

# VIVO

enabling national  
networking of scientists

## VIVO: Origins, Growth, Challenges, and Opportunities

Jon Corson-Rikert and Brian Lowe

September 27, 2010

VIVO: Enabling National Networking of Scientists  
is supported by NIH Award U24 RR029822.





enabling national  
networking of scientists

## VIVO Collaboration:

**Cornell University:** Dean Krafft (Cornell PI), Manolo Bevia, Jim Blake, Nick Cappadona, Brian Caruso, Jon Corson-Rikert, Elly Cramer, Medha Devare, Elizabeth Hines, Huda Khan, Brian Lowe, Joseph McEnerney, Holly Mistlebauer, Stella Mitchell, Anup Sawant, Christopher Westling, Tim Worrall, Rebecca Younes.

**University of Florida:** Mike Conlon (VIVO and UF PI), Chris Barnes, Cecilia Botero, Kerry Britt, Erin Brooks, Amy Buhler, Ellie Bushhousen, Linda Butson, Chris Case, Christine Cogar, Valrie Davis, Mary Edwards, Nita Ferree, George Hack, Chris Haines, Sara Henning, Rae Jesano, Margeaux Johnson, Meghan Latorre, Yang Li, Paula Markes, Hannah Norton, Narayan Raum, Alexander Rockwell, Sara Russell Gonzalez, Nancy Schaefer, Dale Scheppler, Nicholas Skaggs, Matthew Tedder, Michele R. Tennant, Alicia Turner, Stephen Williams. **Indiana University:** Katy Borner (IU PI), Kavitha Chandrasekar, Bin Chen, Shanshan Chen, Jeni Coffey, Suresh Deivasigamani, Ying Ding, Russell Duhon, Jon Dunn, Poornima Gopinath, Julie Hardesty, Brian Keese, Namrata Lele, Micah Linnemeier, Nianli Ma, Robert H. McDonald, Asik Pradhan Gongaju, Mark Price, Yuyin Sun, Chintan Tank, Alan Walsh, Brian Wheeler, Feng Wu, Angela Zoss. **Ponce School**

**of Medicine:** Richard J. Noel, Jr. (Ponce PI), Ricardo Espada Colon, Damaris Torres Cruz, Michael Vega Negrón. **The Scripps Research Institute:** Gerald Joyce (Scripps PI), Catherine Dunn, Brant Kelley, Paula King, Angela Murrell, Barbara Noble, Cary Thomas, Michaelleen Trimarchi. **Washington University**

**School of Medicine in St. Louis:** Rakesh Nagarajan (WUSTL PI), Kristi L. Holmes, Caerie Houchins, George Joseph, Sunita B. Koul, Leslie D. McIntosh. **Weill Cornell Medical College:** Curtis Cole (Weill PI), Paul Albert, Victor Brodsky, Mark Bronnimann, Adam Cheriff, Oscar Cruz, Dan Dickinson, Richard Hu, Chris Huang, Itay Klaz, Kenneth Lee, Peter Michelini, Grace Migliorisi, John Ruffing, Jason Specland, Tru Tran, Vinay Varughese, Virgil Wong.



# Talk overview

- VIVO origins and evolution as an application
- Transitioning VIVO to the Semantic Web
- VIVO: Enabling National Networking of Scientists
- Opportunities in the open source Semantic Web and Linked Open Data communities



# VIVO origins and motivation

- Genomics and New Life Science faculty initiatives
- Library seeking a role as an information broker
- Needs expressed by faculty
- Favorable response – build it and they will come



