

Cyberinfrastructure and Datasets for Science of Team Science Research

Katy Börner

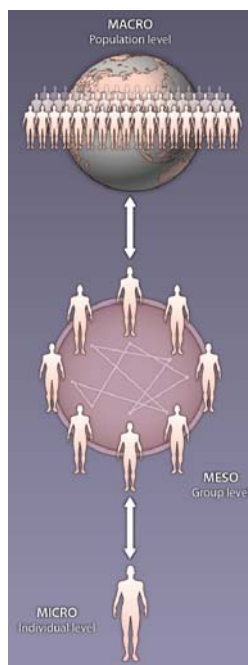
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Information Visualization Laboratory, Director
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With special thanks to the members at the Cyberinfrastructure for Network Science Center, the NWB team, the Sci2 team, the EpiC team, the VIVO Collaboration, and the Science of Team Science Conference Program Committee.

*Second Annual International Science of Team Science Conference
Chicago, IL*

April 13, 2011



TEAM SCIENCE

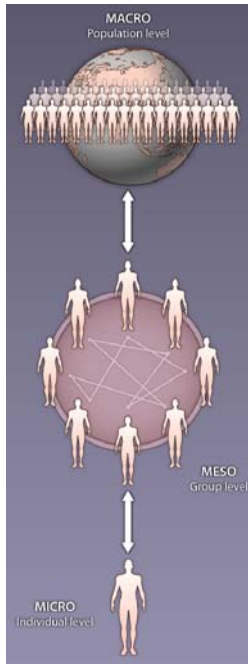
A Multi-Level Systems Perspective for the Science of Team Science

Katy Börner,^{1*} Noshir Contractor,² Holly J. Falk-Krzesinski,³ Stephen M. Fiore,⁴ Kara L. Hall,⁵ Joann Keyton,⁶ Bonnie Spring,⁷ Daniel Stokols,⁸ William Trochim,⁹ Brian Uzzi¹⁰

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This Commentary describes recent research progress and professional developments in the study of scientific teamwork, an area of inquiry termed the “science of team science” (SciTS, pronounced “sahyts”). It proposes a systems perspective that incorporates a mixed-methods approach to SciTS that is commensurate with the conceptual, methodological, and translational complexities addressed within the SciTS field. The theoretically grounded and practically useful framework is intended to integrate existing and future lines of SciTS research to facilitate the field’s evolution as it addresses key challenges spanning macro, meso, and micro levels of analysis.

SciTS research and practice require an interdisciplinary, multi-level, mixed-methods approach. **Expertise, theories, methods, data, and tools** from diverse research fields need to be applied and advanced to arrive at a holistic understanding of the science system.



Mixed-methods, multi-level SciTS needs:

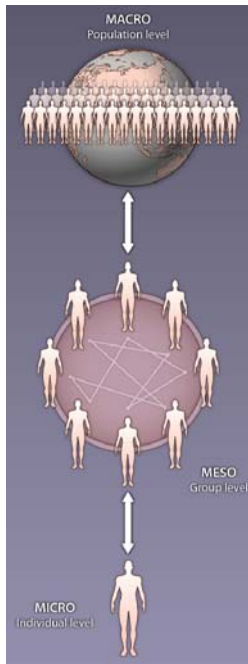
Expertise – identify and access it at the perfect moment using, e.g., Facebook, LinkedIn, Academia, VIVO, Harvard Profiles, Elsevier’s Collexis, Loki, Stanford’s CAP, or other systems.

Theories and Methods – find, understand, apply, advance them, e.g., using <http://scienceofteams.science.northwestern.edu/team-science-resources>.

Data – find, interlink, unify, merge, reformat, share them, e.g., using web sites analogous to <http://www.diggingintodata.org/Repositories/tabid/167/Default.aspx>, SDB, or LOD.

Tools – identify, learn, advance, share code, e.g., via Plug-and-Play Macroscopes, to arrive at a holistic understanding of the science system.

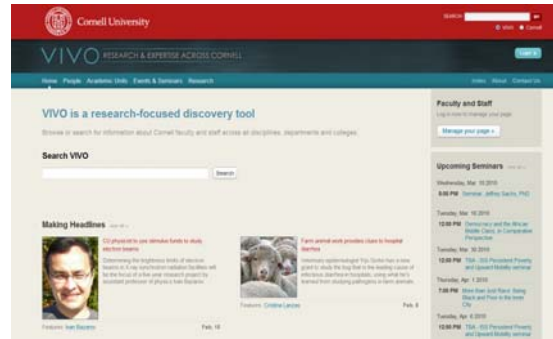
Note that the evolution of all of the above could be an extremely interesting and valuable SciTS study object.



Expertise – identify and access it at the perfect moment using, e.g., Facebook, LinkedIn, Academia, VIVO, Harvard Profiles, Elsevier’s Collexis, Loki, Stanford’s CAP, or other systems.

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

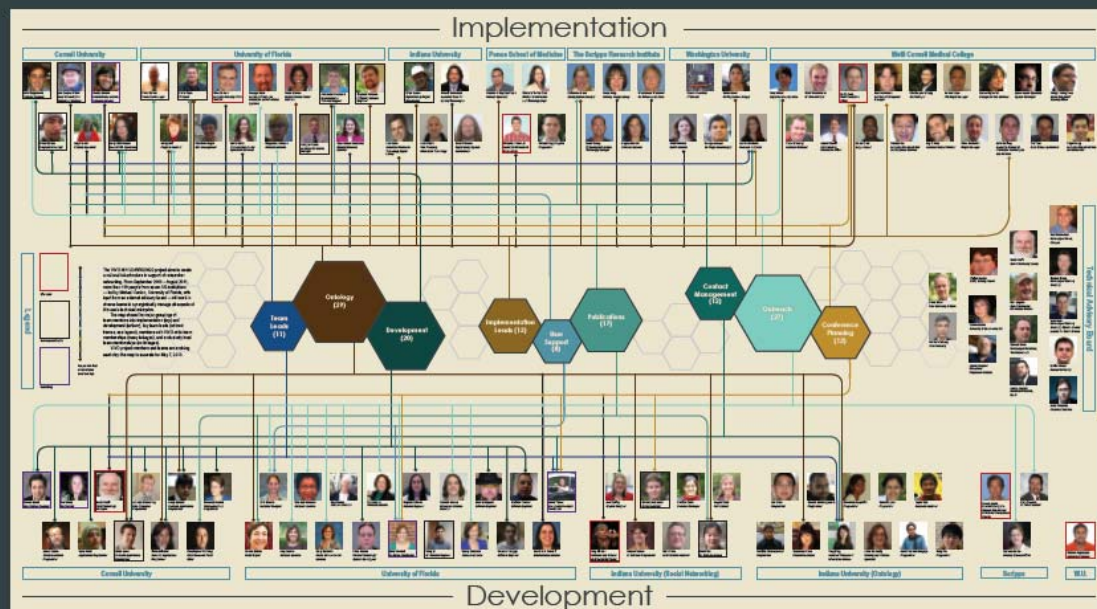
- Semantic web application and ontology editor originally developed at Cornell U.
- Integrates research and scholarship info from systems of record across institution(s).
- Facilitates research discovery and cross-disciplinary collaboration.
- Simplify reporting tasks, e.g., generate biosketch, department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

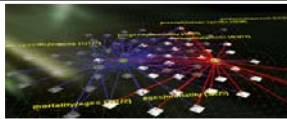
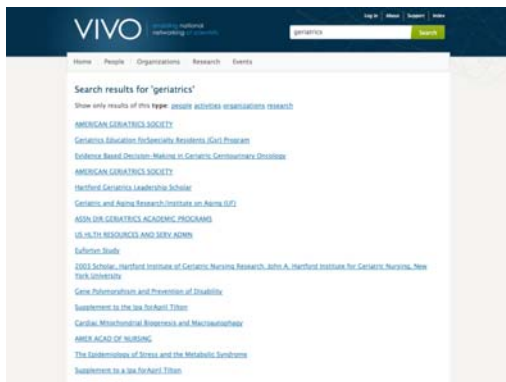
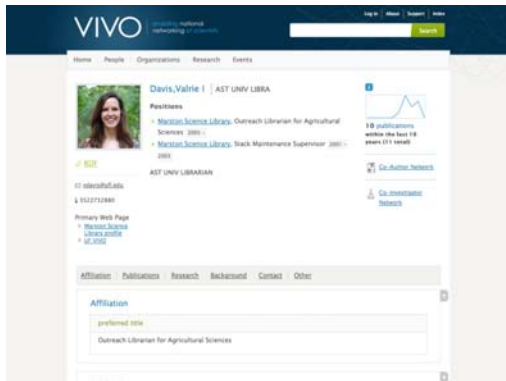


Funded by \$12 million NIH award.

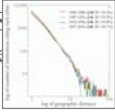

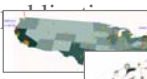
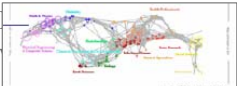


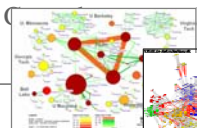
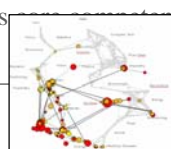
Cornell University: Dean Krafft (Cornell PI), Manolo Bevia, Jim Blake, Nick Cappadona, Brian Caruso, Jon Corson-Rikert, Elly Cramer, Medha Devare, John Ferreira, Brian Lowe, Stella Mitchell, Holly Mistlebauer, Anup Sawant, Christopher Westling, Rebecca Younes. **University of Florida:** Mike Conlon (VIVO 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 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, 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.

