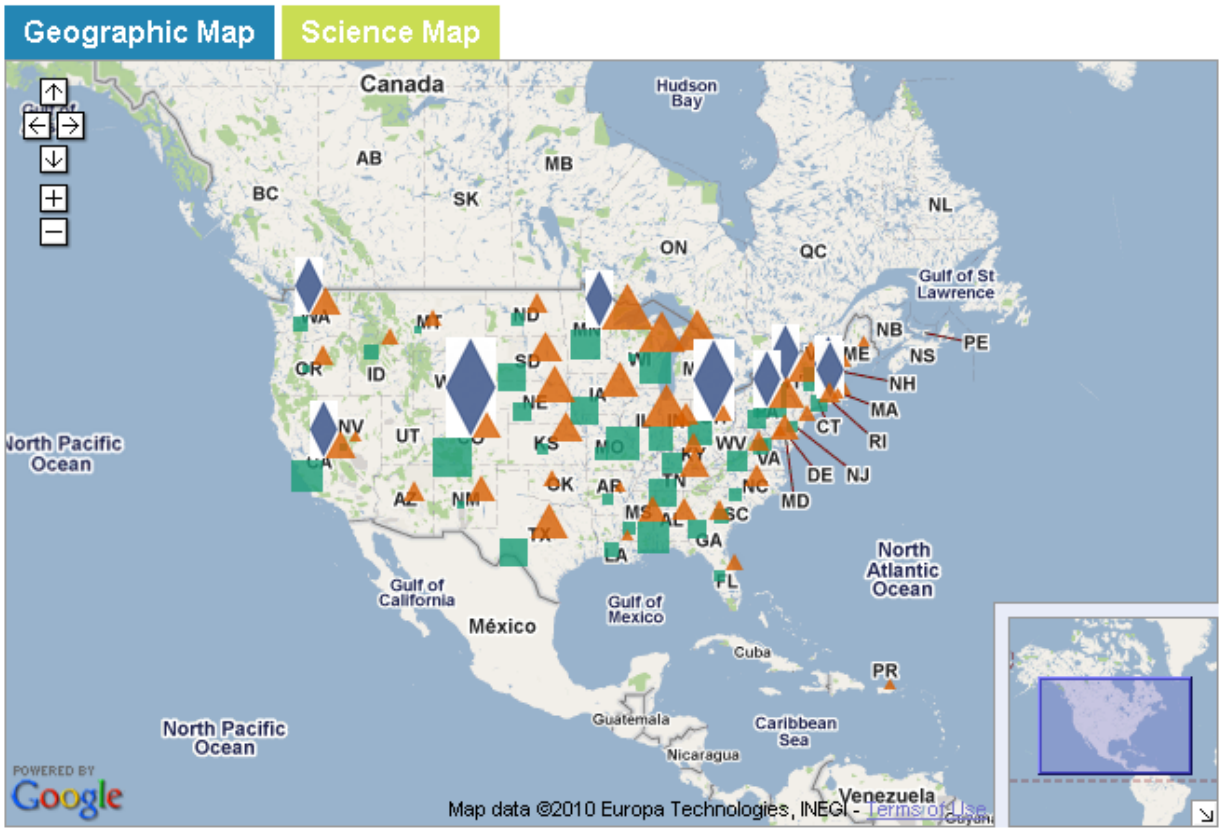
☑ **Patents**
☑ USPTO

Citations ◉ Count ○

From year 1901 to year 2009

Search by keyword [ ] Search

http://mapsustain.cns.iu.edu



Maps Detail Data **About**

About

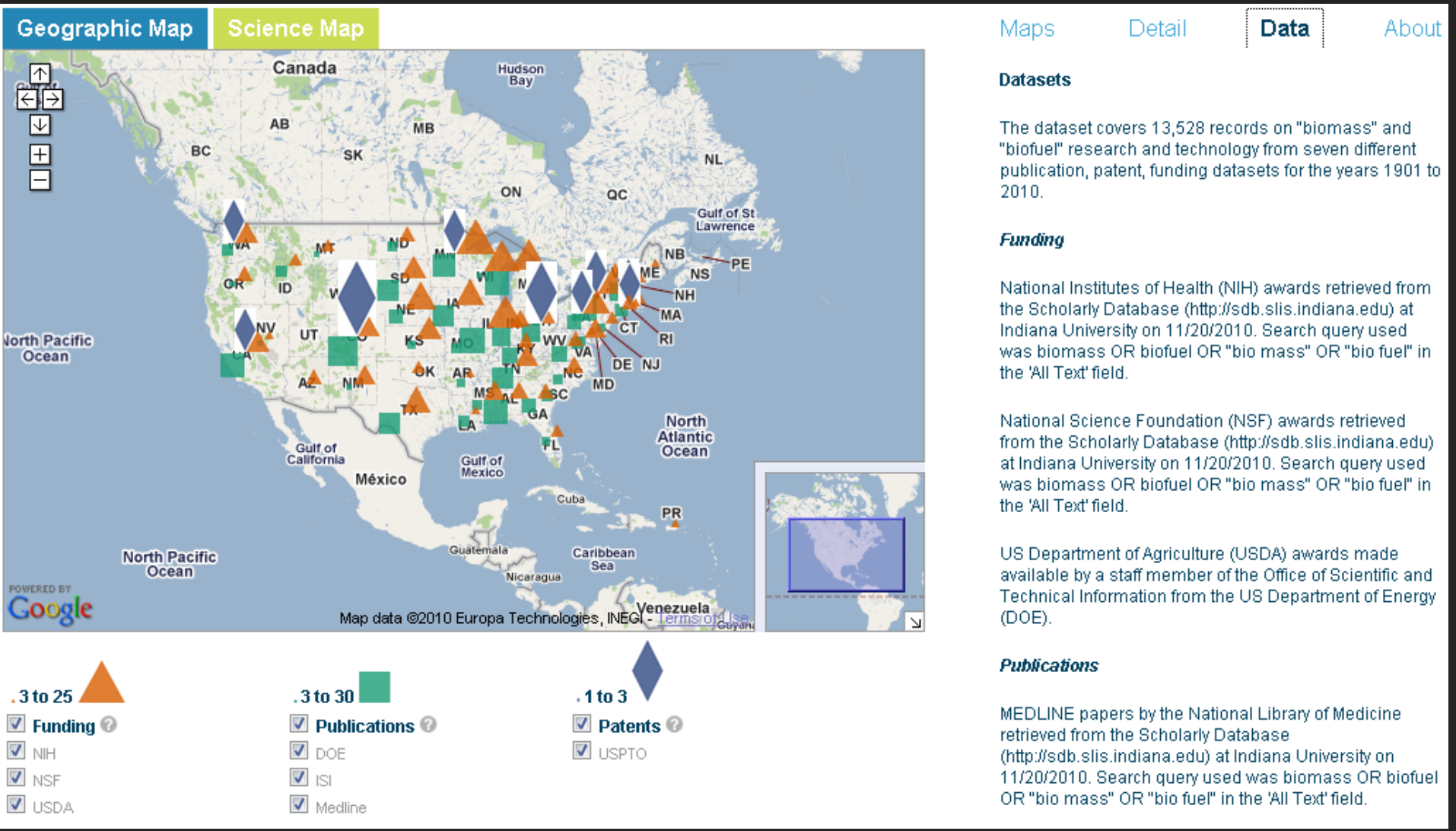
A new field of *Sustainability Science and Engineering* is emerging that seeks to understand the fundamental character of interactions between nature and human society and to help steer the impact of humanity's needs on the planet's natural resources towards sustainable trajectories. The field is unified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

Please consult the Mapping the Structure and Evolution of Sustainability Science workshop web page for further information and details.

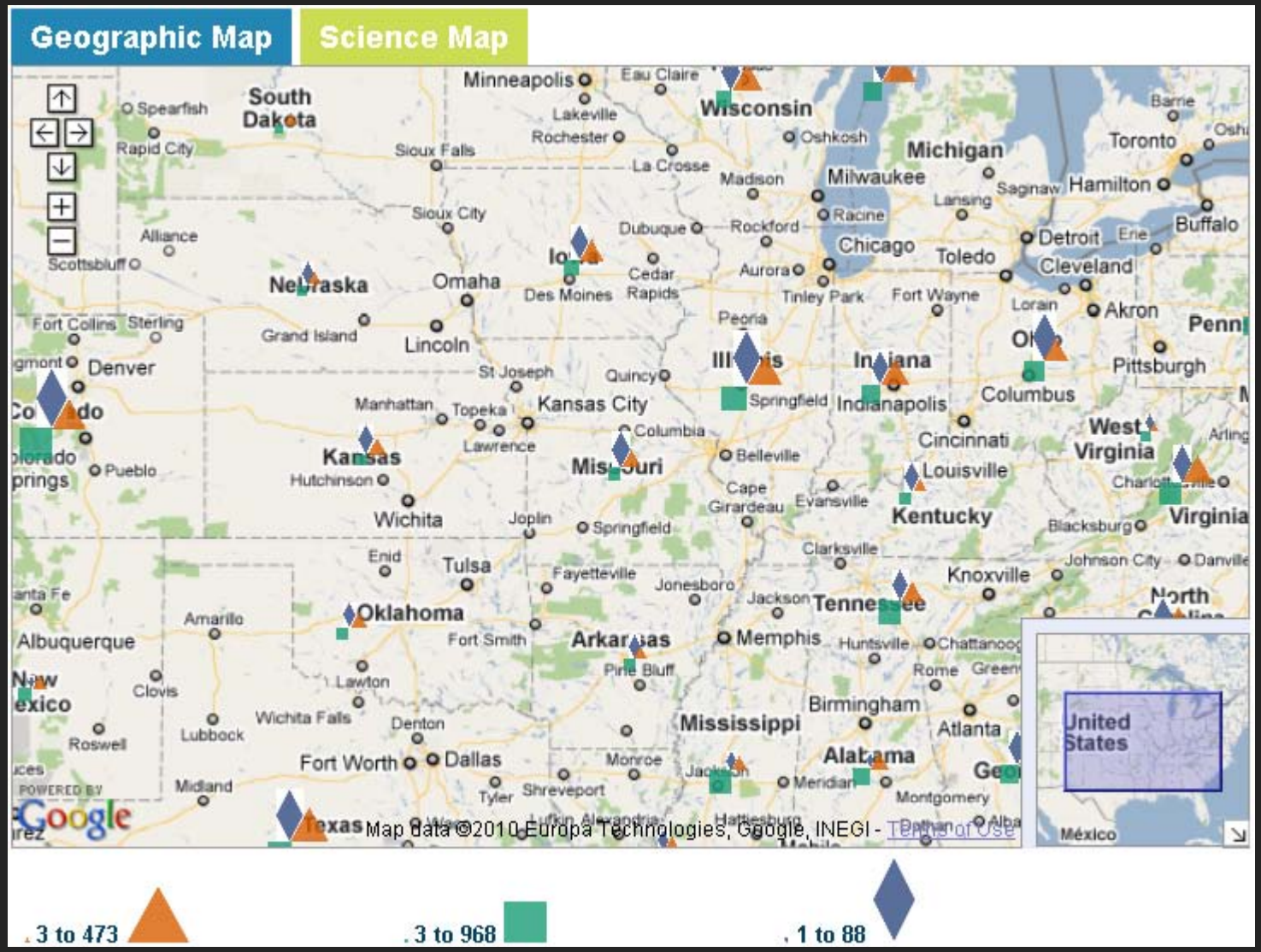
Web Page Design

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

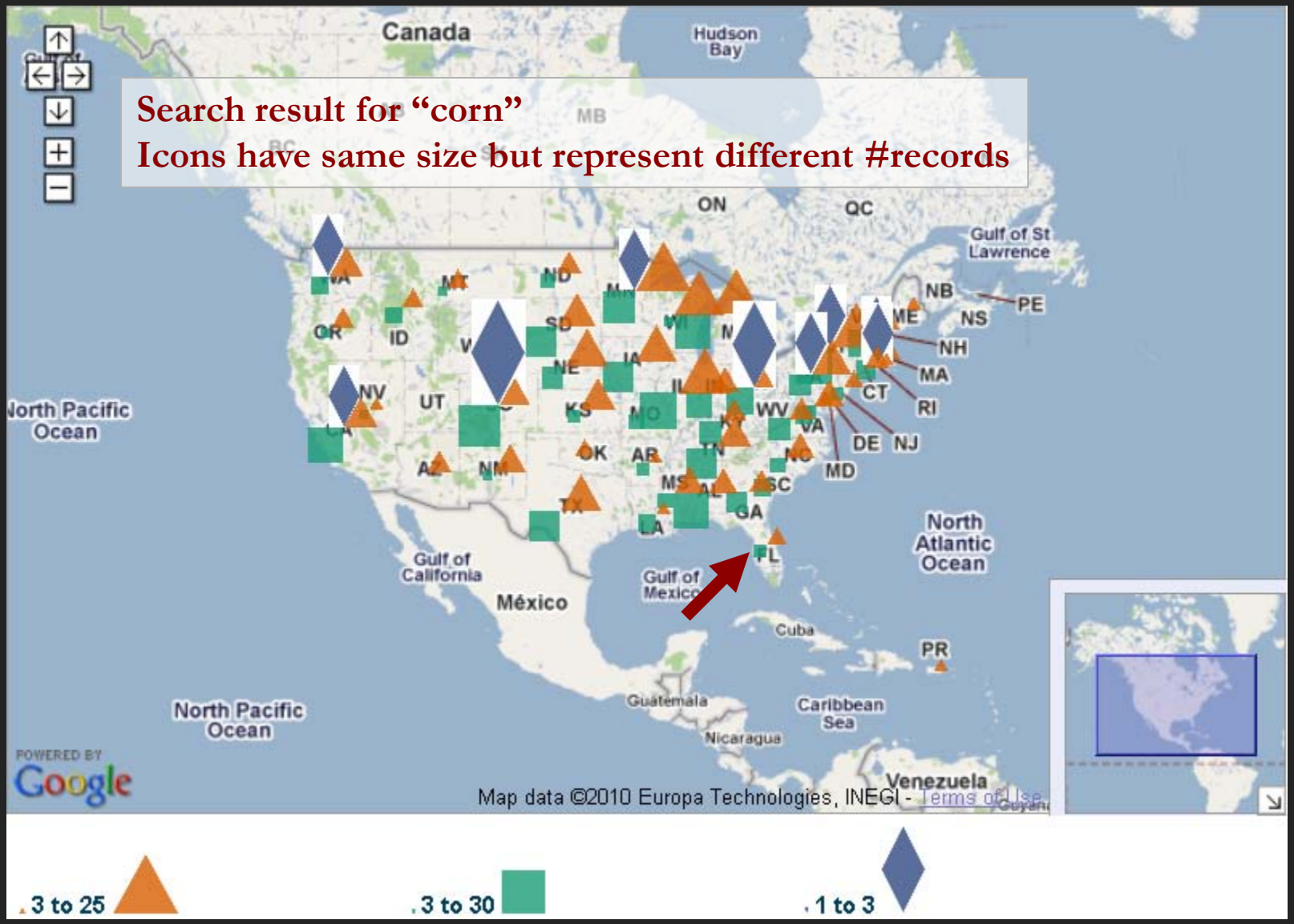
Google Map JavaScript API was used to implement both maps with two aggregation layers for each. The geographic map aggregates to the **state level** and the **city level**. The science map has a high level of aggregation of 13 top-level scientific **disciplines** and a low level of 554 **sub-disciplines**.