# Core ideas

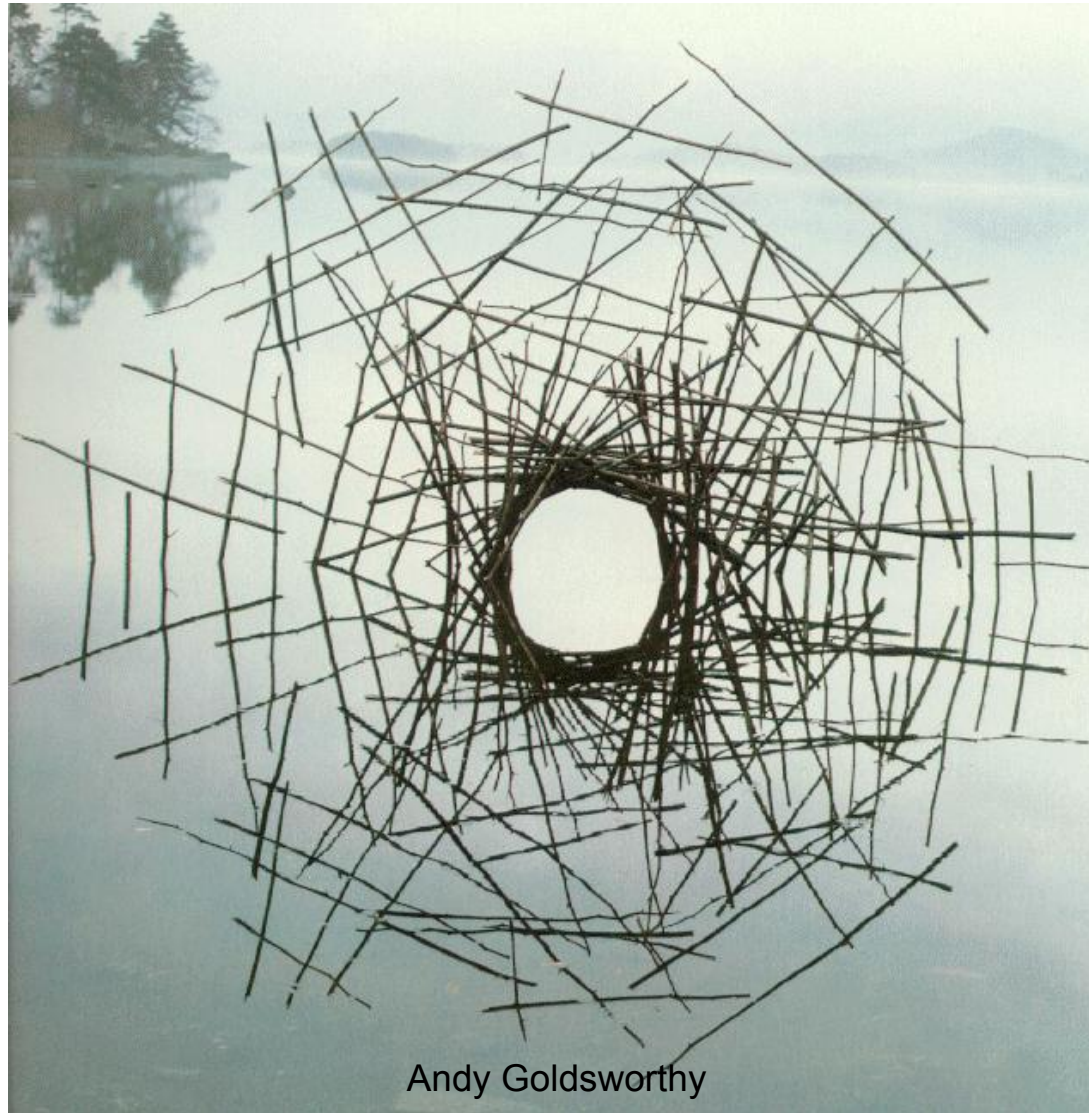
- Research and researchers should be discoverable independently of administrative hierarchies
- Relationships are as interesting as the facts
  - It's the network, not just the nodes
- Static data models are too confining
- Granular data management allows multiple views and re-purposing
- Discovery is improved by linking pages to surrounding context

# Individual networks



Andy Goldsworthy

# Overlapping connections



Andy Goldsworthy

# VIVO at launch: 2004

- Initially largely hand-curated
- RDB implementation emulating OWL class and property structure
- No standardized import and export of data
- No reasoning
  - Hand classification of data to disciplines
- No SPARQL queries
  - Had to write code to leverage relationships



# VIVO by 2006

- Several automated feeds (HR & grants)
- Permission to post article citations from Biosis for 90 days
- Four “portals” within College of Agriculture & Life Sciences
- Attracted support for campus-wide implementation

## FOCUS on Cornell University Library

### Life sciences libraries aren't just for books anymore – they're wired

BY JANET MCCUE, JEAN POLAND AND CAROLYN REID

**A**mong the workplace amenities that life scientists value is a good library, according to a survey published recently by The Scientist. Cornell, which has one of the best library systems in the world, recently enhanced its resources for the life sciences by hiring a bioinformatics and life sciences specialist and offering such new services as VIVO, a Web-based community for the life sciences (see sidebar).