VIVO Enabling National Networking of Scientists Project Members and Teams





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 NSF, all of science, USA, 
Temporal Analysis (When)	Funding portfolio of one individual	Topic bursts of PNAS	113 Years of PNAS Research 
Geospatial Analysis (Where)	Career trajectory of one individual	Mapping a state intellectual landscape	PNAS 
Topical Analysis (What)		Flows in research	VxOrd/Topic in NIH funding 
Network Analysis (With Whom?)	NSF one work of 	Work 	NIH's 

How do you want to compare?

by Grants

Who do you want to compare?

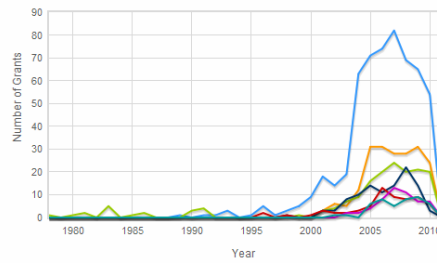
Search: X

Records 1 - 10 of 30 < First < Prev Next > Last >

Entity Label	Grant Count	Entity Type
<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

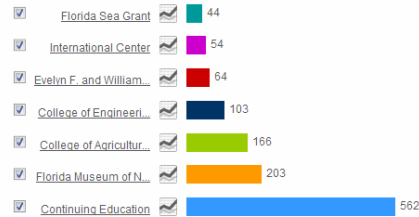
Save as CSV Clear

Comparing Grants of Organizations in University of Florida

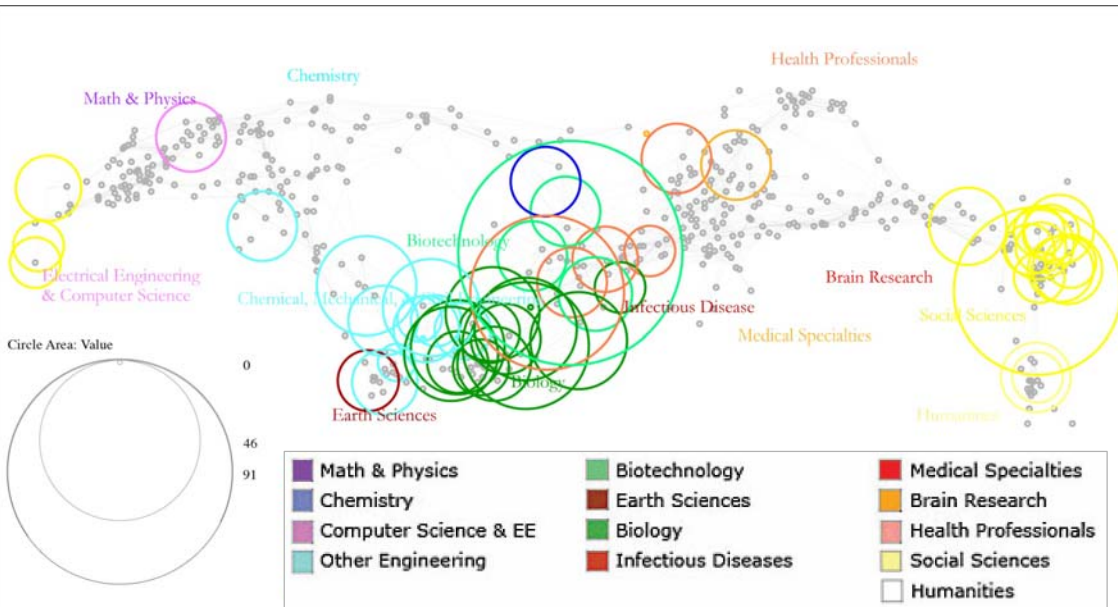


Total Number of Grants

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



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



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

Conlon, Mike

Associate Director and Chief Operating Officer



VIVO

Enabling a National Network of Scientists

Co-Author Network [\(GraphML File\)](#)

Profile

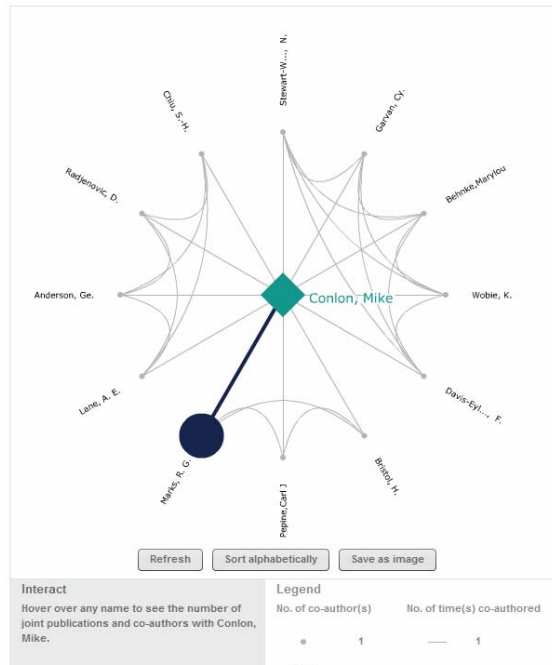
Conlon, Mike

Associate Director and Chief O...

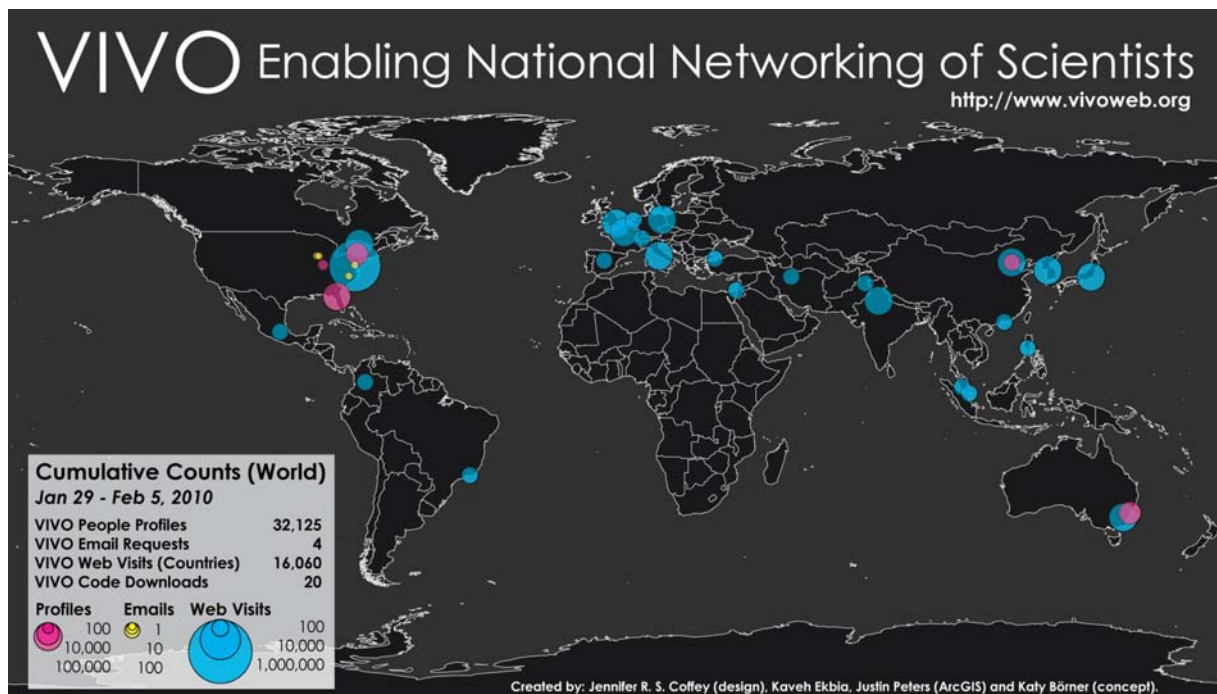
[VIVO profile](#) | [Co-author network](#)

- 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.



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

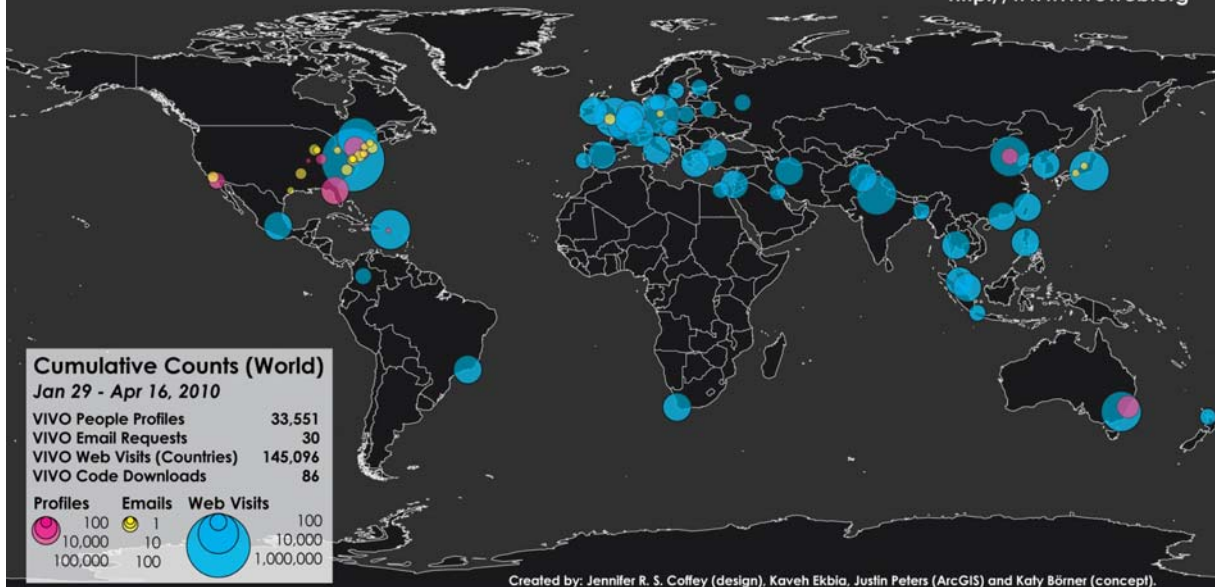


Science is global. World view of VIVO activity.
Web site visits are aggregated at the country level.