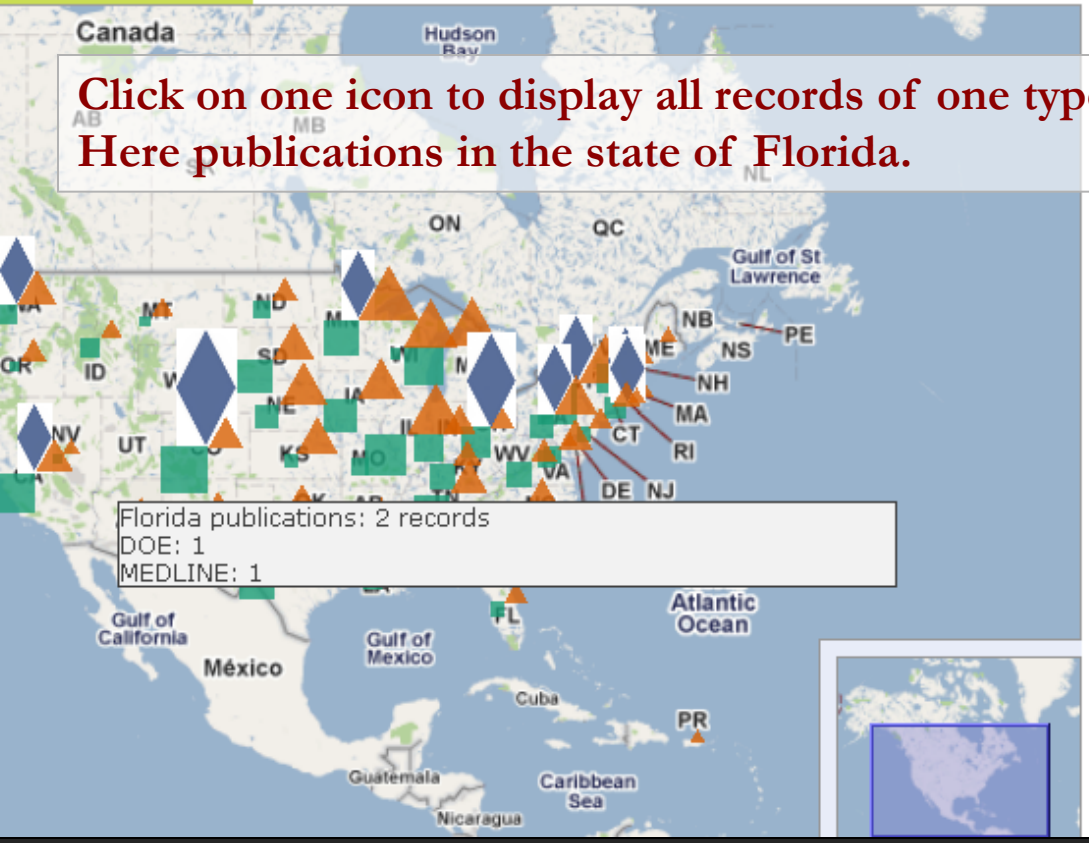
The geographic map at **state level**.



The geographic map at **city level**.


Search result for "corn"
Icons have same size but represent different #records
Canada
Hudson Bay
Gulf of St Lawrence
North Pacific Ocean
North Atlantic Ocean
Gulf of California
Gulf of Mexico
México
Cuba
PR
Guatemala
Nicaragua
Caribbean Sea
Venezuela
North Pacific Ocean
Map data ©2010 Europa Technologies, INEGI - Terms of Use
.3 to 25
.3 to 30
.1 to 3

Science Map



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

Maps Detail Data About

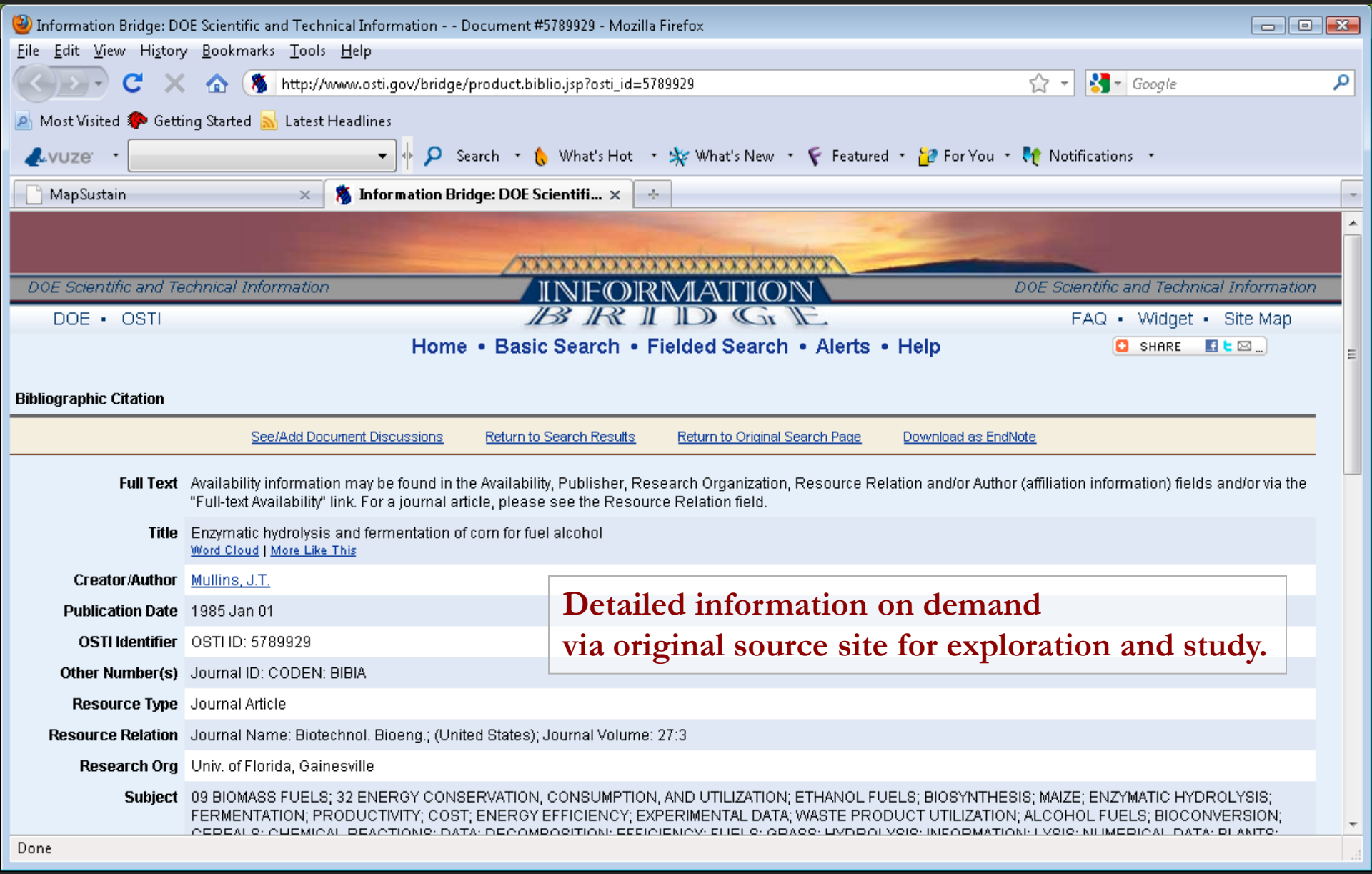
> Florida

MEDLINE
2002

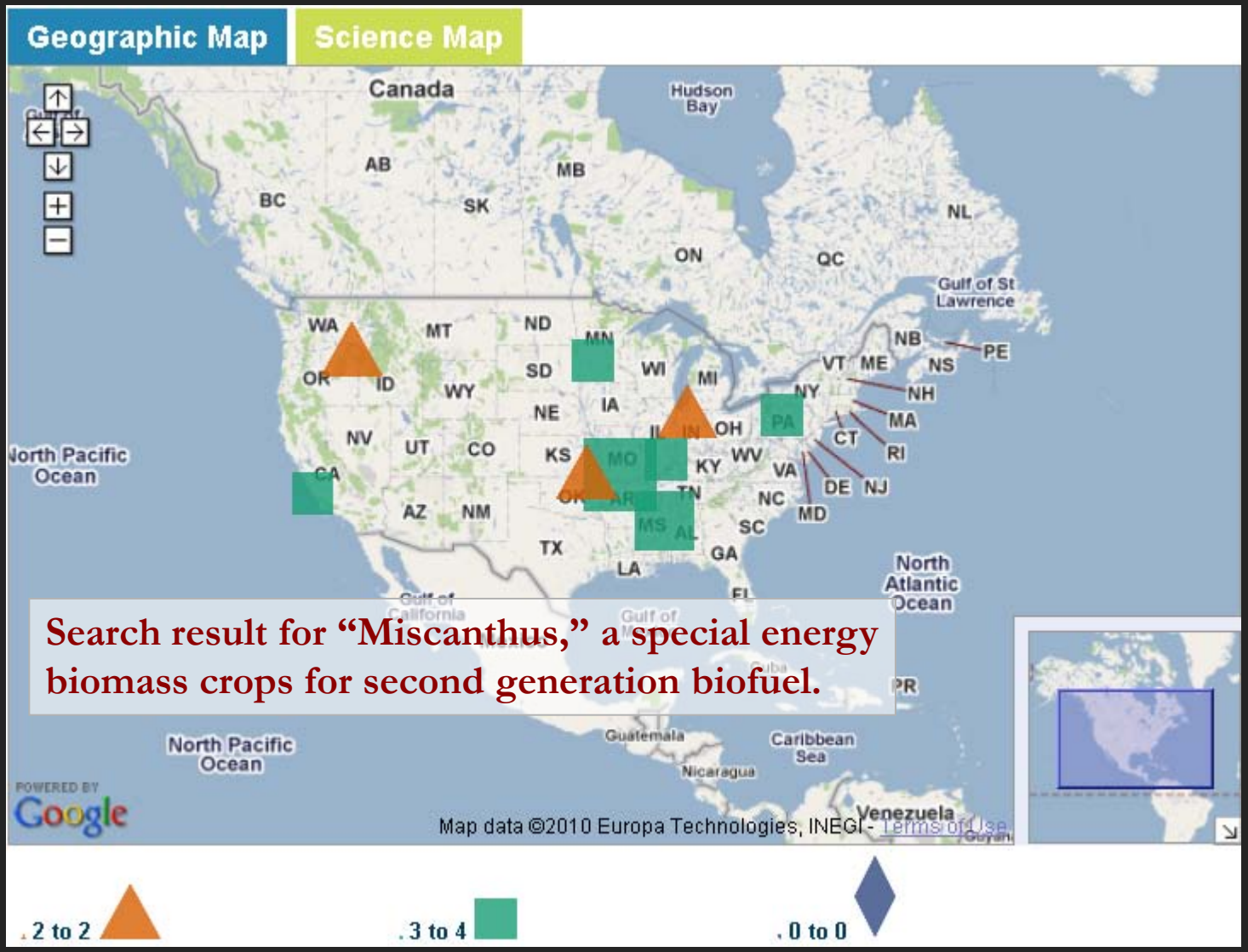
- Recovery Of Dairy Manure Nutrients By Benthic Freshwater Algae.