The Scientist survey lists a “well-stocked and well-maintained library” as an important feature. Indeed, Cornell's libraries deliver thousands of electronic journals, databases and resources directly to the desktop.

“Immediate access to the available scientific literature greatly facilitates the scientific process by allowing one to quickly check on a hunch without ever having to leave the lab,” says Stephen Jesch, a Cornell postdoctoral researcher. “Verifying or negating a hunch then allows one to judge efficiently how to proceed with a set of experiments. Moreover, electronic access to research articles makes it easier to stay on top of the current literature.”

As more research on the Ithaca campus is directed toward the biomedical sciences, it's increasingly important to provide online access to the key medical literature as well. Cornell's libraries have pooled their resources and, whenever possible, negotiated joint online subscriptions so that biomedical literature is available on the desktops of Cornell researchers in Ithaca, Geneva, N.Y., and New York City; extension educators in the Adirondacks; and also at the Weill Cornell Medical College in Dubai, Qatar. For example, Cornell's libraries have jointly purchased electronic access and complete back files to *Methods in Enzymology*, a key resource for laboratory research in the life sciences, and coordinated purchases for *Nature* and *Nature Monthlies* (i.e., *Nature Genetics* and *Nature Biotechnology*), as well as other review journals.

In a recent review of Cornell's medical journal collection, Cornell librarians found that 75 percent of the some 1,500 specialized titles subscribed to by the Weill Cornell Medical College (WCMC) library are now available to users on the Ithaca campus. These include such popular titles as the *New England Journal of Medicine* and *British Medical Journal*, but also all the other key medical journals from major scientific

publishers, including Lippincott, Williams and Wilkins, Springer and Wiley, and important society publications from such organizations as the American Association for Cancer Research. Some of the remaining 25 percent are still not available online.

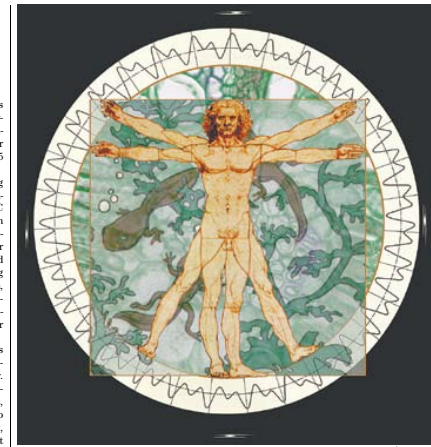
Similarly, Cornell's libraries are expanding their licenses and revamping their authentication systems so that researchers at WCMC and students in the Tri-Institutional Research Program in New York City can access the resources they need – whether in chemistry or psychology. Librarians also have enhanced Cornell's document delivery services among the libraries in the Tri-Institutional program, including Rockefeller University and the Memorial Sloan-Kettering Cancer Center, providing faster turnaround time and better user services at each of these locations.

At the same time, library staff members are developing services to foster collaboration within the life sciences community. Researchers or potential graduate students, administrators or undergraduates, for example, can use VIVO to discover who is working on a particular research topic, what a professor or researcher has taught or published recently, where relevant facilities might be and what online tools are available to expedite research.

Similarly, library instruction programs have recently expanded and now include workshops at Mann Library, the New York State Agricultural Experiment Station Library in Geneva, the WCMC libraries in New York City and Qatar, the Veterinary Library, the Engineering Library and the Physical Sciences Library. New classes include a collaboration with the Department of Public Health to teach evidence-based medicine to first-year medical students.