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

VIVO Enabling National Networking of Scientists

<http://www.vivoweb.org>



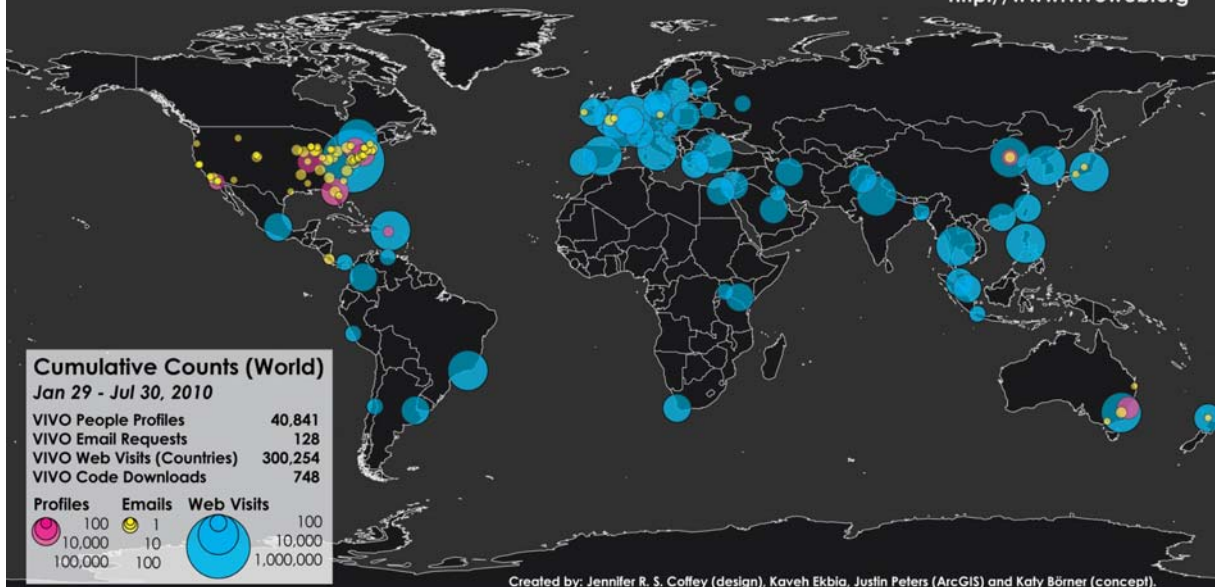
Shown are the

- Number of people profiles in the 7 different VIVO installation sites plus CAS and U Melbourne.
 - Email contacts by data and service providers as well as institutions interested to adopt VIVO.
 - The number of visitors on <http://vivoweb.org>
- Circles are area size coded using a logarithmic scale.

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VIVO Enabling National Networking of Scientists

<http://www.vivoweb.org>



VIVO 1.0 source code was publicly released on April 14, 2010

87 downloads by June 11, 2010.

The more institutions adopt VIVO, the more high quality data will be available to understand, navigate, manage, utilize, and communicate progress in science and technology.

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Networks and Complex Systems Research at Indiana University

This VIVO instance provides information on networks and complex systems

- [Faculty](#) and their [departments](#)
- [Publications](#)
- [Grants](#)
- [Courses](#)

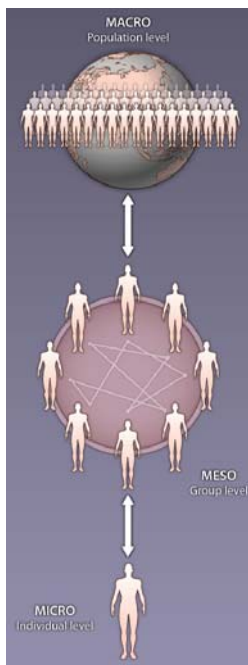
at Indiana University. The site was created in support of a NSF IGERT grant application. A major intent is to cross-fertilize between research done in the social and behavioral sciences, research in natural sciences such as biology or physics, but also research on Internet technologies.

The site will be continuously updated to help

- New faculty to get in contact with relevant researchers.
- Faculty and policy makers to pool teams in response to funding solicitations.
- Faculty to coordinate research efforts – collaborations using existing funding/resources.
- Faculty to coordinate teaching.
- Students identify relevant courses, potential advisors, funding.
- Organize the Mon talk series on [Networks and Complex Systems](#).
- Arrange research meetings for visitors with relevant faculty/students

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

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Theories and Methods

– find, understand, apply, advance them.



SciTS and Team Science Resources

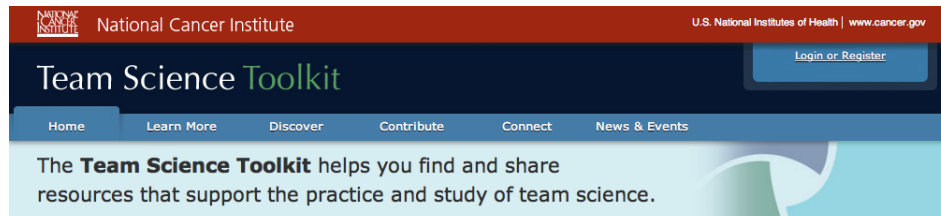
Science of Team Science and Praxis of Team Science

- [Research Team Support & Development](#) at the Kellogg School of Management
- [Team Science](#) graduate course, [MSCI 307](#)
- [Science of Networks in Communities \(SONIC\)](#)
- [Northwestern Institute on Complex Systems](#)
- [Complexity in Action Network \(CANet\)](#)
- Team researchers in [the Kellogg School of Management](#)
- [CollaboLab](#)

Also available are listings of

- **Upcoming conference and workshops:**
- **Past Conferences and Workshops:**
- **Selected References:**
- **Team Science Training:**
- **Team Science Tools:**
- **Interdisciplinary Research and Team Science Resources:**
- **Professional Organizations:**
- **Team Science Blog and Twitter:**
- **Science of Team Science Publishing Venues:**

<http://scienceofteamscience.northwestern.edu/team-science-resources>



It includes tools to facilitate or support team science initiatives, measures to study or evaluate team science, a team science bibliography, expert directory, blog, listserv, and more.

Learn More about team science, the science of team science, and the Toolkit.

Discover resources relevant to your work and resources.

Search by terms: **Search**

Browse to find: **Browse**

Contribute resources to the Toolkit.

Connect to colleagues across disciplines.

Recently Added Resources

Types of resources:

- Tools
- Measures
- Bibliographic entries
- Funding opportunities
- Job announcements
- News
- Events
- All resources

Resources that will help me:

- learn about team science
- conduct effective team science
- enhance team performance
- provide institutional support
- train team members or students
- evaluate team science efforts
- engage community partners

- Facilitates information and knowledge exchange, via a wiki-based platform
- Users can freely upload/download publicly available team science resources
- Will help reduce replication of resources, accelerate advances in the field

www.teamsciencetoolkit.cancer.gov

What is HUBzero?

HUBzero® is a platform used to create dynamic web sites for scientific research and educational activities. With HUBzero, you can easily publish your research software and related educational materials on the web.

[Take a tour →](#)



Conference for the HUBzero® User Community.
April 5-6, 2011, Indianapolis, IN.

[Schedule →](#)

Start your own HUB

Use HUBzero® to create your own site. [Download](#) our open source release or have a hub setup and hosted for you via [Purdue's hosting service](#).

[Get Started →](#)

News & Events

Latest Events

- MAY 09** Hub Owners' Forum
 This regular meeting (second Monday of every month 3:00 - 4:00 Eastern Time ...
- JUN 13** Hub Owners' Forum
 This regular meeting (second Monday of

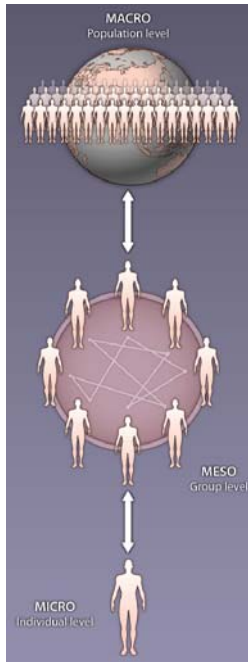
Latest News

- MAR 02** HUBzero Paving the Way for the Third Pillar of Science
 HPC in the Cloud - Feature What if researchers could access and share ...
- DEC** New Documentation Added for Hub Users

<http://hubzero.org>

	<p>Projects Using Hubs</p>
	<p>Funded Development Projects</p>
	<p>HUBzero Consortium</p>

<http://hubzero.org>



Data

– find, access, interlink, unify,
merge, reformat, share them, e.g., using web sites analogous
to [http://www.diggingintodata.org/Repositories/
tabid/167/Default.aspx](http://www.diggingintodata.org/Repositories/tabid/167/Default.aspx), SDB, or LOD.

Wednesday, April 13, 2011

... Home » Repositories ...

Site Navigation

- Home
- Repositories
- DiD Logos
- Award Recipients - 2009
- Conference

List of Data Repositories

Last Updated: 31 March, 2011

Below is a list of digital libraries, data archives, and data repositories that are inviting Digging into Data researchers to use their collections. For each repository, you'll find a description of their contents, contact information, and other details.

This list is being frequently updated, so check back often! If you are a digital repository and would like to be included on this list, please [get in touch with us](#).

The Archaeology Data Service (ADS)
ads.ahds.ac.uk

About: The ADS catalogue holds the digital archives of a huge number of archaeological interventions from the UK and beyond in around 400 collections, these range from the outputs of single excavations to large scale developer funded projects encompassing hundreds of individual archaeological interventions. As well as digital archives and fieldwork outputs the catalogue contains a number of scholarly resources intended specifically as reference sources for further research on topics such as lithics, ceramics and animal bone. The catalogue also contains digitised (or born digital) versions of various significant journals and series running to many thousands

<http://www.diggingintodata.org/Repositories/tabid/167/Default.aspx>

Supports federated search of 25 million publication, patent, grant records.