DOE
1985

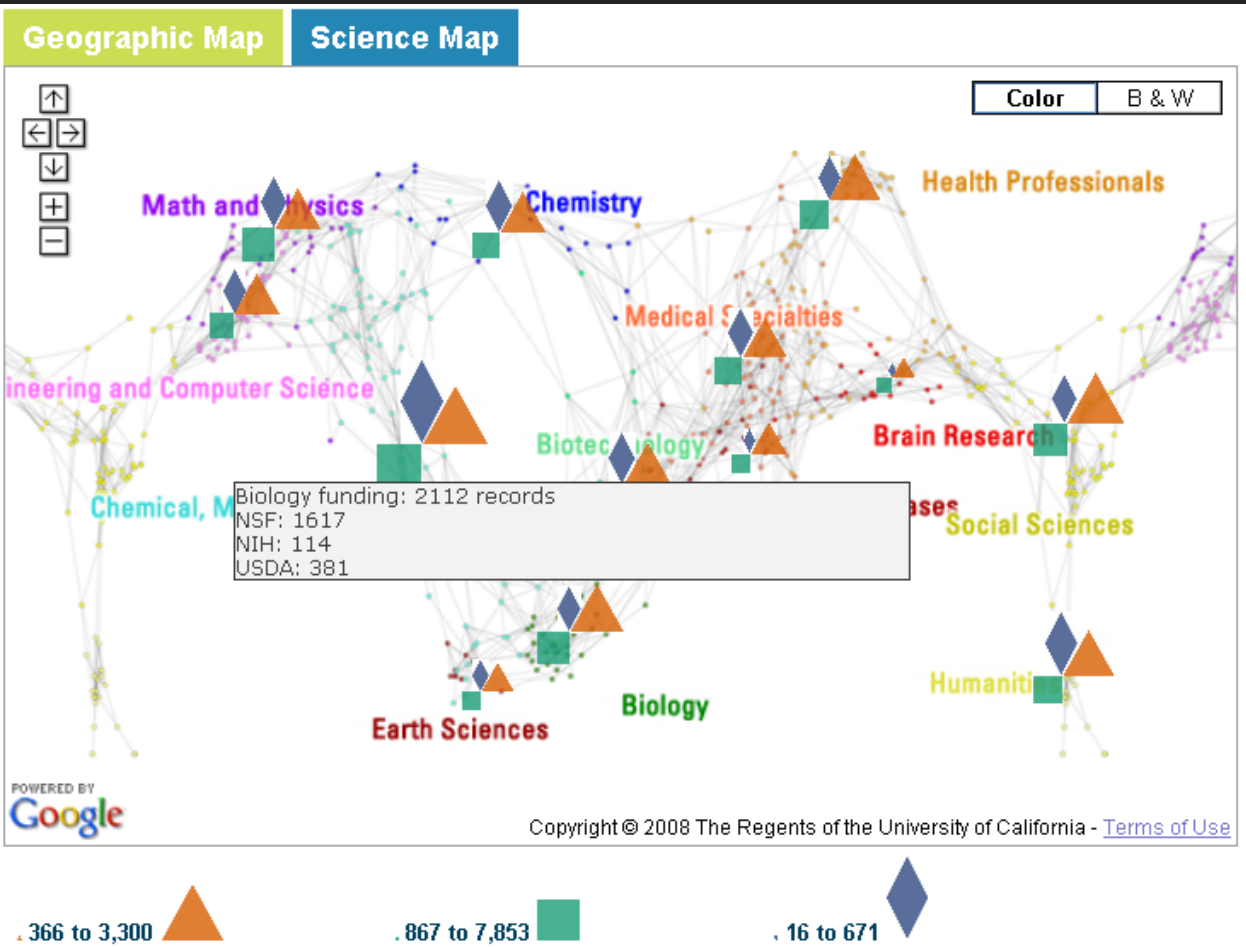
- Enzymatic Hydrolysis And Fermentation Of Corn For Fuel Alcohol



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



Search result for "Miscanthus," a special energy biomass crops for second generation biofuel.



Maps **Detail** Data Ab

> Biology

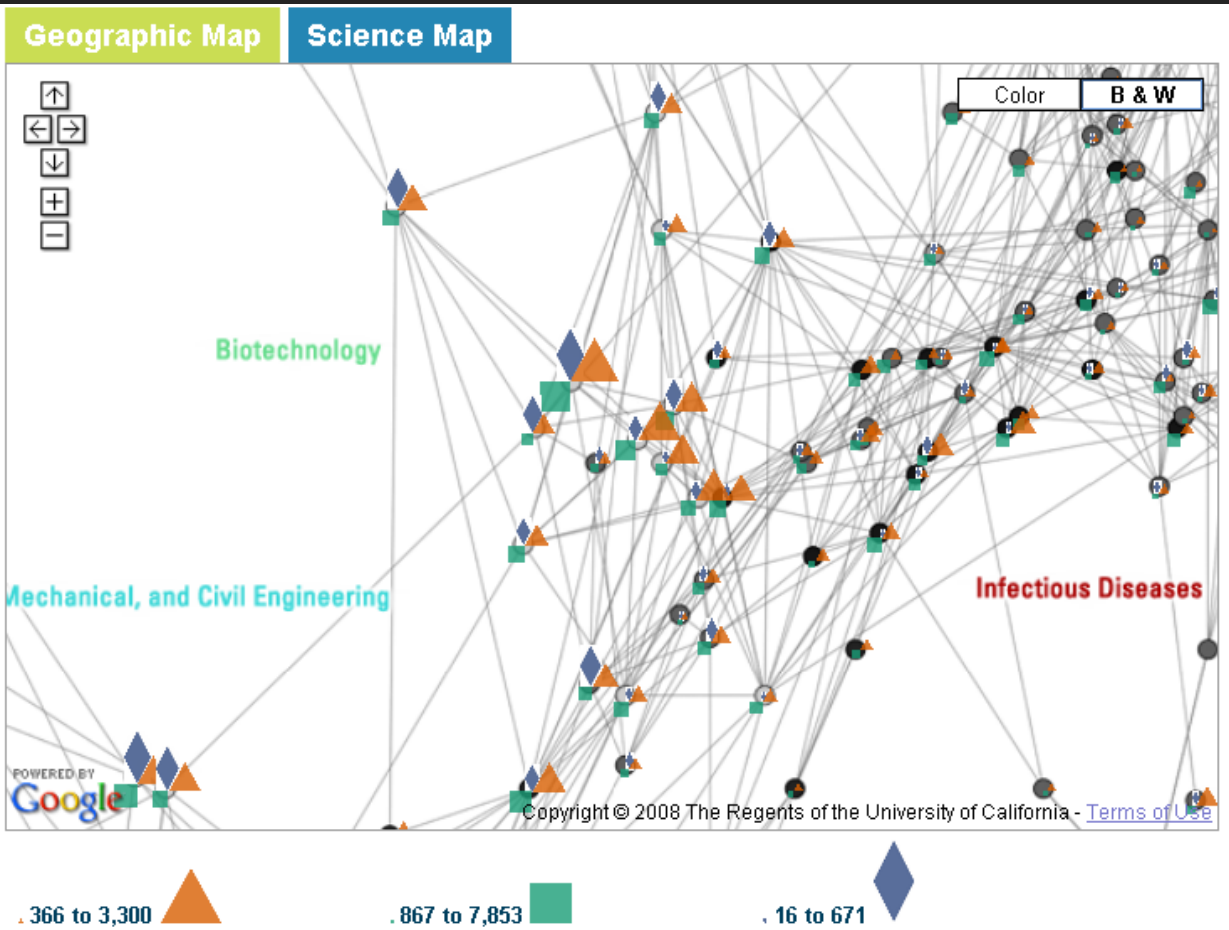
NIH
2009

- Label-Free And Simultaneous Detection Of Multiple Bacterial Pathogens And Virulen
- Mechanism Of Psrp 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 Psrp 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

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



Maps **Detail** Data Abou

> Chemistry

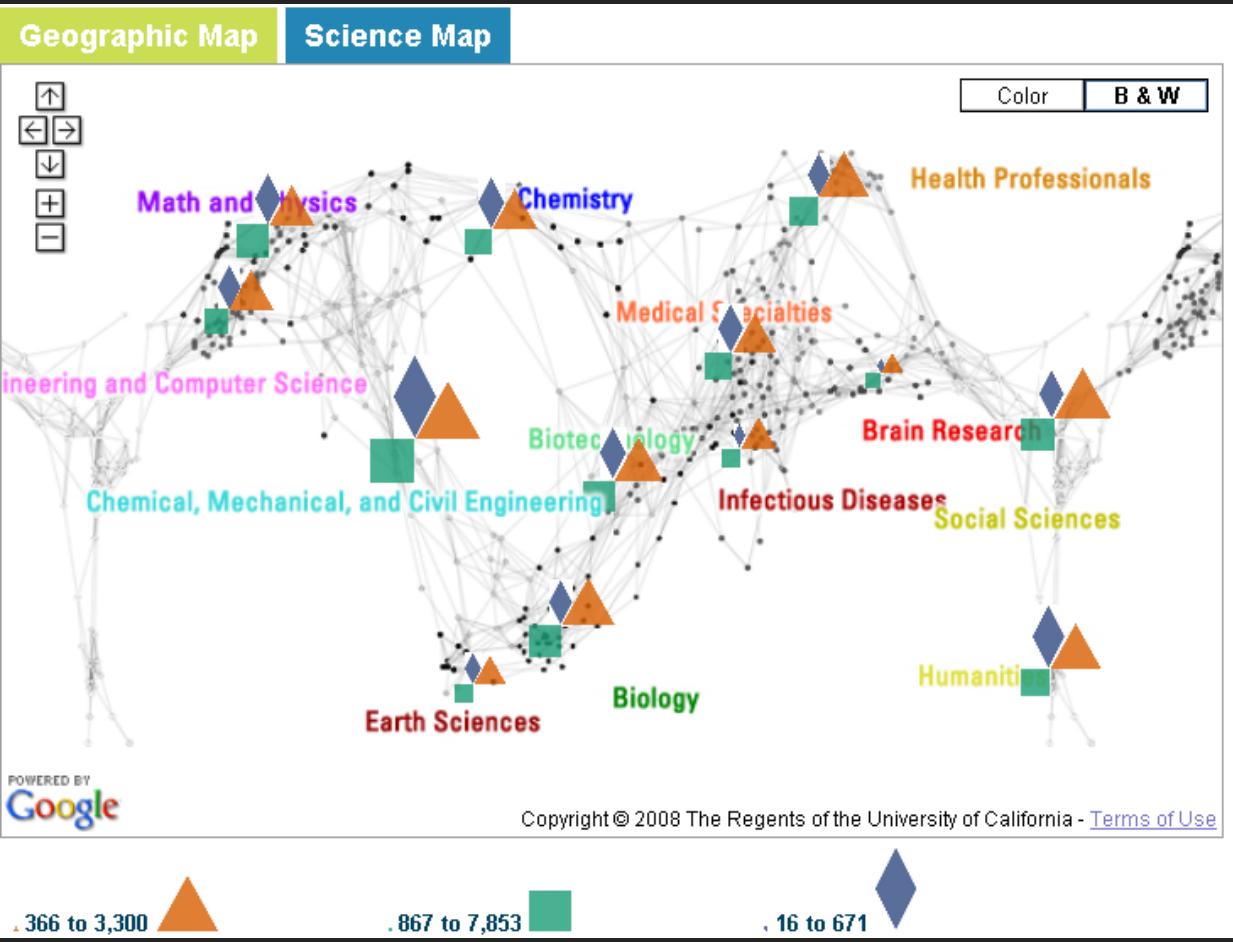
USPTO
2009

- 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**.



Maps **Detail** Data Abou

> Chemistry

USPTO
2009

- Automated Accelerated Extraction Of Trace Elements From Biomass
- Biomass Based Michael Addition Compositions

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- Thermal Tolerant Avicelase From
- Chitosan And Method Of Preparing Chitosan
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- Light Sensing Instrument With Modulated Polychromatic Source
- Method For Purifying Water
- Synthesis Of Caprolactam From Lysine

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(1 of 1)

United States Patent **7,364,890**

Ding , et al. **April 29, 2008**

Thermal tolerant avicelase from Acidothermus cellulolyticus

Abstract

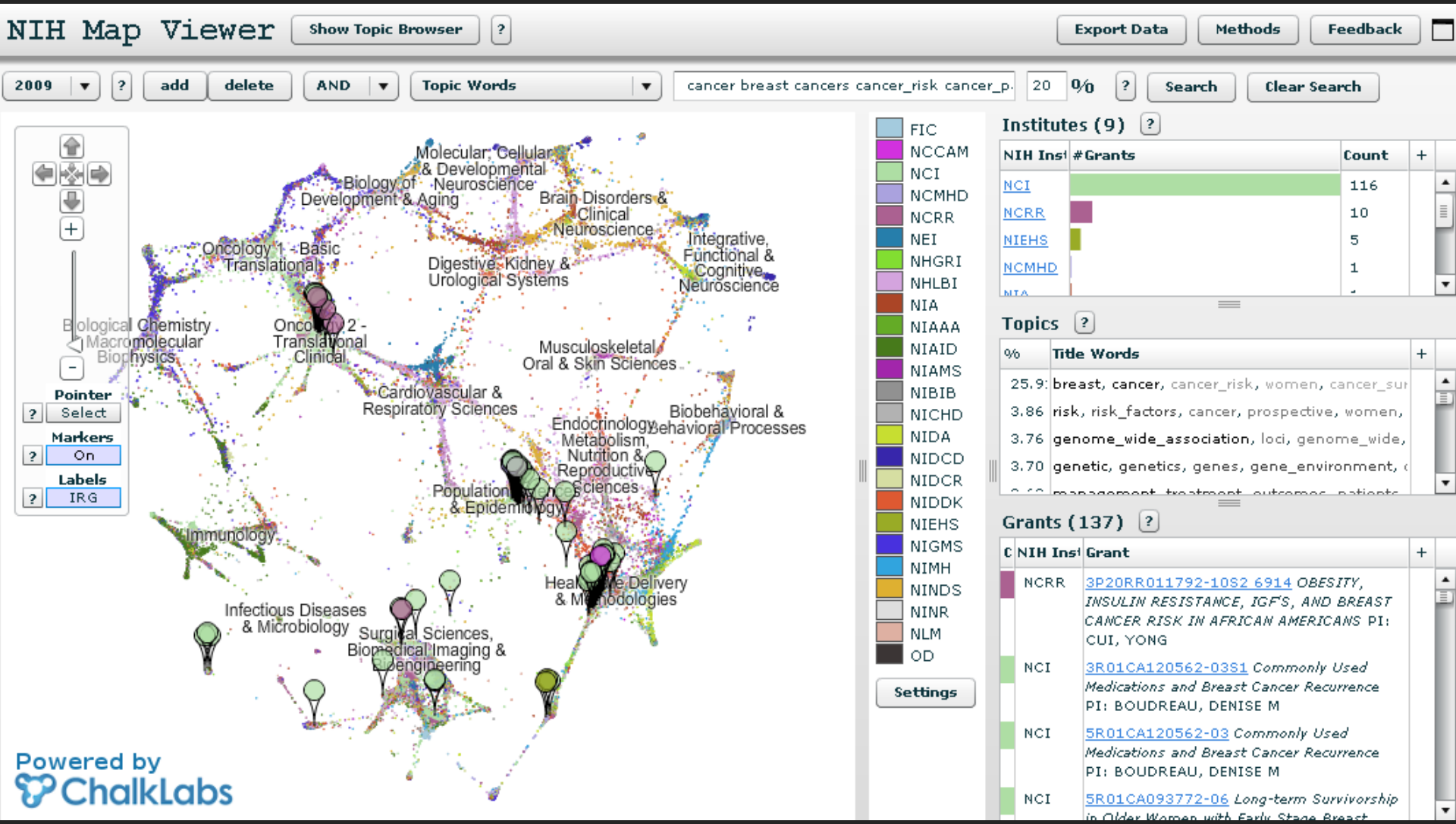
The invention provides a thermal tolerant (thermostable) cellulase, AviIII, that is a member of the glycoside hydrolase (GH) family. AviIII was isolated and characterized from Acidothermus cellulolyticus and, like many cellulases, the disclosed polypeptide and/or its derivatives may be useful for the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