In spite of all this new technology, the library remains a place to grab a cup of coffee, huddle with others on a group project or to get help finding articles for a research paper.

Janet McCue is associate university librarian for the life sciences and director of Mann Library; Jean Poland is associate university librarian for associated science and technology libraries; and Carolyn Reid is the Frances and John L. Loh Librarian of Medicine and director of Weill Cornell Medical Library in New York City. They are members of the Life Sciences Steering Committee.



VIVO LOGO PROVIDED

### Who is doing virtually what, where and how in life sciences at Cornell

BY MEDHA DEVARE

VIVO <<http://vivo.library.cornell.edu>> creates a virtual life sciences community, bringing together in one Web site all the information needed to figure out who is doing what, where and how in the life sciences at Cornell.

A VIVO search transcends campus, college and department divides to provide an integrated view of the life sciences at Cornell. Students and faculty members can find information on scientists and their research, including grants and recent publications, facilities, undergraduate majors and graduate fields, and seminars and other events. This virtual life sciences collection provides easy access to online databases, software tools and image collections licensed for use by the Cornell community, as well as to important external resources.

Unlike most search engines, VIVO displays results with appropriate cross-referencing to place them in a context that makes sense and saves time. For example, a search for “proteomics” displays listings categorized by:

- “people,” for comprehensive profiles of faculty members working in this field no matter which Cornell college or department they belong to;
- “activities,” for courses, graduate fields and grants related to that subject;
- “events,” for lectures, seminars and workshops;

• “organizations,” for research programs, units or centers;

- “online resources,” for online research tools related to proteomics; and
- “publications,” including recent proteomics-related articles published by



Cornell faculty members and news releases and impact statements. Each entry is linked directly to the original resource, which could be the full text of a recent journal article, a new genomics service or a faculty member's Web page.

VIVO was developed by the library's Life Sciences Working Group, a committee of librarians and information technology specialists from the Ithaca campus, Weill Cornell Medical College and the New York State Agricultural Experiment Station, Geneva, N.Y.

Medha Devare is a bioinformatics and life sciences specialist at Mann Library.


FOCUS on Cornell University Library is compiled by Library Communications. Contact the office at <[libcomm@cornell.edu](mailto:libcomm@cornell.edu)>.



Results of plugging the search term proteom\* into the VIVO search engine showing links to key categories.

# VIVO today

<http://vivo.cornell.edu>

**Cornell University**

SEARCH:

☒ VIVO ☐ Cornell

**VIVO** RESEARCH & EXPERTISE ACROSS CORNELL

Home People Events & Seminars Academic Units Research

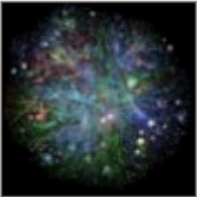
Logged in as jc55 (Log out) Site Admin About Contact Us

## VIVO is a research-focused discovery tool

Browse or search for information about Cornell faculty and staff across all disciplines, departments and colleges.

### Search VIVO

### Making Headlines view all »




**Cornell shares in \$7.5 million grant to create safer Internet**

The three-year grant will allow Cornell and 10 other institutions to revisit principles that have shaped the Internet through a project called Nebula.

Features: [Hakim Weatherspoon](#)

Aug. 30



**Elephants, unfazed by dynamite blasts, seek to avoid humans**

Nearby human activity prompts elephants to dramatically change their behavior, even becoming nocturnal, reports a Cornell study. Photo credit Ruth Starkey.

Features: [Peter Wrege](#)

Sep. 8

### Faculty and Staff

Log in now to manage your page

### Upcoming Seminars view all »

Monday, Sep. 27 2010

**7:30 PM** [AEM 1210 Entrepreneurship and Personal Enterprise Speaker Series presents Jacqueline Novogratz \(Open to the public\)](#)

Tuesday, Sep. 28 2010

**12:20 PM** [TBA Seminar in Nutritional Sciences](#)

**4:15 PM** [Conversations with Entrepreneurs presents Jim Farrell](#)

**6:00 PM** [CEN NYC: The Convergence of Sustainability, IT and Mainstream Business Practices](#)

Wednesday, Sep. 29 2010

**12:30 PM** [TBA - Molecular Medicine Seminar](#)

# Data, data, data

VIVO harvests much of its data automatically from verified sources

- Reduces the need for manual input of data
- Provides an integrated and flexible source of publicly visible data at an institutional level