Results can be downloaded as data dump and (evolving) co-author, paper-citation networks.

Register for free access at <http://sdb.cns.iu.edu>

Browse Results

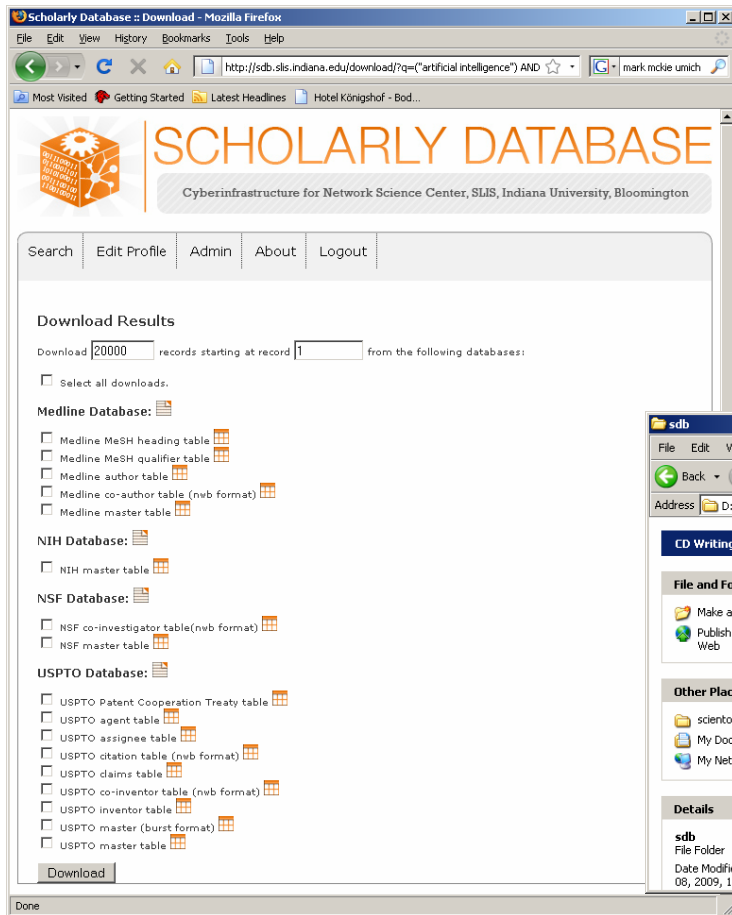
Your search returned 13,231 results in 0.295 seconds. [Download](#)

Total results per database: NIH: 2,103, Medline: 10,235, USPTO: 279, NSF: 614.

Results 1 through 20.

[Next>>](#)

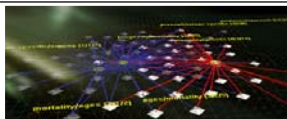
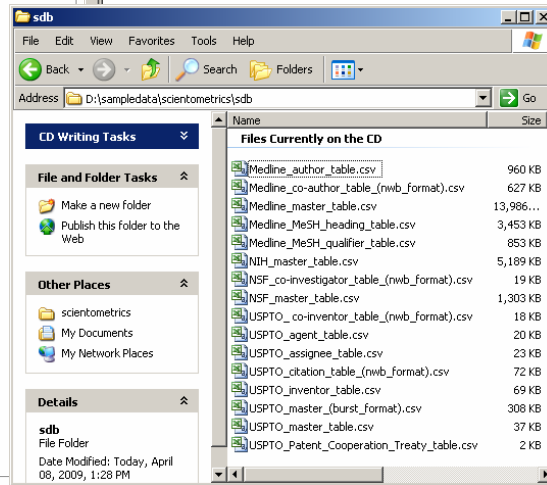
Source	Authors/Creators	Year	Title	Score (out of 5.71)
Medline	LaCombe	1987	Artificial intelligence.	5.71
Medline		1989	Artificial intelligence: expert systems.	5.71
Medline	Schmitt	1990	[Artificial intelligence in dentistry]	5.71
Medline	Adlassnig and Adlassnig	2002	Artificial-intelligence-augmented systems.	5.60
Medline	Touretzky	1980	Artificial intelligence.	4.86
Medline	Goldenberg	1980	Artificial intelligence.	4.86



Since March 2009:

Users can download networks:

- Co-author
 - Co-investigator
 - Co-inventor
 - Patent citation
- and tables for burst analysis in NWB.