Inventors: **Ding; Shi-You** (Golden, CO), **Adney; William S.** (Golden, CO), **Vinzant; Todd B.** (Golden, CO), **Himmel; Michael E.** (Littleton, CO)

Assignee: **Midwest Research Institute** (Kansas City, MO)

Appl. No.: 09/917,376

Done



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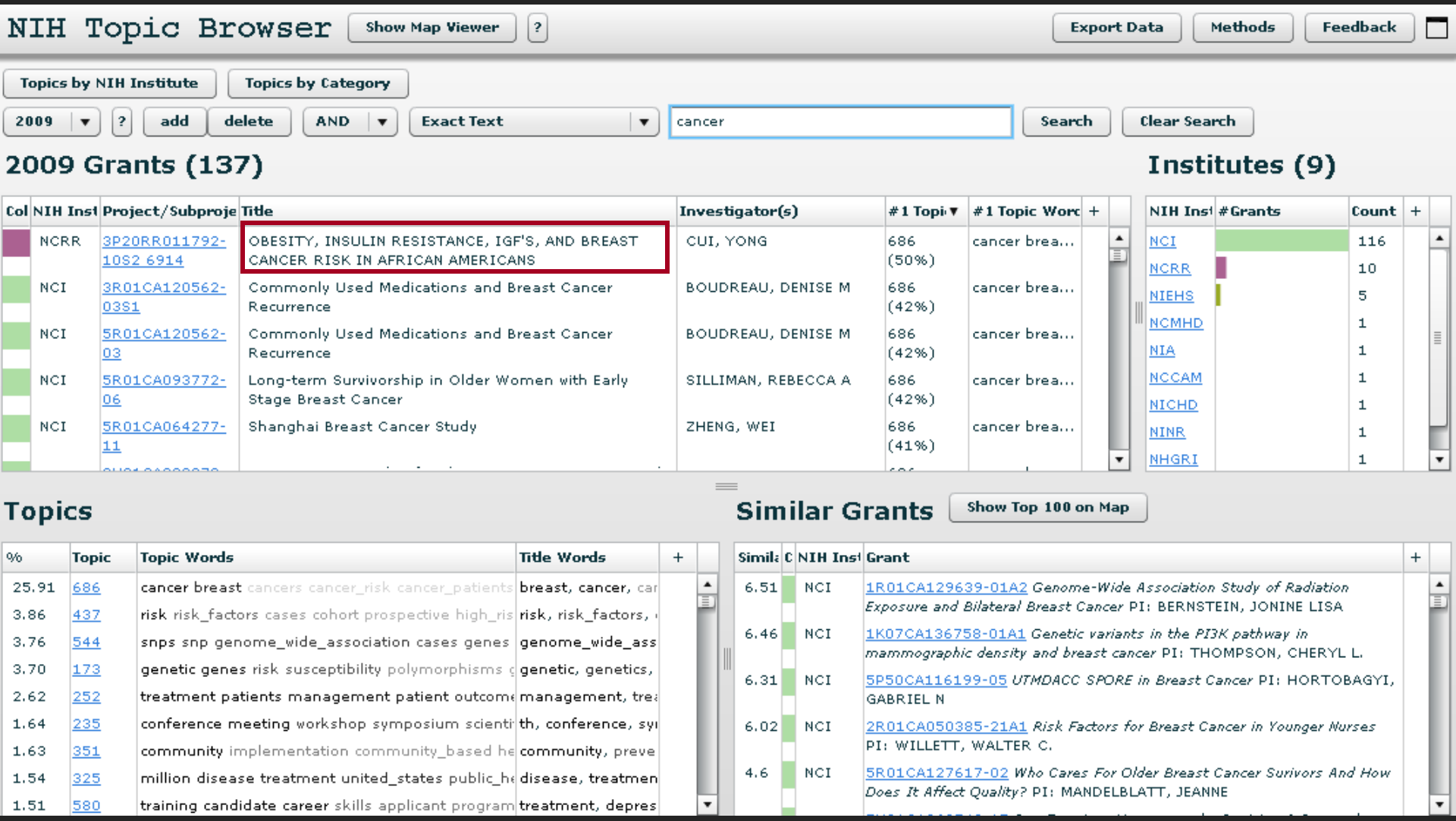

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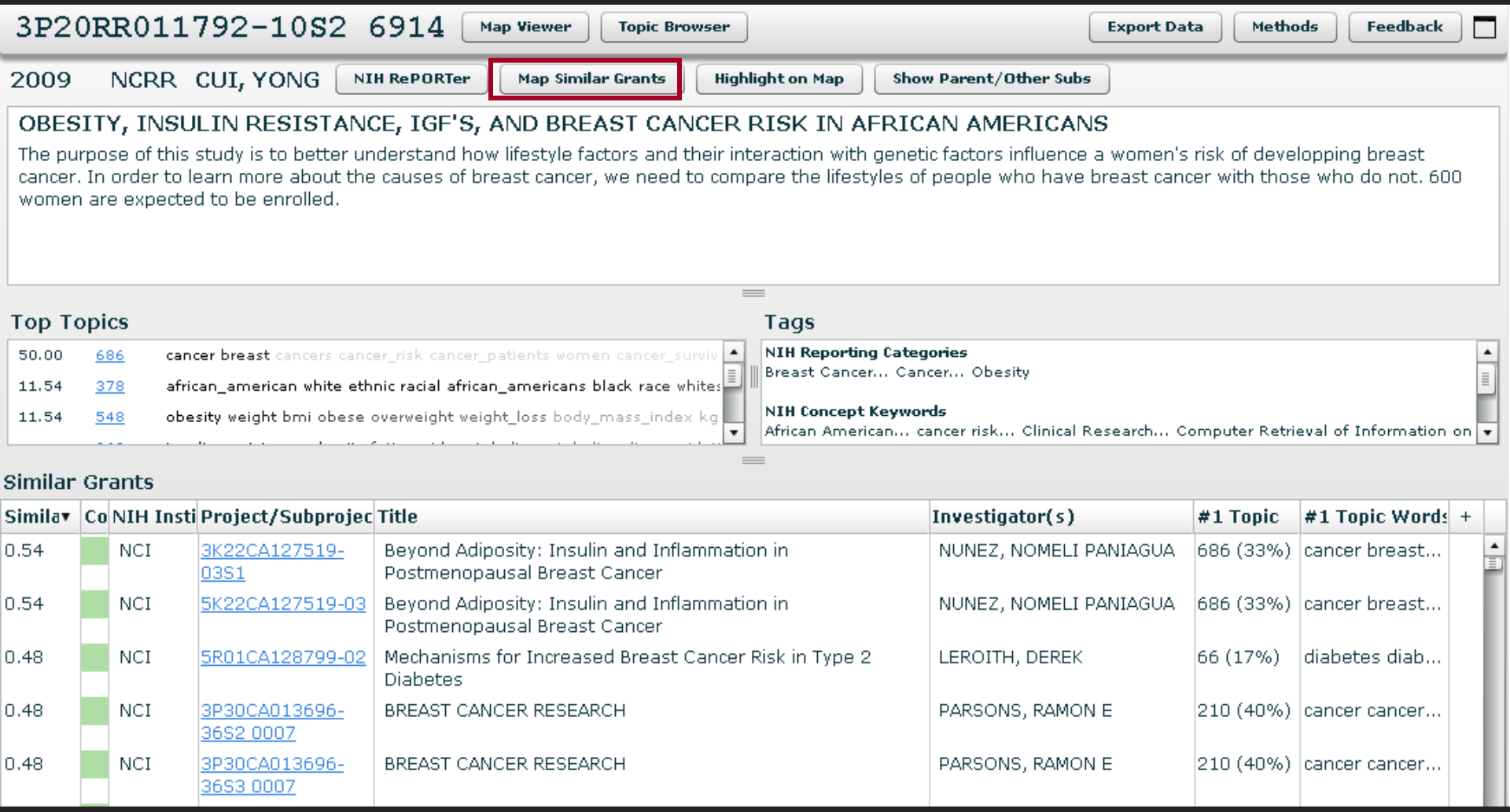

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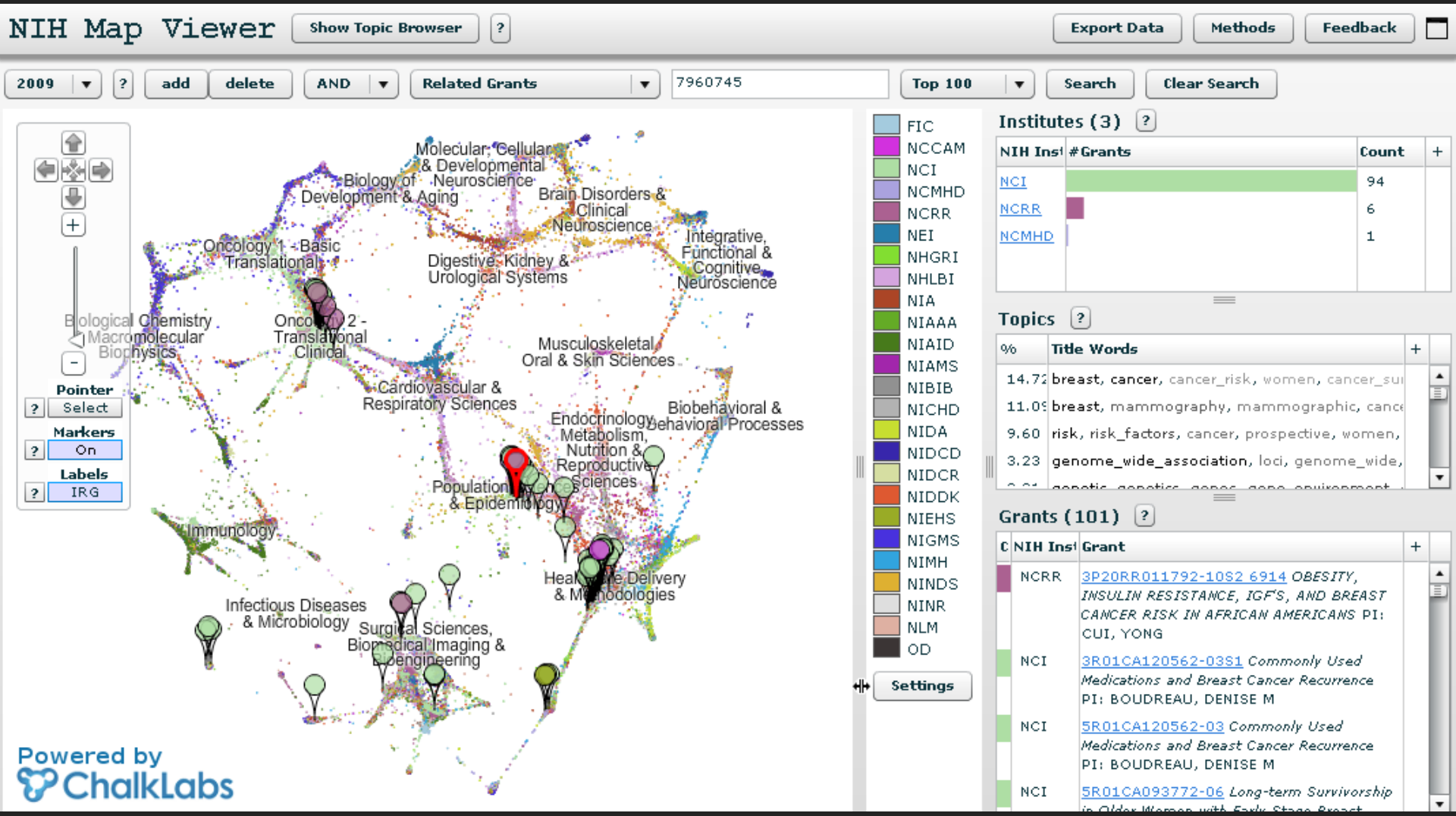