# VIVO as harvester



Faculty  
updates



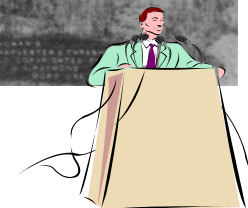
Campus  
directory



News Service RSS feed



Events calendar  
Departmental seminars



Conference  
presentations



Course listings



Grant Money

Grants



# VIVO as disseminator

The screenshot shows the homepage of the Cornell University Graduate Programs in the Life Sciences website. The header includes the Cornell University logo and a search bar. The main title is "Graduate Programs in the Life Sciences". Below the title is a navigation bar with links: Home, Graduate Fields, Research Areas, Faculty, Facilities, and Search. The main content area is divided into two columns. The left column contains a list of research fields with corresponding icons: applied biology (microscope), biomedical sciences (pill), ecology, evolution, and integrative biology (leaf), genetics, genomics, and bioinformatics (DNA helix), molecular and cellular biology (molecule), and physical, chemical, and computational biology (flask). Below this list is a link to "see the full list of Fields instead". The right column contains a search bar for research areas, a site search bar, and a list of helpful pages including "More about how Graduate Fields work", "Fellowships & Assistantships", "Graduate student life at Cornell", and "Facts about Cornell". At the bottom of the page is a footer with copyright information and a link to the site feedback page.

Cornell University

Search Cornell

## Graduate Programs in the Life Sciences

Home Graduate Fields Research Areas Faculty Facilities Search

Graduate programs at Cornell are organized by Fields. The first step in applying is identifying a Field that best matches your academic goals.

With over 30 Fields to choose from in the Life Sciences, let's narrow it down by selecting a broad interest...

-  **applied biology**
-  **biomedical sciences**
-  **ecology, evolution, and integrative biology**
-  **genetics, genomics, and bioinformatics**
-  **molecular and cellular biology**
-  **physical, chemical, and computational biology**

...or see the [full list](#) of Fields instead

Already determined which Field is right for you? [Apply Now](#)

Have a research area in mind?

--- try one --- [go](#)

Search this site

[go](#)

### Helpful Pages

- [More about how Graduate Fields work](#)
- [Fellowships & Assistantships](#)
- [Graduate student life at Cornell](#)
- [Facts about Cornell](#)

© 2008 Life Sciences Cornell University Ithaca, NY 14853 [Site Feedback](#)

<http://gradeducation.lifesciences.cornell.edu/>

# VIVO as disseminator

Cornell University  
College of Agriculture and Life Sciences

Search CALS

CALS Impact Statements

Q

HOMEBROWSEMAPSSearch

Search impact statements

biofuel

Search

## Search results

### The costs and benefits of biofuels policies

2007 Impact statement

... renewable energy policy/biofuels abstract ... greenhouse gas (GHG) emissions resulting from alternative biofuels policies under the 2007 Energy Bill. We examine the effects of three ...

### Cornell Biofuels teaching game: The Race to the Pump!

2007 Impact statement

... R&D" spot to advance more rapidly toward the goal. The biofuel pump at the end of the game states, "We all win!", reminding us of the ecological benefits to the whole planet from use of biofuels. response ...

### Evaluation of grasses and legumes for use as biofuels

2007 Impact statement

... will provide more economical production of feedstocks for biofuels. key personnel ... and quality of biomass needed to support the emerging biofuel industry in NY. The majority of research conducted on bioenergy crops ...

### Producing plant-grown fungal enzymes to break down plant waste into biofuel

2005 Impact statement

... biofuels through biomolecular farming ... opportunities in converting agricultural plant waste into biofuel. Although laboratory-scale advances in molecular and genetic ...

### Engineering cellulases with higher activity on pretreated biomass substrates for biofuel

## FILTERS

Select items below to narrow the list. Totals on the right indicate the number of impact statements linked to a particular item.