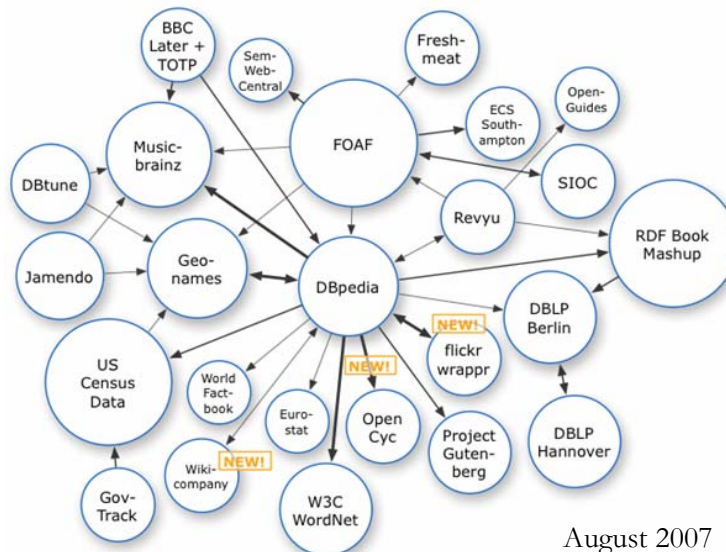
Semantic Web: Linked Open Data

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

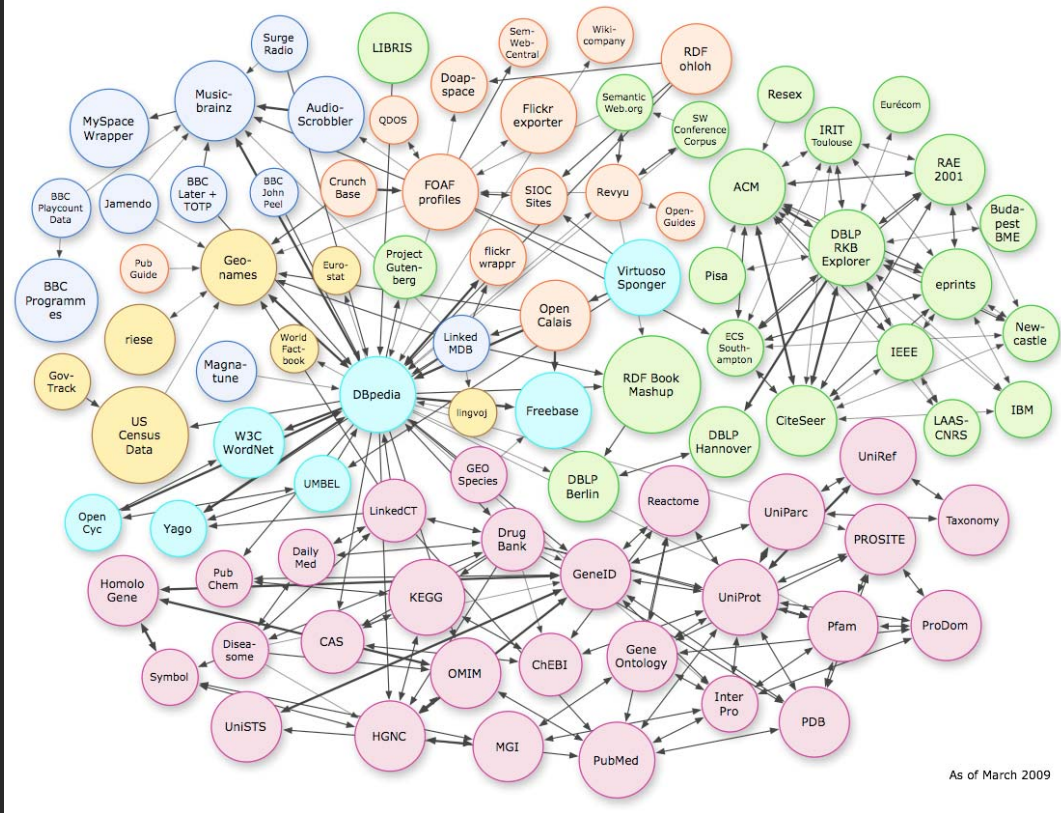
<http://linkeddata.org>

Save Data.gov, sign the petition at <http://om.ly/BRPRE>

Twitter #savethedata

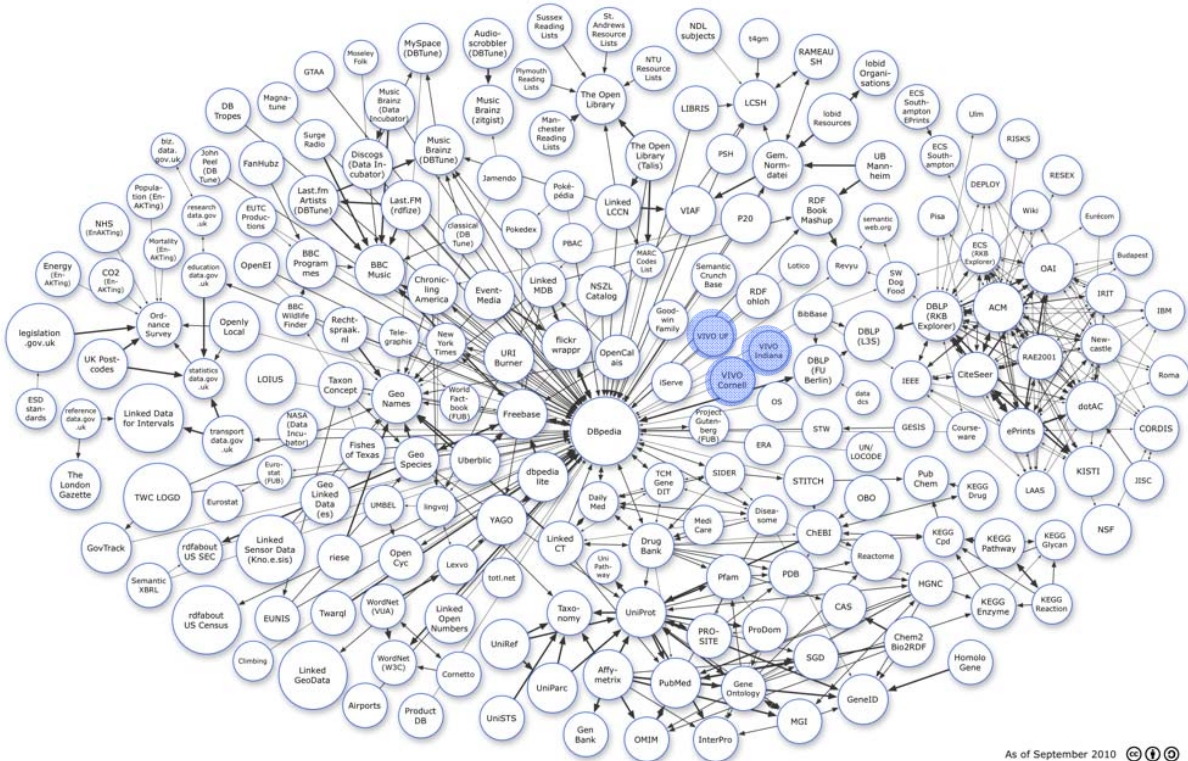


August 2007



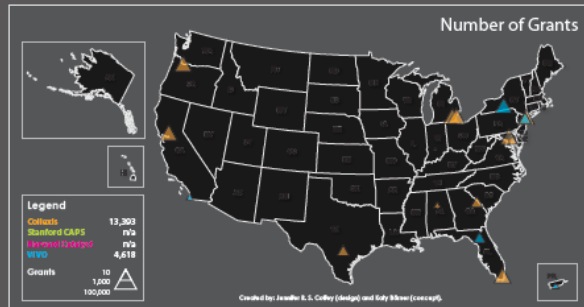
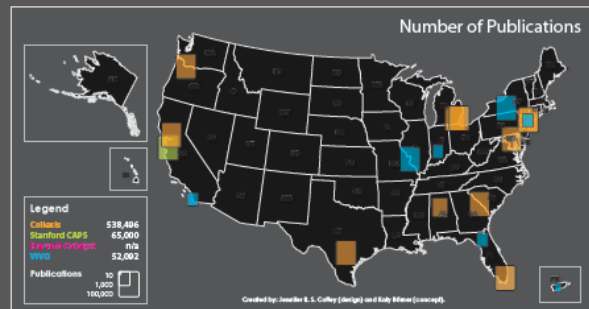
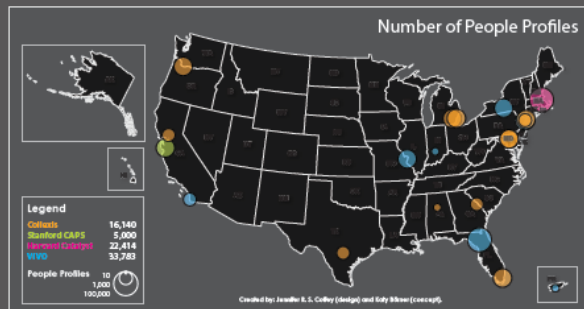
As of March 2009

<http://www4.wiwiss.fu-berlin.de/bizer/pub/lod-datasets> 2009-03-05 colored.png



As of September 2010

National Research Networking (NRN) Activity Visualization



Federated Search University of Florida

Search Term: Search

Results for "cancer".

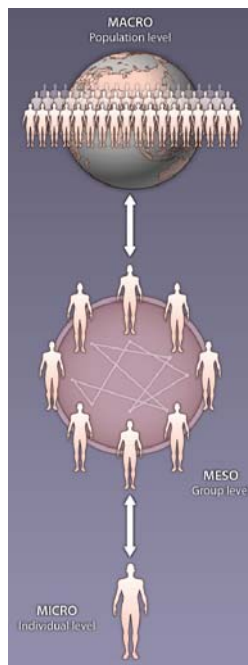
University of Florida 29 People

UF VIVO contains all 6,900 faculty and 7,600 full-time staff of the University of Florida, as well as award information for all grants, UF students, affiliates and employees of Shands HealthCare can request to be added.

Cornell University 200 People

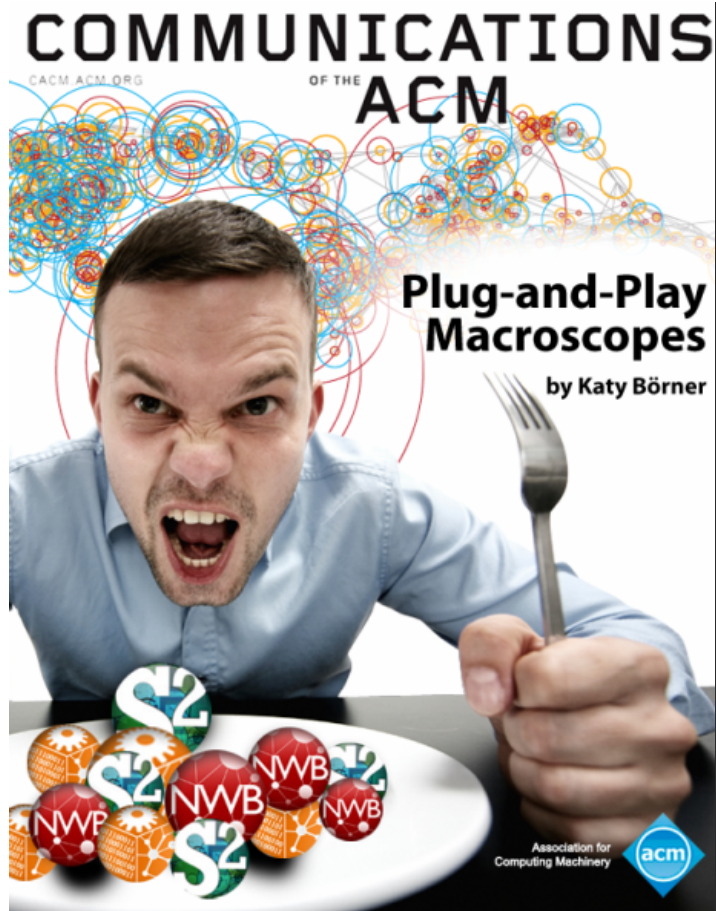
Participants in the VIVO National Network include institutions with local installations of VIVO or those with research discovery and profiling applications that can connect to remote VIVO endpoints.

<http://vivoexperts.ctsi.ufl.edu>



Tools

– continuously identify, learn, advance, share code, e.g., via Plug-and-Play Macroscopes



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

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

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Designing “Dream Tools”

Many of the best micro-, tele-, and macroscopes are designed by **scientists keen to observe and comprehend what no one has seen or understood before.** Galileo Galilei (1564–1642) recognized the potential of a spyglass for the study of the heavens, ground and polished his own lenses, and used the improved optical instruments to make discoveries like the moons of Jupiter, providing quantitative evidence for the Copernican theory.

Today, scientists **repurpose, extend, and invent new hardware and software** to create **“macroscopes”** that may solve both local and global challenges.

Plug-and-play macroscopes **empower** me, my students, colleagues, and 100,000 others that downloaded them.

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Macroscopes

Decision making in science, industry, and politics, as well as in daily life, requires that we make sense of data sets representing the structure and dynamics of complex systems. Analysis, navigation, and management of these continuously evolving data sets require a new kind of data-analysis and visualization tool we call a macroscope (from the Greek macros, or “great,” and skopein, or “to observe”) inspired by de Rosnay’s futurist science writings.

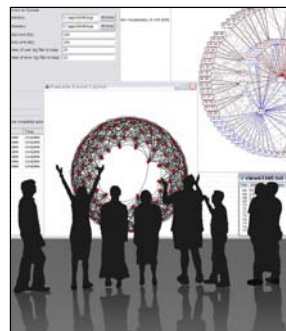
Macroscopes provide a “vision of the whole,” helping us “synthesize” the related elements and enabling us to detect patterns, trends, and outliers while granting access to myriad details. Rather than make things larger or smaller, **macroscopes let us observe what is at once too great, slow, or complex for the human eye and mind to notice and comprehend.**



Microscopes



Telescopes



Macroscopes

33



Macroscopes cont.