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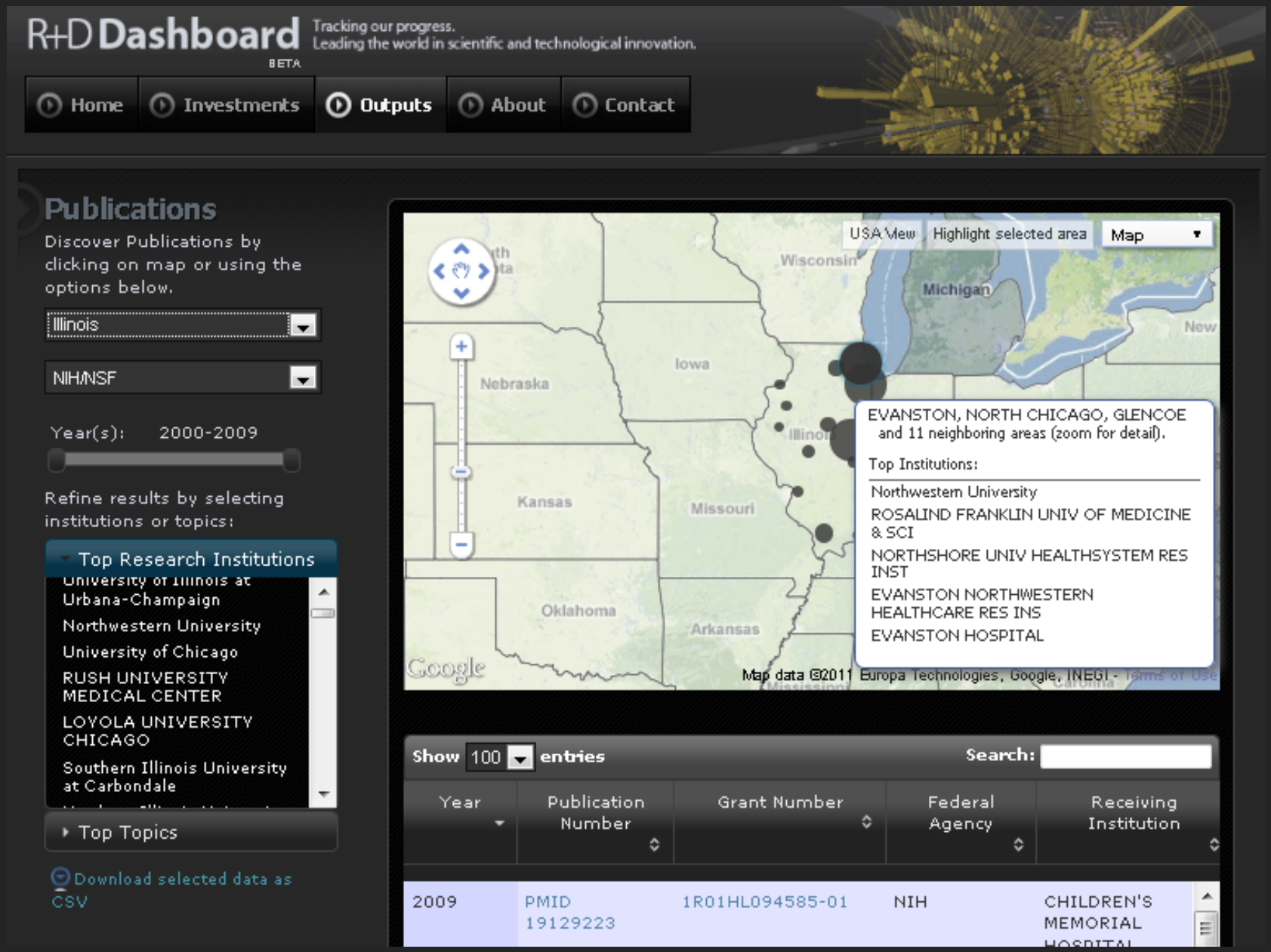

http://rd-dashboard.nitrd.gov/pub.html

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Publications

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Illinois

National Science Foundation

Year(s): 2000-2009

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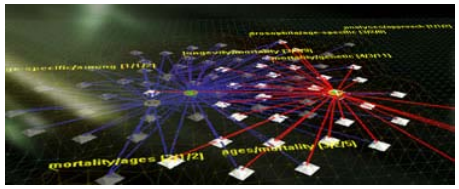
Year	Publication Number	Grant Number	Federal Agency	Receiving Institution
2009	PUB 5767715	0848647	NSF	American Bar Foundation

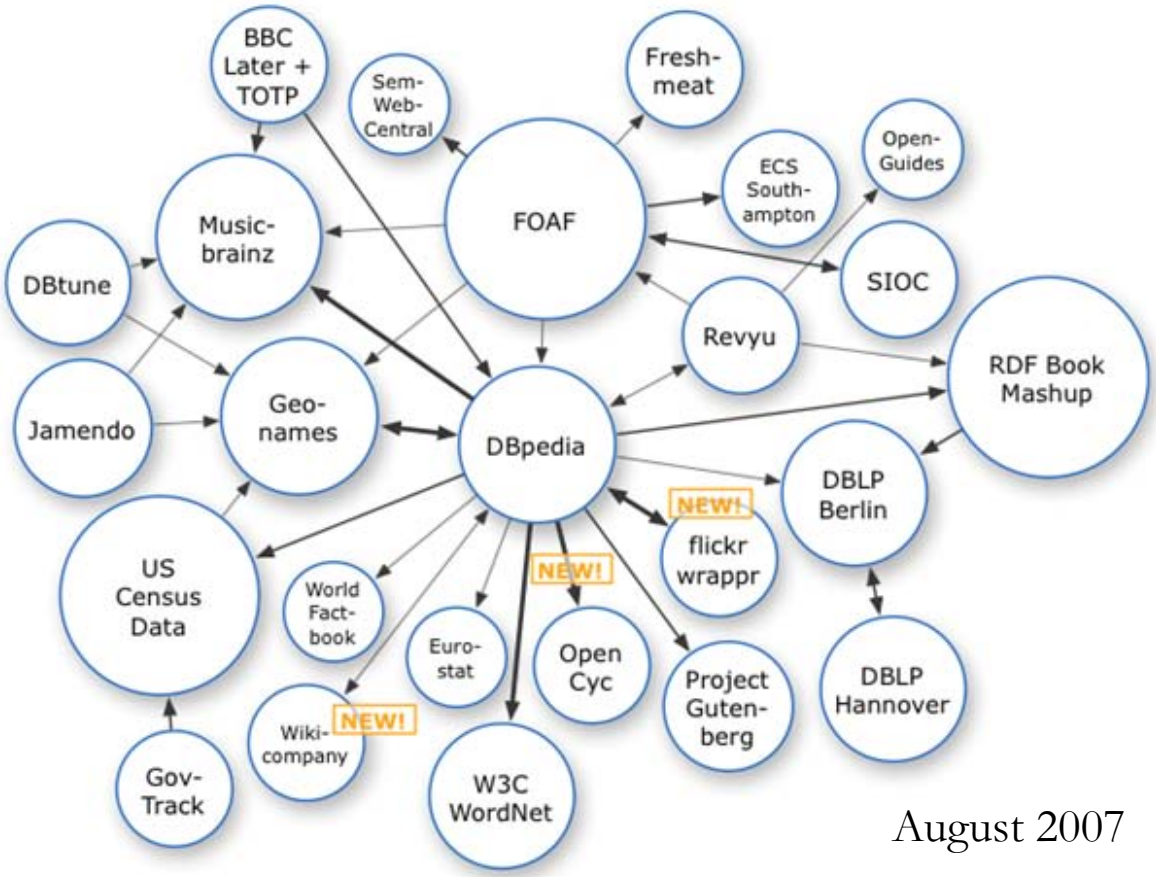
S&T Studies Using Semantic Web Data

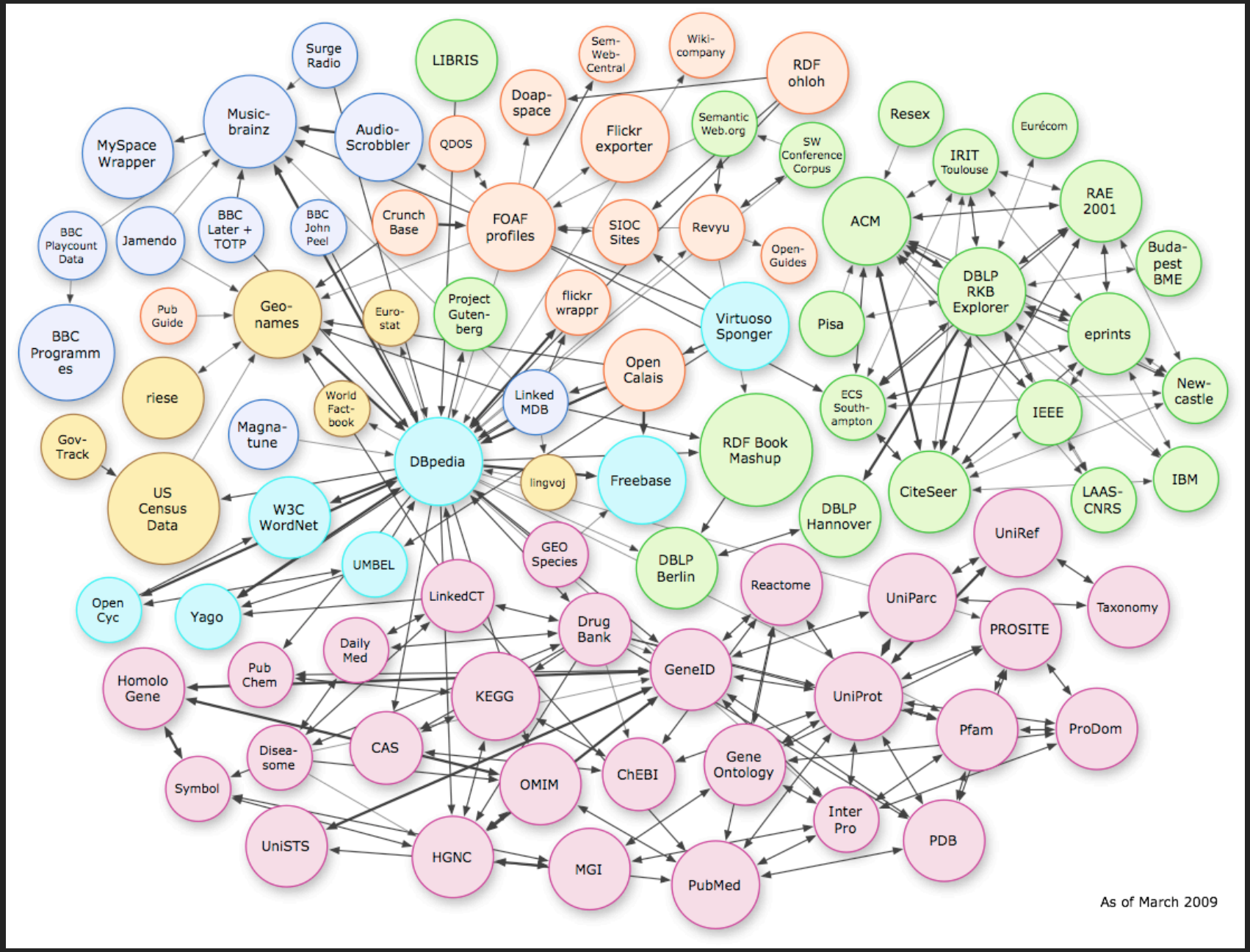


Linked Open Data

- Interlinking existing data silos and
- Exposing them as structured data
- Adding new high quality data relevant for S&T studies

http://linkeddata.org





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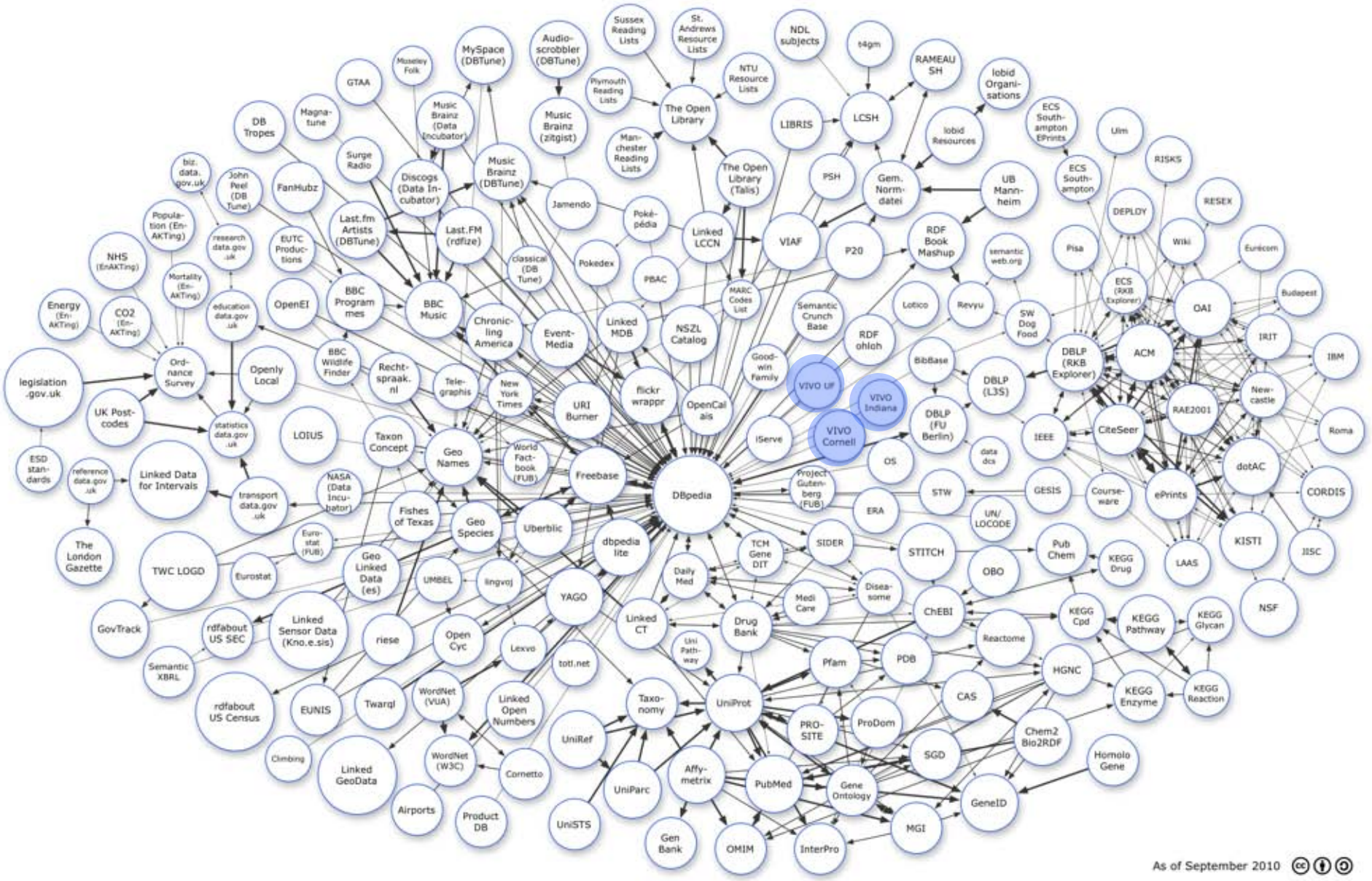
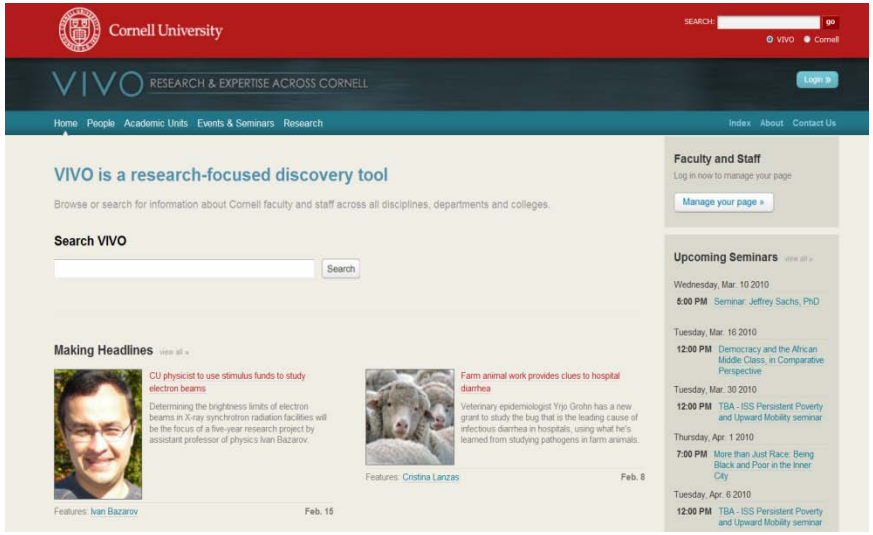