### Years

2005 Impact statement	2
2006 Impact statement	6
2007 Impact statement	14

### Departments


Biological and Environmental Engineering (BEE)	1
Boyce Thompson Institute for Plant Research (BTI)	1
Controlled Environment Agriculture (CEA)	1
Cornell Cooperative Extension (CCE)	2

### Submitters

Bento, Antonio Miguel R.	1
Cherney, Jerry H.	1
Davis, Jerrold I	1
Davis-Manigaulte, Jacqueline Ann	2

### Locations: International

Afghanistan	1
-------------	---

Cornell University  
College of Agriculture and Life Sciences

Search CALS Search Cornell


CALS Impact Statements

Q

HOMEBROWSEMAPSSearch

International and domestic locations where CALS research focuses

International  
170 impact statements in 127 areas



MapData | Terms of Service

# VIVO as disseminator

 Cornell University

Search Cornell

## https://confluence.cornell.edu/display/collaborate/

### Collaborate@Cornell

Global Partnerships, Knowledge, and Technology

*“As globalization reshapes academic disciplines as well as regional economies, institutions have begun to see their public-service missions in global terms. And they are forging new kinds of international partnerships to expand upon their expertise in the fields of particular importance to the developing world...”*

The Chronicle of Higher Education

#### Discover locally what others are doing internationally

Collaborate@Cornell: Global Partnerships, Knowledge, and Technology is an on-campus opportunity for faculty, staff, and graduate students to reach across the quads and discuss how to share knowledge and research with international partners, particularly partners in developing countries. Nominate topics and participate in small-group discussions focused on technology and knowledge-sharing, and share and learn about current and on-the-horizon projects through lightning presentations.

#### Find Cornell Collaborators by Country

Select a country to see who at Cornell has research interests there. (Don't see yourself listed? Visit [VIVO](#), login with your NetID and password to modify your page, or send an e-mail to [vivo-contact-L@cornell.edu](mailto:vivo-contact-L@cornell.edu).)

--- Select a Country ---



**May 21, 2009**  
9:00am - 4:00pm  
Mann Library


 Welcoming address by Alice Pell, Vice Provost for International Relations

#### Topics

Topics will be continually updated as users register for this event.

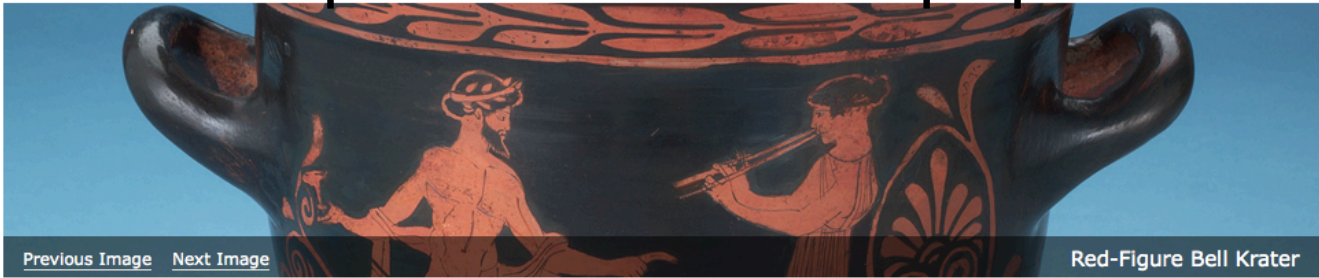
- Cell phone technology
- Knowledge management systems
- Radio technology
- Knowledge sharing tools
- Information resources for researchers in developing countries
- Policy and capacity building
- Mapping technology
- Biodiversity conservation
- Online professional development for practitioners in developing countries
- Community Film Making

# VIVO as disseminator

**Cornell University**  
Department of Classics

☒ Classics ☐ Cornell

## <http://classics.cornell.edu/people>




[Previous Image](#) [Next Image](#)

Red-Figure Bell Krater

[Home](#) [Undergraduate](#) [Graduate](#) [People](#) [Research](#) [Courses](#) [News and Events](#)