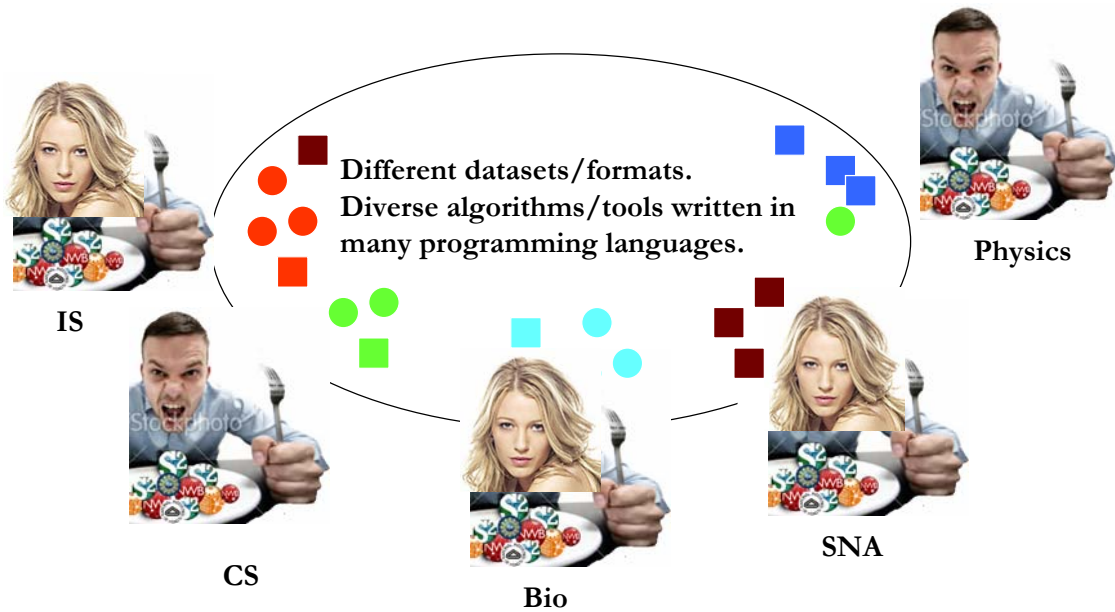
While microscopes and telescopes are physical instruments, **macroscopes resemble continuously changing bundles of software plug-ins.** Macroscopes make it easy to select and combine algorithm and tool plug-ins but also interface plug-ins, workflow support, logging, scheduling, and other plug-ins needed for scientifically rigorous yet effective work.

They make it easy to share plug-ins via email, flash drives, or online. To use new plugins, simply copy the files into the plug-in directory, and they appear in the tool menu ready for use. No restart of the tool is necessary. **Sharing algorithm components, tools, or novel interfaces becomes as easy as sharing images on Flickr or videos on YouTube. Assembling custom tools is as quick as compiling your custom music collection.**

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Macrosopes Serve the Changing Scientific Landscape



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Changing Scientific Landscape—General Observations

Science becomes more data driven and computational but also collaborative and interdisciplinary. There is increased demand for tools that are easy to extend, share, and customize:

- *Star scientist* —> *Research teams*. Traditionally, science was driven by key scientists. Today, science is driven by collaborating co-author teams, often comprising experts from multiple disciplines and geospatial locations.
- *Users* —> *Contributors*. Web 2.0 technologies empower users to contribute to Wikipedia and exchange images, videos, and code via Flickr, YouTube, and SourceForge.net.
- *Disciplinary* —> *Cross-disciplinary*. The best tools frequently borrow and synergistically combine methods and techniques from different disciplines of science, empowering interdisciplinary and/or international teams to collectively fine-tune and interpret results;
- *Single specimen* —> *Data streams*. Microscopes and telescopes were originally used to study a single specimen at a time. Today, many researchers must make sense of massive data streams comprising multiple data types and formats from different origins; and
- *Static instrument* —> *Evolving cyberinfrastructure*. The importance of hardware instruments that are static and expensive tends to decrease relative to software tools and services that are highly flexible and evolving to meet the needs of different sciences. Some of the most successful tools and services are decentralized, increasing scalability and fault tolerance.

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Related Work

Google Code and SourceForge.net provide special means for developing and distributing software

- In August 2009, SourceForge.net hosted more than 230,000 software projects by two million registered users (285,957 in January 2011);
- In August 2009 ProgrammableWeb.com hosted 1,366 application programming interfaces (APIs) and 4,092 mashups (2,699 APIs and 5,493 mashups in January 2011)

Cyberinfrastructures serving large biomedical communities

- Cancer Biomedical Informatics Grid (caBIG) (<http://cabig.nci.nih.gov>)
- Biomedical Informatics Research Network (BIRN) (<http://nbirn.net>)
- Informatics for Integrating Biology and the Bedside (i2b2) (<https://www.i2b2.org>)
- HUBzero (<http://hubzero.org>) platform for scientific collaboration uses
- myExperiment (<http://myexperiment.org>) supports the sharing of scientific workflows and other research objects.

Missing so far is a **common standard** for

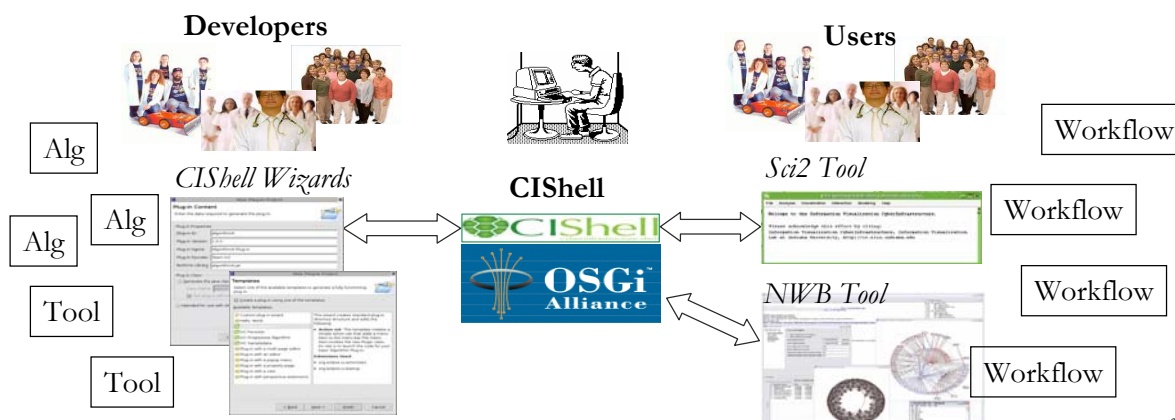
- the design of **modular, compatible algorithm and tool plug-ins** (also called “modules” or “components”)
- that can be **easily combined into scientific workflows** (“pipeline” or “composition”),
- and packaged as **custom tools**.

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OSGi & CIShell

- CIShell (<http://cishell.org>) is an open source software specification for the integration and utilization of datasets, algorithms, and tools.
- It extends the Open Services Gateway Initiative (OSGi) (<http://osgi.org>), a standardized, component oriented, computing environment for networked services widely used in industry since more than 10 years.
- Specifically, CIShell provides “sockets” into which existing and new datasets, algorithms, and tools can be plugged using a wizard-driven process.



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Tools Workshop on “Social Network Analysis”

Thursday, April 14 • 1:15 – 5:00 PM

This workshop presents and demonstrates CIShell-powered tools such as the Network Workbench (NWB) Tool (<http://nwbcns.iu.edu>) and the Science of Science (Sci2) Tool (<http://sci2.cns.iu.edu>). The NWB Tools is a network analysis, modeling, and visualization toolkit for physics, biomedical, and social science research. The Sci2 Tool was specifically designed for researchers and science policy makers interested to study and understand the structure and dynamics of science. Both tools are standalone desktop applications that install and run on Windows, Linux x86 and Mac OSX. The tools provide easy access to more than 160 algorithms for the study of temporal, geospatial, topical, and network datasets at the micro (individual), meso (local), and macro (global) levels.

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



The screenshot shows the CIShell Powered Tools Portal. At the top, there is a green header with the CIShell logo and the text "CIShell Powered Tools Portal". Below the header, there is a main content area with a green background. On the left, there is a green power button icon. To its right, the text reads: "Cyberinfrastructure Shell (CIShell) CIShell supports the plug-and-play of datasets and algorithms and their bundling into custom tools that serve the specific needs of a user group or research community. It has been applied to develop diverse custom tools, see below. Feel free to take plugins from any of these tools to design your personal dream tool." Below this text, it says "Provided by the Cyberinfrastructure for Network Science Center at Indiana University." To the right of this text is a grey button that says "Visit the CIShell wiki to learn more about using CIShell as a platform for your tool!". Below this, there is a section titled "Learn more about existing CIShell-powered tools below." with two tool entries. The first entry is for the "Network Workbench Tool (NWB)" with a red circular icon containing "NWB". The text describes it as a tool for researchers, educators, and practitioners in biomedical, social, and behavioral science, physics, and other networks. It includes a link to a "user manual" and a "Gallery" of three small images. The second entry is for the "Science of Science Tool (Sci2)" with a green circular icon containing "S2". The text describes it as a tool for science policy makers and researchers that study science by scientific means. It supports temporal, geospatial, topical, and network analysis and visualization of scholarly datasets at the micro (individual), meso (local), and macro (global) levels. It includes links to a "112-page user manual" and "24 hours of NIH tutorials".

The Network Workbench (NWB) tool supports researchers, educators, and practitioners interested in the study of biomedical, social and behavioral science, physics, and other networks.

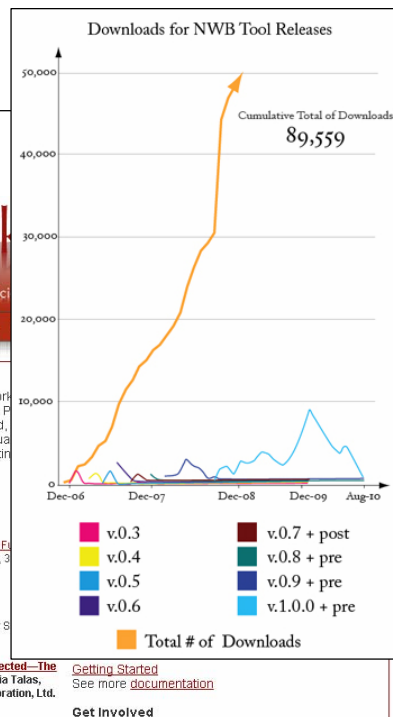
In February 2009, the tool provides more 169 plugins that support the preprocessing, analysis, modeling, and visualization of networks.

More than 50 of these plugins can be applied or were specifically designed for S&T studies.