As of September 2010

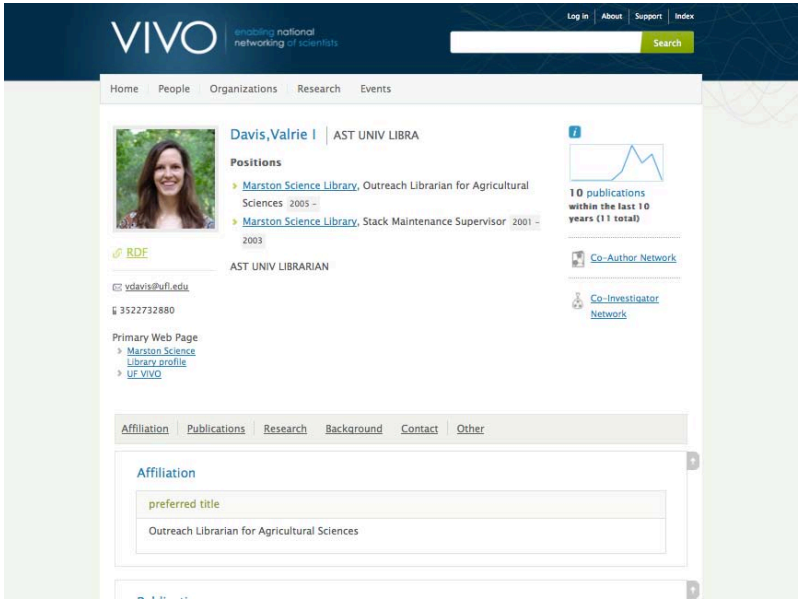
VIVO: A Semantic Approach to Creating a National Network of Researchers (http://vivoweb.org)

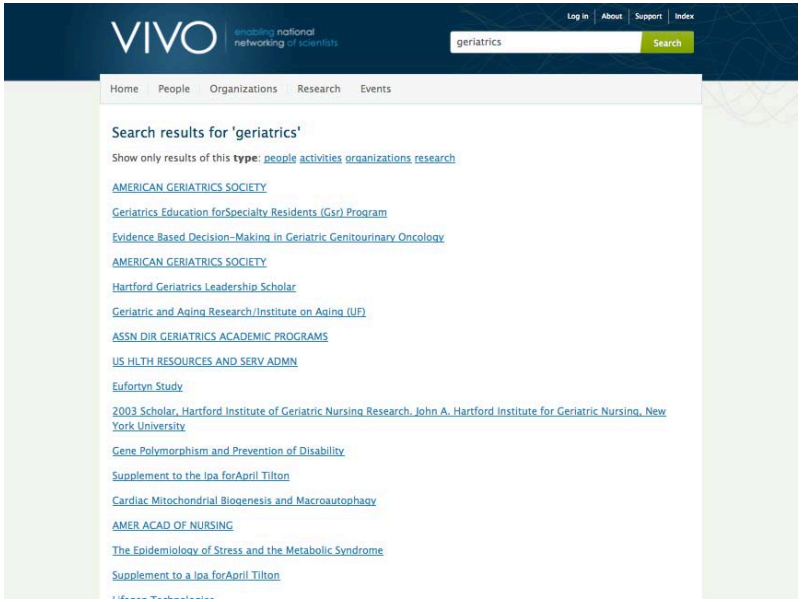
- Semantic web application and ontology editor originally developed at Cornell U.
- Integrates research and scholarship info from systems of record across institution(s).
- Facilitates research discovery and cross-disciplinary collaboration.
- Simplify reporting tasks, e.g., generate biosketch, department report.

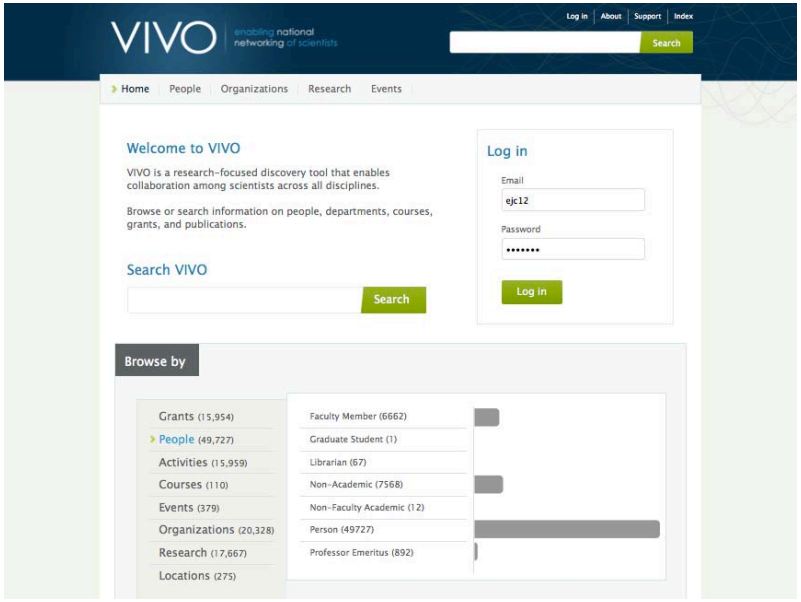


Funded by $12 million NIH award.

Cornell University: Dean Krafft (Cornell PI), Manolo Bevia, Jim Blake, Nick Cappadona, Brian Caruso, Jon Corson-Rikert, Elly Cramer, Medha Devare, John Fereira, Brian Lowe, Stella Mitchell, Holly Mistlebauer, Anup Sawant, Christopher Westling, Rebecca Younes. **University of Florida:** Mike Conlon (VIVO and UF PI), Cecilia Botero, Kerry Britt, Erin Brooks, Amy Buhler, Ellie Bushhousen, Chris Case, Valrie Davis, Nita Ferree, Chris Haines, Rae Jesano, Margeaux Johnson, Sara Kreinest, Yang Li, Paula Markes, Sara Russell Gonzalez, Alexander Rockwell, Nancy Schaefer, Michele R. Tennant, George Hack, Chris Barnes, Narayan Raum, Brenda Stevens, Alicia Turner, Stephen Williams. **Indiana University**: Katy Borner (IU PI), William Barnett, Shanshan Chen, Ying Ding, Russell Duhon, Jon Dunn, Micah Linnemeier, Nianli Ma, Robert McDonald, Barbara Ann O'Leary, Mark Price, Yuyin Sun, Alan Walsh, Brian Wheeler, Angela Zoss. **Ponce School of Medicine:** Richard Noel (Ponce PI), Ricardo Espada, Damaris Torres. **The Scripps Research Institute:** Gerald Joyce (Scripps PI), Greg Dunlap, Catherine Dunn, Brant Kelley, Paula King, Angela Murrell, Barbara Noble, Cary Thomas, Michaeleen 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.

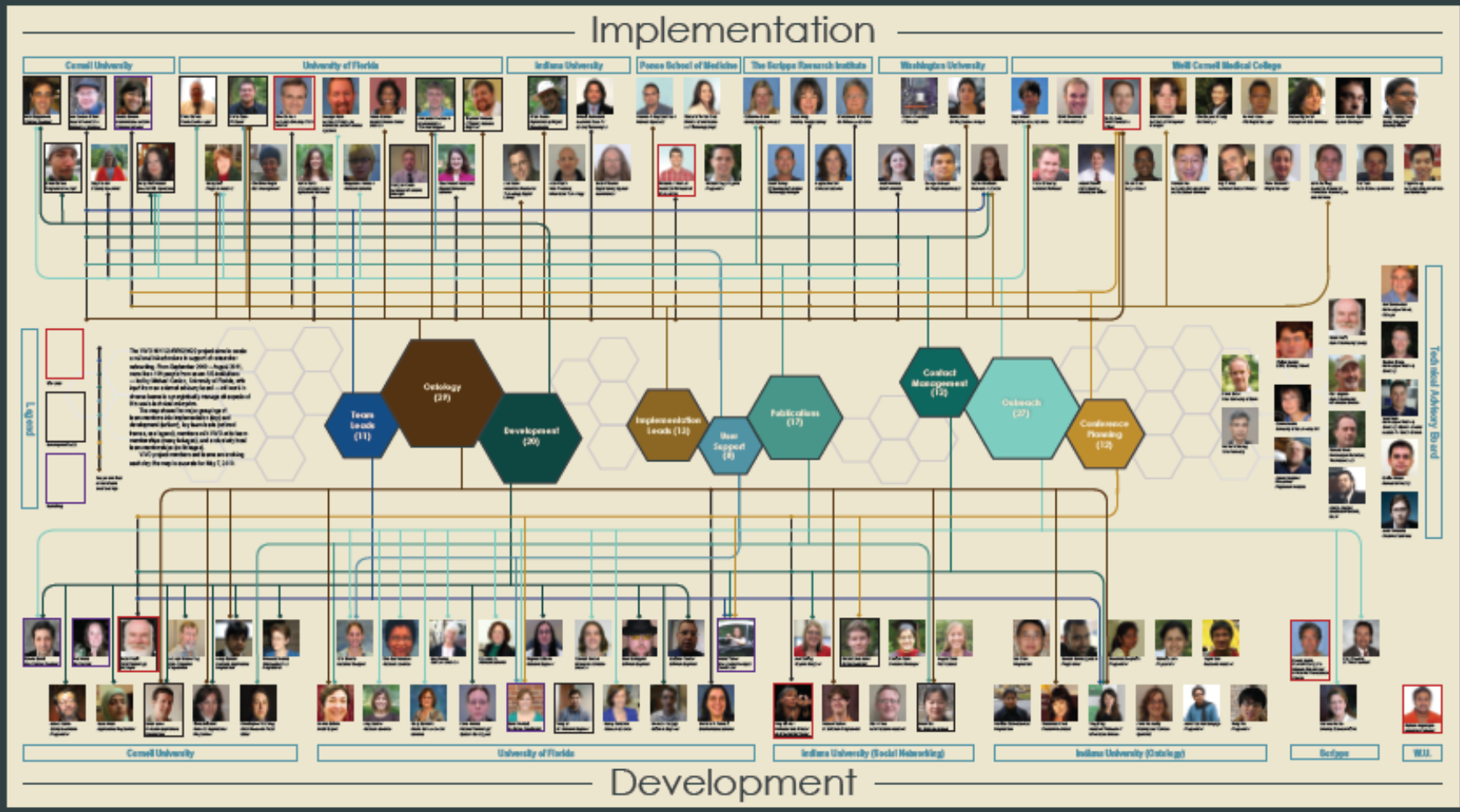






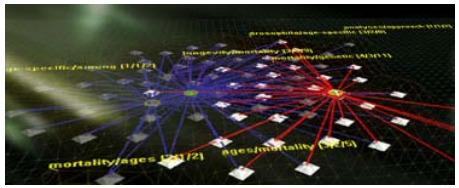
UF Clinical and Translational Science Institute
UNIVERSITY of FLORIDA

VIVO Enabling National Networking of Scientists
Project Members and Teams



Please send comments and questions to Jeni Coffey <coffeyje@indiana.edu> (design) and Valrie I. Davis <vdavis@ufl.bvu.edu> (data acquisition) and Katy Börner (concept).
For more information, visit www.vivoweb.org.

2010.05.07



Type of Analysis vs. Level of Analysis

	Micro/Individual (1-100 records)	*Meso/Local (101–10,000 records)*	*Macro/Global (10,000 < records)*
Statistical Analysis/Profiling	Individual person and their expertise profiles	Larger labs, centers, universities, research domains, or states	All of NS SA, all of scie
Temporal Analysis (When)	Funding portfolio of one individual	ic bursts f PNAS	113 Years of P Research
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a st intellectual la	PNAS
Topical Analysis (What)	s.	e flows in research	VxOrd/Topic m NIH funding
Network Analysis (With Whom?)	NSF work of one	k	NIH's cy

University of Florida

VIVO
Enabling a National Network of Scientists

How do you want to compare?

by Grants

Who do you want to compare?

Search: X

Records 1 - 10 of 30 « First ‹ Prev Next › Last »

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

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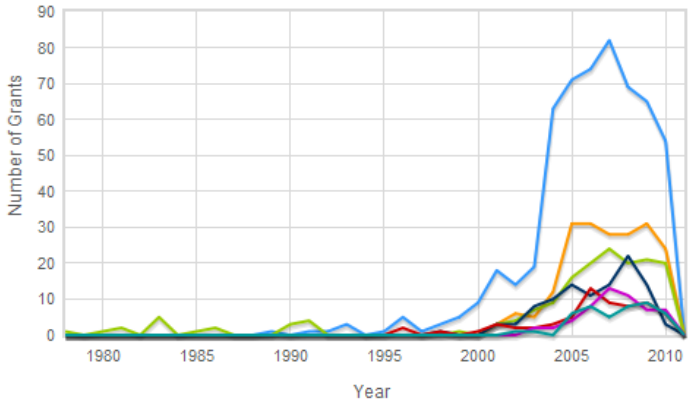
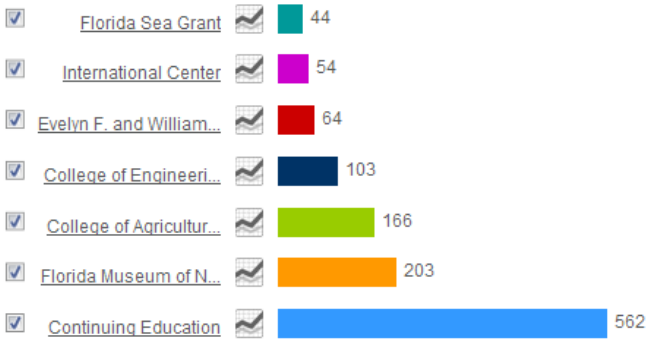
Comparing **Grants** of **Organizations** in University of Florida

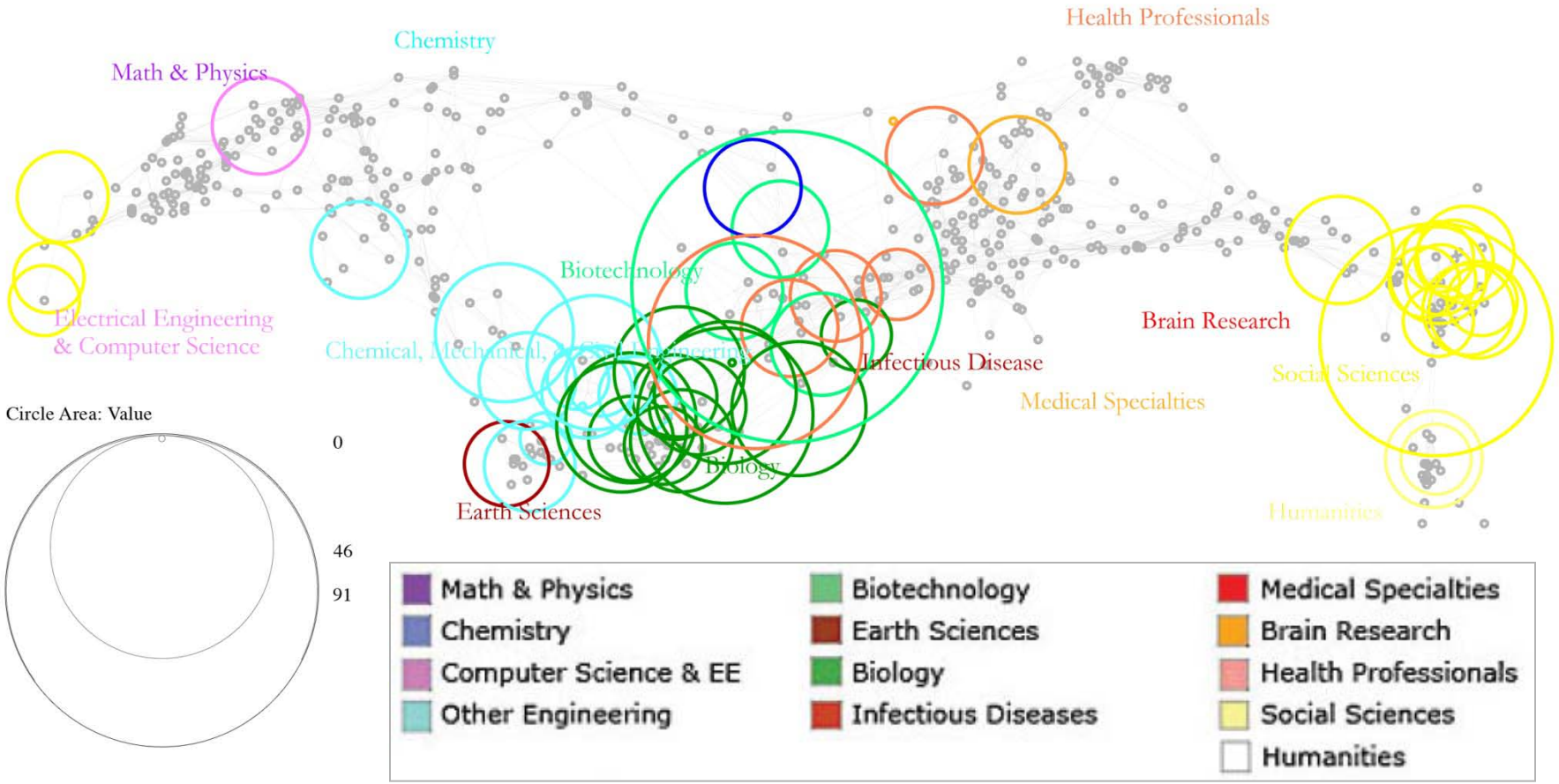


Total Number of Grants

You have selected 7 of a maximum 10 *organizations* to compare. Clear



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



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

Conlon, Mike

Co-Investigator Network

Associate Director and Chief Operating Officer

Co-Author Network (GraphML File)

Profile

Conlon, Mike

Associate Director and Chief O...

VIVO profile | Co-author network

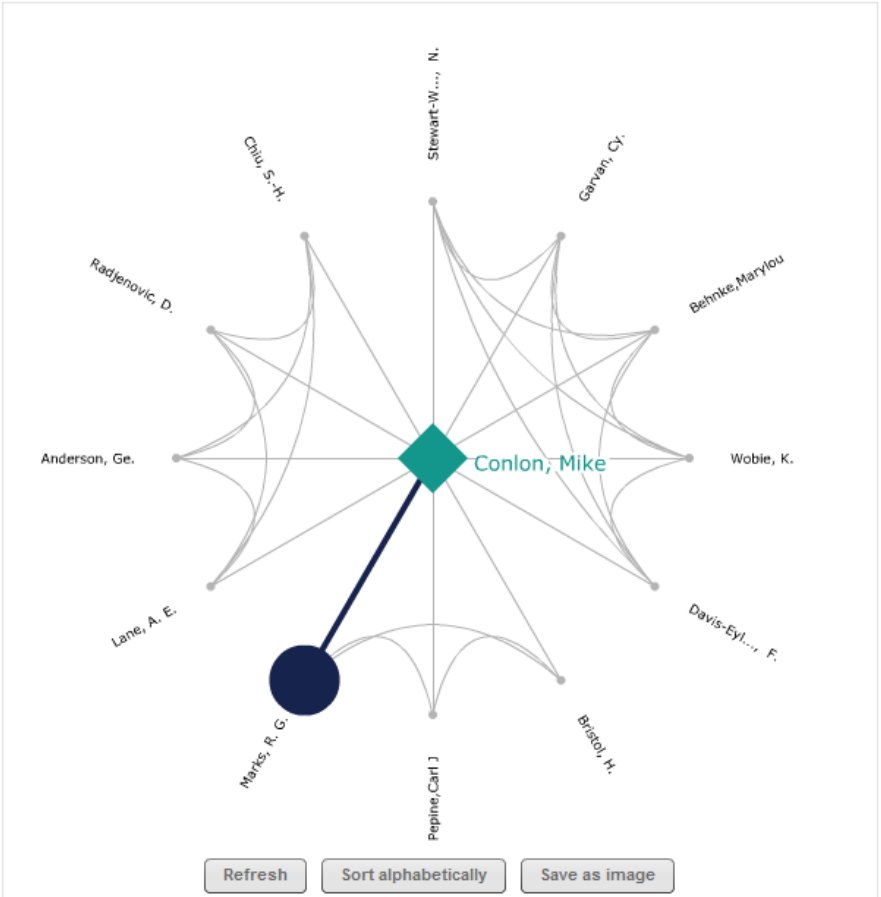
5 Publication(s)

12 Co-author(s)

1991 First Publication

2004 Last Publication

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



Interact

Hover over any name to see the number of joint publications and co-authors with Conlon, Mike.

Legend

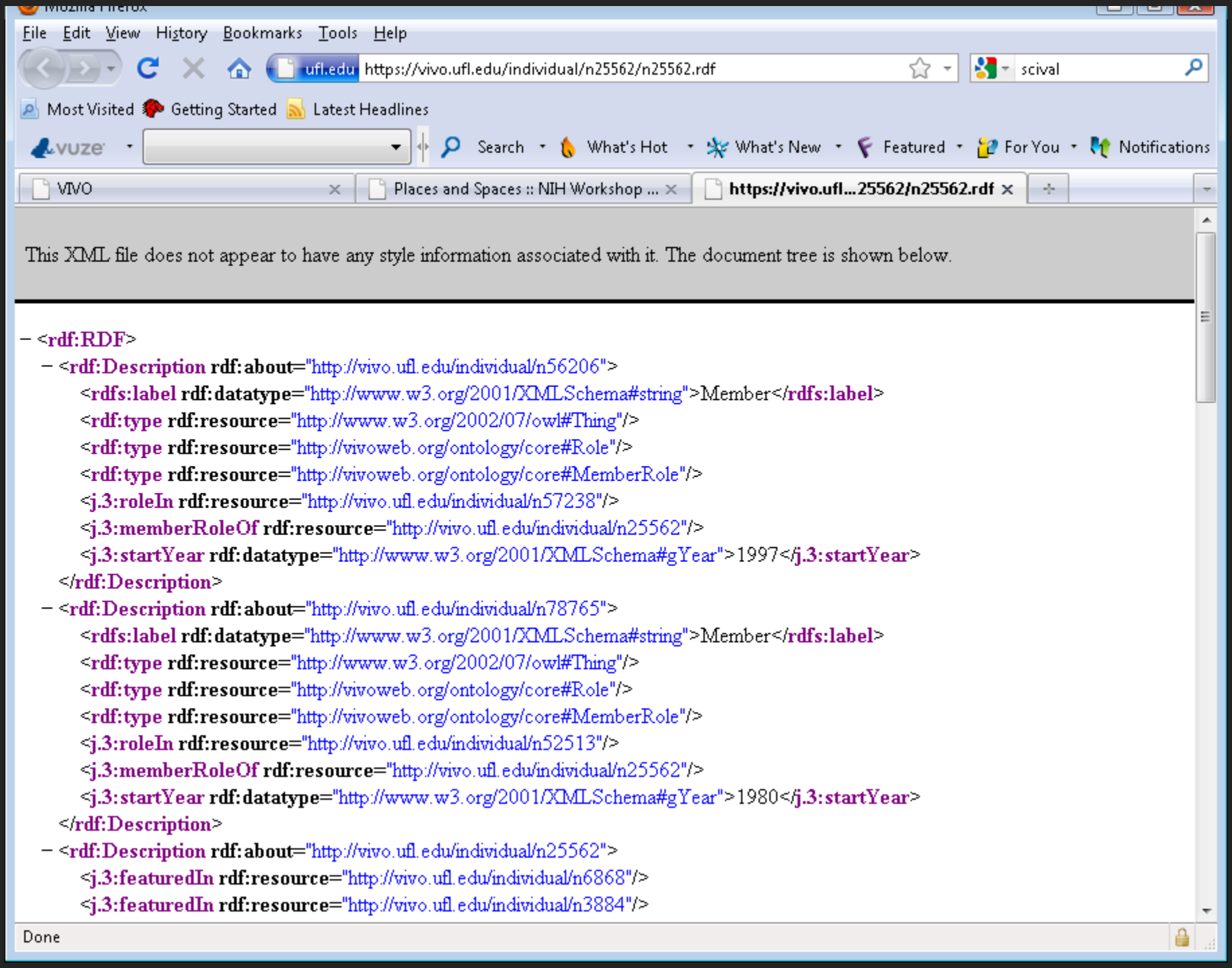
No. of co-author(s) — No. of time(s) co-authored

1 — 1

2 — 2

Enabling a National Network of Scientists

Network Analysis (With Whom?) Who is co-authoring, co-investigating, co-inventing with whom? What teams are most productive in what projects?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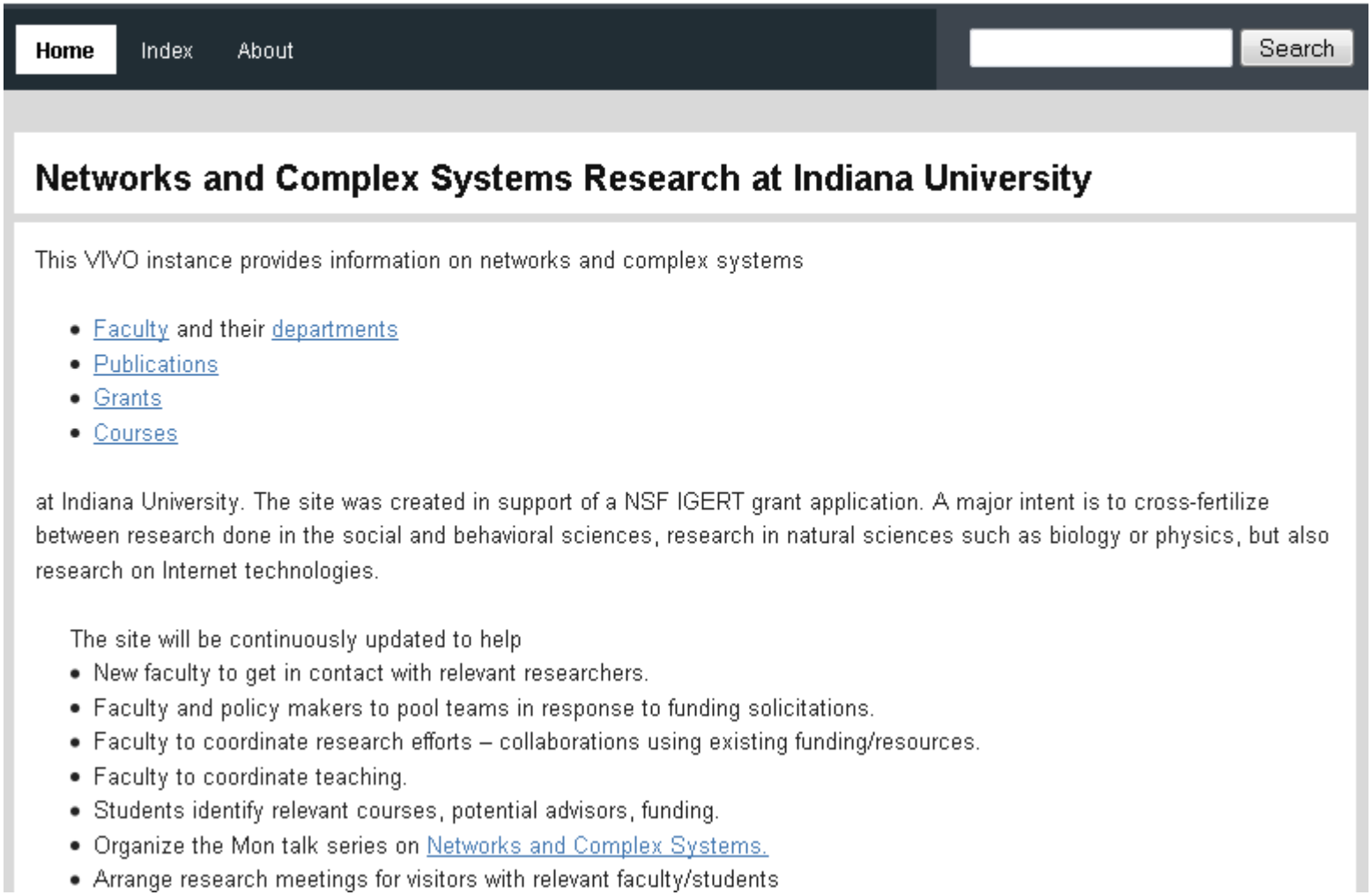
VIVO enabling national networking of scientists