It has been downloaded more than 65,000 times since December 2006.



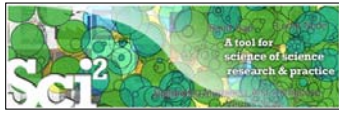
The screenshot shows the Network Workbench website interface. At the top, it says "Network Workbench A Workbench for Network Science". Below that are navigation tabs: Home, People, Research, Publications. A "Summary" section describes the tool as a "Large-Scale Network Toolkit for Biomedical, Social Science and Research". A "News & Updates" section lists several articles and releases, including "Mapping the Frontiers of Knowledge" and "1.0.0 beta 5 Released". There are also links for "Getting Started" and "See more documentation".



Herr II, Bruce W., Huang, Weixia (Bonnie), Penumarthi, Shashikant & Börner, Katy. (2007). *Designing Highly Flexible and Usable Cyberinfrastructures for Convergence*. In Bainbridge, William S. & Roco, Mibail C. (Eds.), *Progress in Convergence - Technologies for Human Wellbeing* (Vol. 1093, pp. 161-179), *Annals of the New York Academy of Sciences*, Boston, MA.

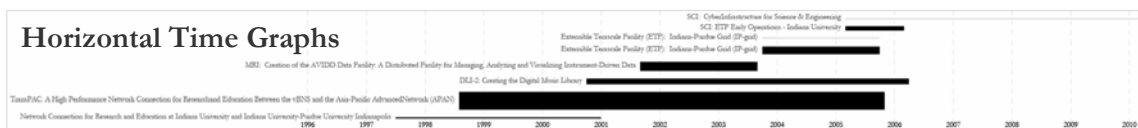
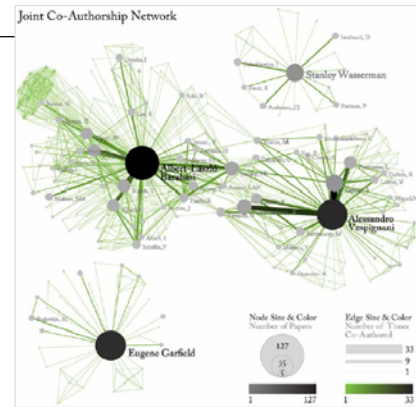
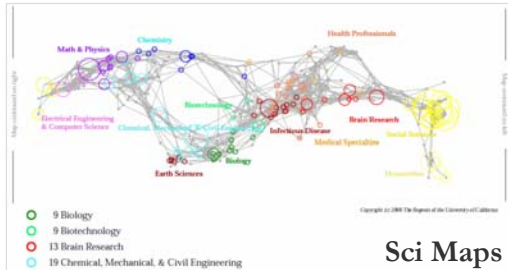


The screenshot shows the Sci2 Tool website interface. At the top, it says "Sci² Tool A tool for science of science research & practice". Below that are input fields for "Email Address" and "Password", and a "Login" button. There are links for "Forgot your password?", "Not registered yet?", and "Register now". A "Tutorials" section lists 12 tutorials, including "Science of Science Research", "Network Science / Information Visualization", "CIShell Powered Tools: Network Workbench and Science of Science Tool", "Temporal Analysis—Burst Detection", "Geospatial Analysis and Mapping", "Topical Analysis & Mapping", "Tree Analysis and Visualization", "Network Analysis and Visualization", "Large Network Analysis and Visualization", "Using the Scholarly Database at IU", "VIVO National Researcher Networking", and "Future Developments". There are also links for "http://sci2.cns.in.edu" and "http://sci2.wiki.cns.in.edu". At the bottom, there is a citation for Geetha Senthil (2010) and a link to "Network Visualizations Using SPIRES Data and the Sci2 Tool".



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

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



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



Sci² Tool

Sci² Tool

File Preprocessing Modeling Analysis Visualization Scientometrics Help

Console

Welcome to the Science of Science Tool (Sci²). The development of this tool is supported in Network Science center and the School of Li Indiana University, the National Science Foundation (NSF-0715303), and the James S. McDonnell Cyberinfrastructure portal (<http://sci.slis.indiana.edu>).

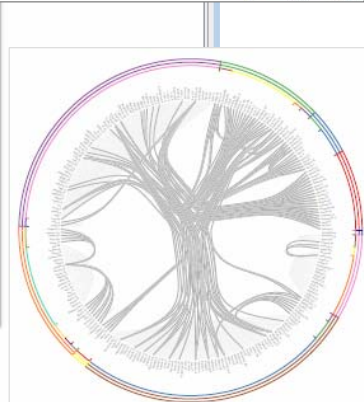
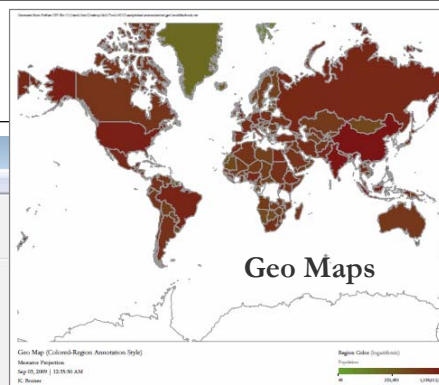
The primary investigators are Katy Börner, In SciTech Strategies Inc. The Sci² tool was developed by J. Duhon, Patrick A. Phillips, Chintan Tank, a Cyberinfrastructure Shell (<http://cishell.org>) for Network Science Center (<http://cns.slis.indiana.edu>). Many algorithm plugins were derived from the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

Please cite as follows:
Sci² Team. (2009). Science of Science Tool. In SciTech Strategies Inc., <http://sci.slis.indiana.edu>.

Scheduler

Remove From List Remove completed

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





OSGi/CIShell Adoption

A number of other projects recently adopted OSGi and/or CIShell:

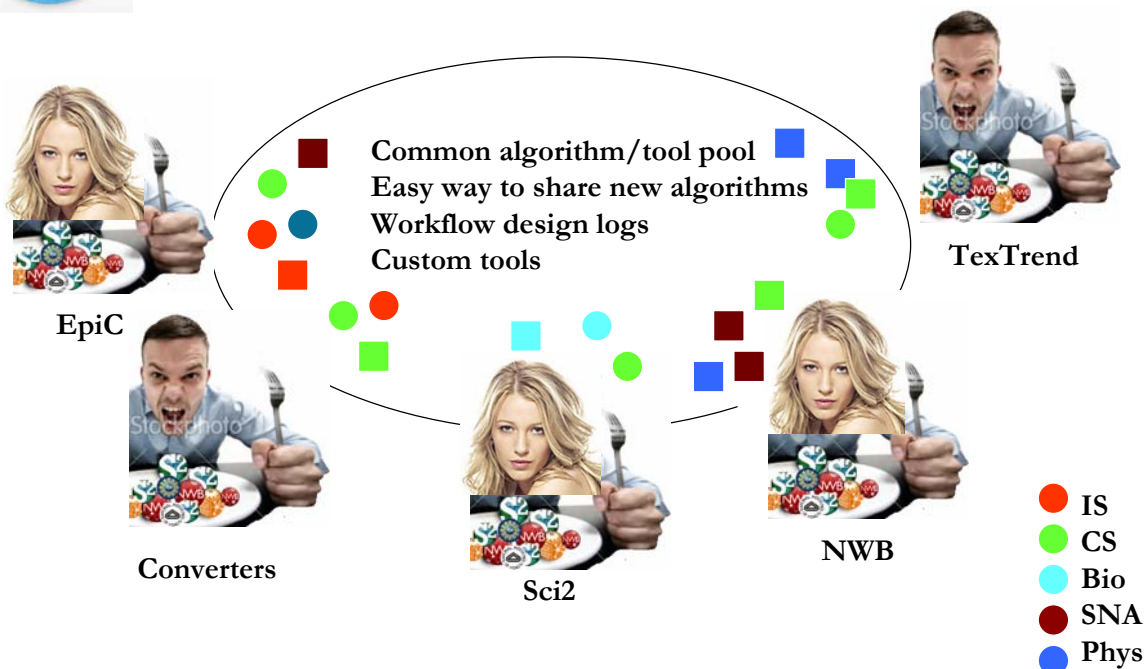
Cytoscape (<http://cytoscape.org>) Led by Trey Ideker at the University of California, San Diego is an open source bioinformatics software platform for visualizing molecular interaction networks and integrating these interactions with gene expression profiles and other state data (Shannon et al., 2002).

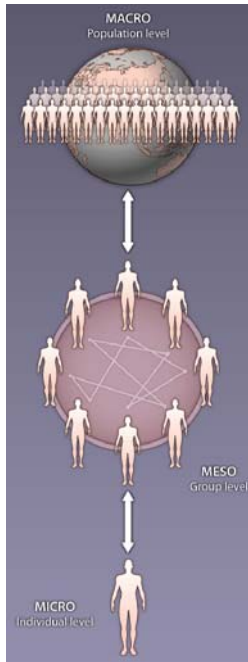
- *Taverna Workbench* (<http://taverna.org.uk>) Developed by the myGrid team (<http://mygrid.org.uk>) led by Carol Goble at the University of Manchester, U.K. is a free software tool for designing and executing workflows (Hull et al., 2006). Taverna allows users to integrate many different software tools, including over 30,000 web services.
- *MAEviz* (<https://wiki.ncsa.uiuc.edu/display/MAE/Home>) Managed by Jong Lee at NCSA is an open-source, extensible software platform which supports seismic risk assessment based on the Mid-America Earthquake (MAE) Center research.
- *TEXTrend* (<http://textrend.org>) Led by George Kampis at Eötvös Loránd University, Budapest, Hungary supports natural language processing (NLP), classification/mining, and graph algorithms for the analysis of business and governmental text corpuses with an inherently temporal component.
- *DynaNets* (<http://www.dynanets.org>) Coordinated by Peter M.A. Sloot at the University of Amsterdam, The Netherlands develops algorithms to study evolving networks.