VIVO Enabling a National Network of Scientists



http://vivo-netsci.cns.iu.edu

Co-Investigator Network (GraphML File)

Profile

Daniels,Michael Joseph

PROFESSOR

VIVO profile | Co-investigator network

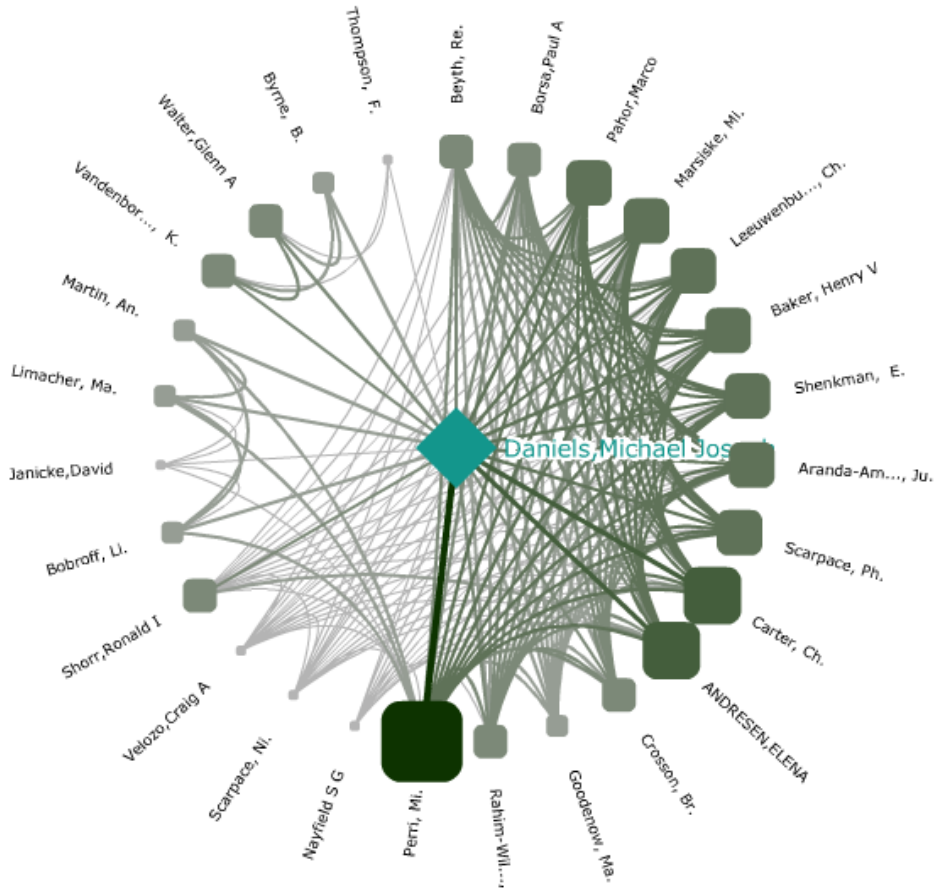
17 Grant(s)

27 Co-investigator(s)

2003 First Grant

2010 Last Grant

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



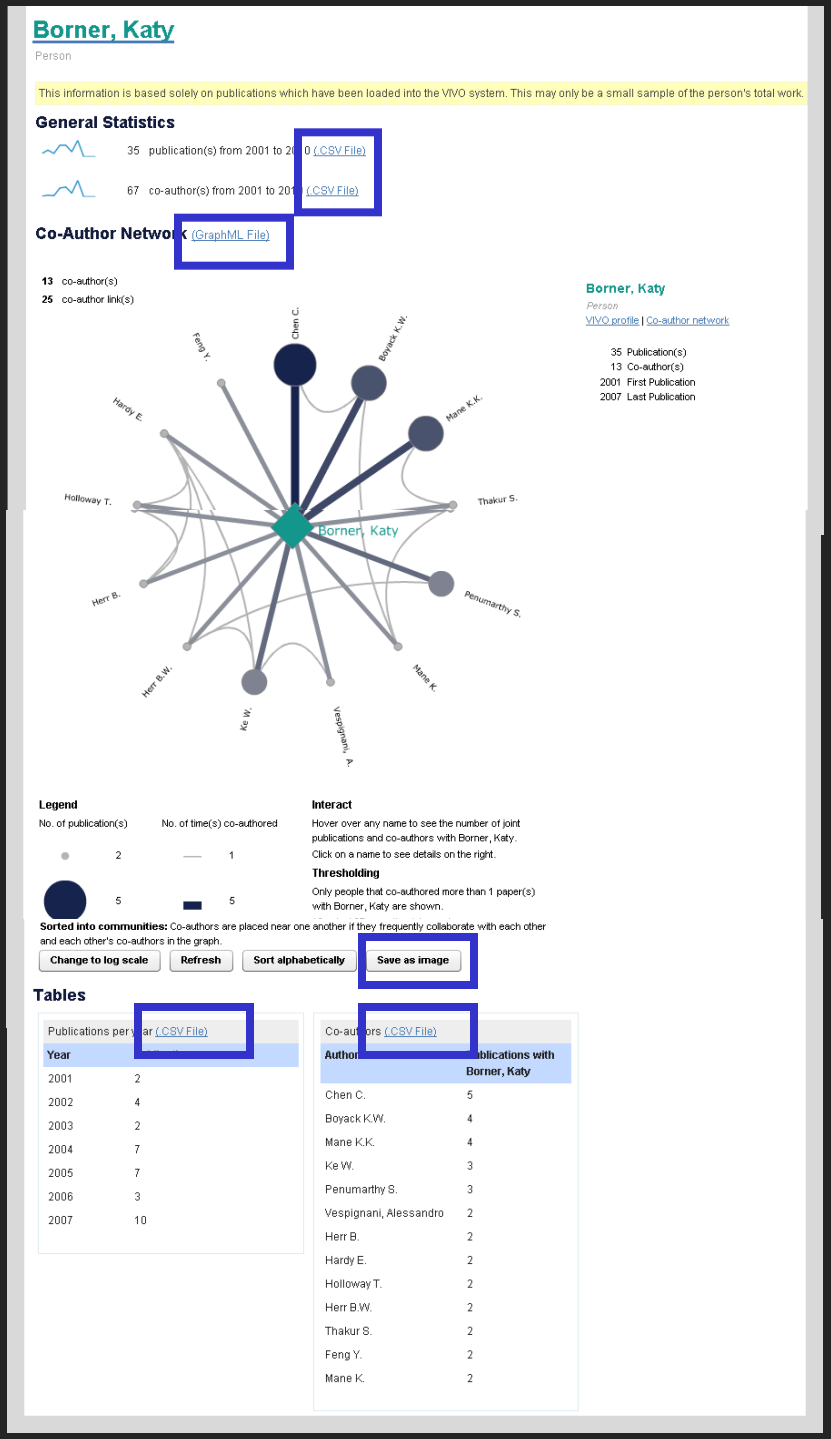
Interact

Hover over any name to see the number of joint grants and co-investigators with Daniels,Michael Joseph.

Legend

No. of co-Investigator(s)		No. of time(s) co-investigated	
	1		1
	7		7

Sorted into communities: Co-investigators are placed near one another if they frequently co-investigate grants.



Data Download Support

General Statistics

- 36 publication(s) from 2001 to 2010 (.CSV File)
- 80 co-author(s) from 2001 to 2010 (.CSV File)

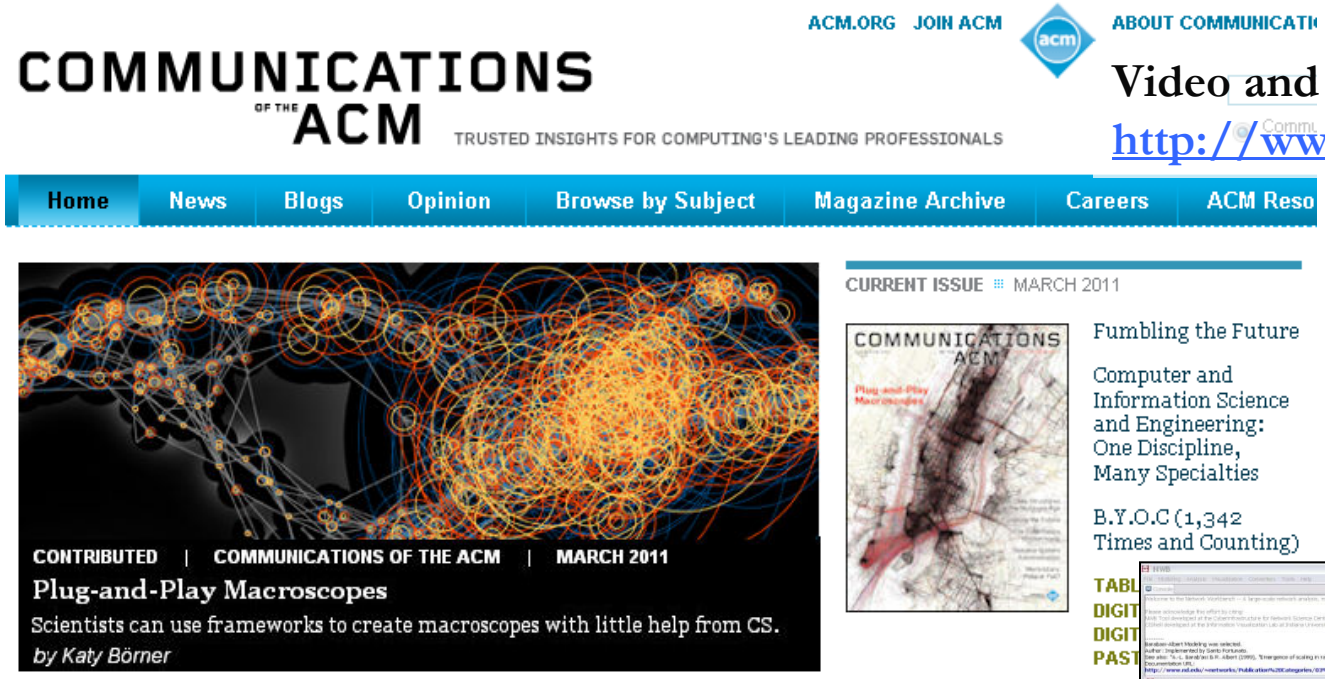
Co-Author Network

(GraphML File)

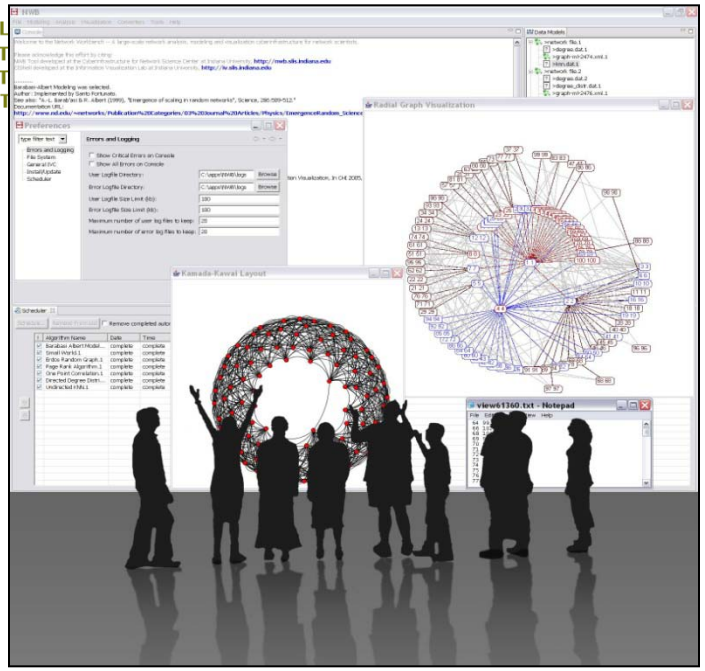
Save as Image (.PNG file)

Tables

- Publications per year (.CSV File)
- Co-authors (.CSV File)



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



VIVO Research Networking
http://vivoweb.org

Network Workbench Tool & Community Wiki
http://nwb.cns.iu.edu

Science of Science (Sci²) Tool
http://sci2.cns.iu.edu

Epidemics Cyberinfrastructure
http://epic.cns.iu.edu

OSGi Alliance

CIShell
cyberinfrastructure shell