As the functionality of OSGi-based software frameworks improves and the number and diversity of dataset and algorithm plugins increases, the capabilities of custom tools will expand.



Embrace the Changing Scientific Landscape





Mixed-methods, multi-level SciTS needs:

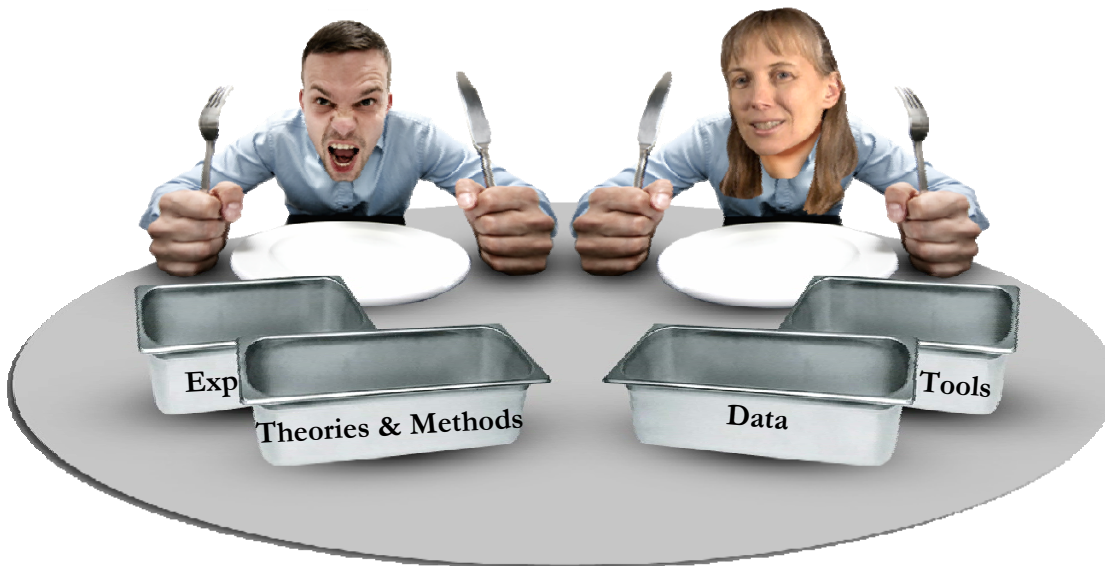
Expertise – identify and access it at the perfect moment using, e.g., Facebook, LinkedIn, Academia, VIVO, Harvard Profiles, Elsevier’s Collexis, Loki, Stanford’s CAP, or other systems.

Theories and Methods – find, understand, apply, advance them, e.g., using <http://scienceofteamsceince.northwestern.edu/team-science-resources>.

Data – find, interlink, unify, merge, reformat, share them, e.g., using web sites analogous to <http://www.diggingintodata.org/Repositories/tabid/167/Default.aspx>, SDB, or LOD.

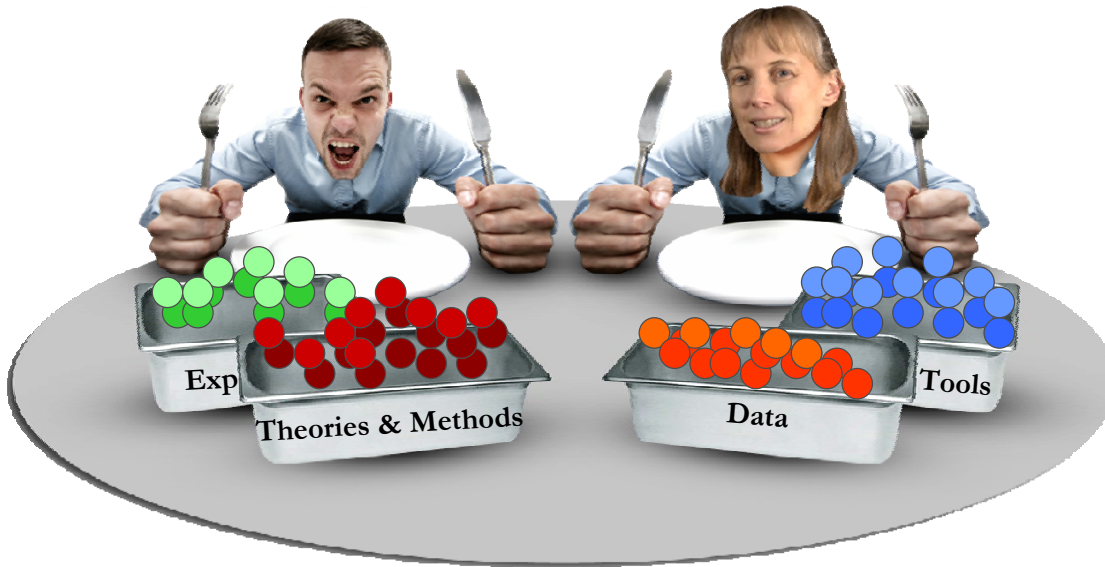
Tools – identify, learn, advance, share code, e.g., via Plug-and-Play Macroscopes, to arrive at a holistic understanding of the science system.

Note that the evolution of all of the above could be an extremely interesting and valuable SciTS study object.



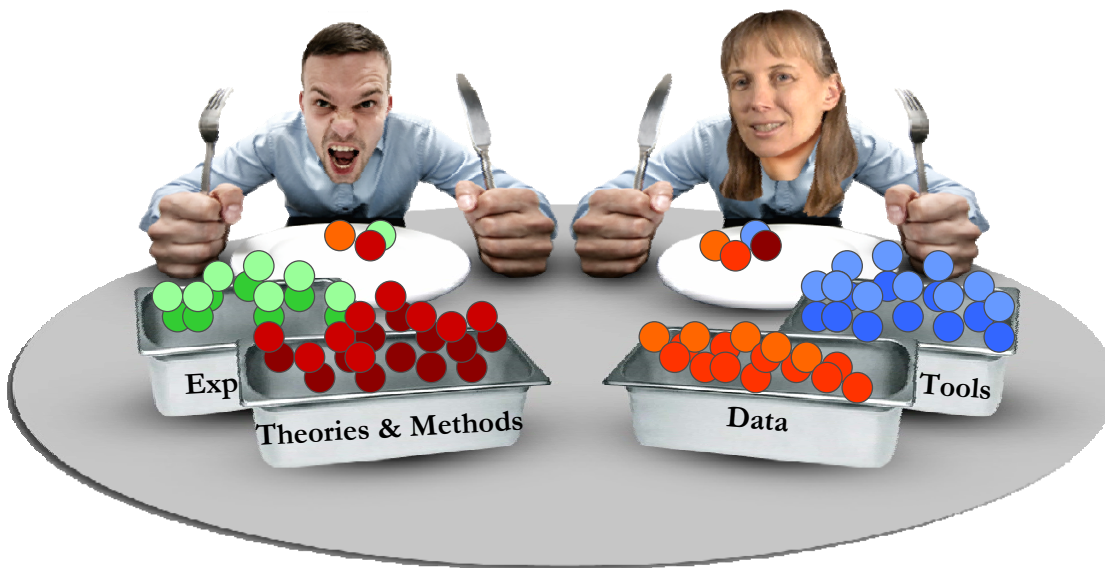
Different levels and types of analysis will require access to very different

Expertise, Theories and Methods, Data, and Tools.



Ideally, a future SciTS CI can provide easy access to the best, highest quality
Expertise, Theories and Methods, Data, and Tools.

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So that researchers, practitioners, and students can fully benefit and advance
Expertise, Theories and Methods, Data, and Tools.

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References

Börner, Katy, Chen, Chaomei, and Boyack, Kevin. (2003). **Visualizing Knowledge Domains**. In Blaise Cronin (Ed.), *ARIST*, Medford, NJ: Information Today, Volume 37, Chapter 5, pp. 179-255.
<http://ivl.slis.indiana.edu/km/pub/2003-borner-arist.pdf>

Shiffrin, Richard M. and Börner, Katy (Eds.) (2004). **Mapping Knowledge Domains**. *Proceedings of the National Academy of Sciences of the United States of America*, 101(Suppl_1).
http://www.pnas.org/content/vol101/suppl_1/

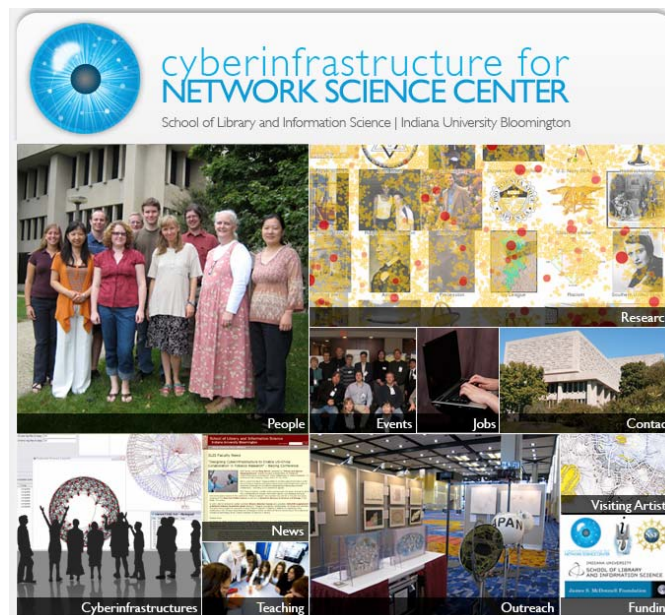
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<http://ivl.slis.indiana.edu/km/pub/2007-borner-arist.pdf>

Börner, Katy (2010) **Atlas of Science**. MIT Press.
<http://scimaps.org/atlas>

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



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

CNS Facebook: <http://www.facebook.com/pages/Cyberinfrastructure-for-Network-Science-Center/144339535612571>

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