### Rebillard, Eric

*Professor*



**email:**  
[er97@cornell.edu](mailto:er97@cornell.edu)  
**phone:**  
607-255-8640  
**room:** Goldwin  
Smith Hall, Room  
127

#### Department Appointments

- Classics (CLASS)
- History (HIST)

#### Graduate Fields

- Archaeology
- Classics
- History

### Overview

Professor Rebillard received his PhD from the Sorbonne (Paris, France) in 1993 and is a former member of the Ecole française de Rome. He came at Cornell in 2004 after having held a research position in the French CNRS between 1996 and 2003. He works on the transformations of religious practices in Late Antiquity. His second book has recently been translated into English: *The Care of the Dead in Late Antiquity* (Cornell University Press 2009).

He is also the Editor of [L'Année philologique on the Internet](#), the Bibliography of reference for Classical studies, and Principal Investigator of the [Classical Works Knowledge Base](#) Project.

### Research Focus

- History of Late Antiquity and Early Christianity
- Augustine of Hippo
- Roman Funerary Archaeology

### Courses

*On leave 2010-2012.*

# Disciplinary portals

- Filtered campus-wide views of social sciences, physical sciences & engineering, humanities, medical/veterinary, plus and “all” portal
  - People, departments, events, centers, facilities
- In anticipation of strong differences in content and faculty desire for disciplinary coherence
  - Brand identification of VIVO with life sciences
- Librarian curators with student assistants worked with faculty and departments to solicit ideas & feedback

# Lessons learned

- The “all” portal had the most interest and traffic
- Much less than anticipated call for separation
- Impossible to define edges
  - Arbitrary
  - Inconsistent
  - Manual
  - Downstream effects
- More consequences from getting it wrong
  - “You'll understand that as a scientist, I'm not crazy about inaccuracy.”

# Faculty reporting

- Year-long evaluation of VIVO as an instrument for capturing faculty reporting data
- Implemented self-editing with university single sign-on authentication
- Joint team with college business and IT staff to define desired data elements
- Eventually mutual cold feet
  - Colleges needed reporting by defined period and private data – 7 of them chose Activity Insight
  - Library not eager to be associated with metrics
- VIVO chosen as a “lite” alternative for web profile data

# Relationship to central administration

- Strong interest from vice provosts for life sciences, social sciences, and Ithaca-Weill partnerships
  - Proposed VIVO initially as a core facility
- Modest foundation funding reallocated
- Advisory committee established
- Seen as the new phone book
  - Basic facts of employment, courses, grants
  - Opt-out rather than opt-in
  - Fix it yourself
- Never a clear moment when “ready”



# Challenges

- Keeping VIVO up to date
- Managing expectations
- Balancing administrative SORs against requirements for public-facing websites
  - Always easier to build a shadow system or custom website
  - Real issues of branding, message, coherence
  - “We already have web pages!”
- Data integrity in cross-linking
  - Harder to hide broken data, duplicates
- Data that’s visible becomes cleaner data

# Internal sustainability questions

- Moving targets
  - University communications needs
  - Data security and stewardship concerns
  - Central systems of record migrations (Kuali finance)
  - Hub vs. spokes – changing IT governance
  - Research office compliance issues
- Changing views of research libraries
  - Mostly positive response to engagement

# How else can VIVO help Cornell?

- Fostering collaboration and synergy through greater awareness
- Reducing duplication of research
- Determining strategic trends based on strengths and weaknesses of the network
- Identifying missing expertise
- Improving responsiveness to calls for proposals
- Facilitating team formation
- Providing a marketing tool for research

# Motivations beyond Cornell

- Competition – follow the lead of Harvard, Stanford, ...
- Outcome-based evaluations need data
  - NIH CTSA program and others
  - Bibliometric analysis
- NIH publication deposit mandate
- NSF data management plan requirements
- Gradual awareness of Linked Open Data

# VIVO proposal, 2006

- Cornell University needs a single access point on the Web for anyone seeking information on scholarly activity at Cornell. This single point of access needs to consistently convey a sense of **one Cornell**, despite its size, complexity, and many interdisciplinary programs, and to direct users efficiently to the individuals, programs, departments, or other points of contact they seek.

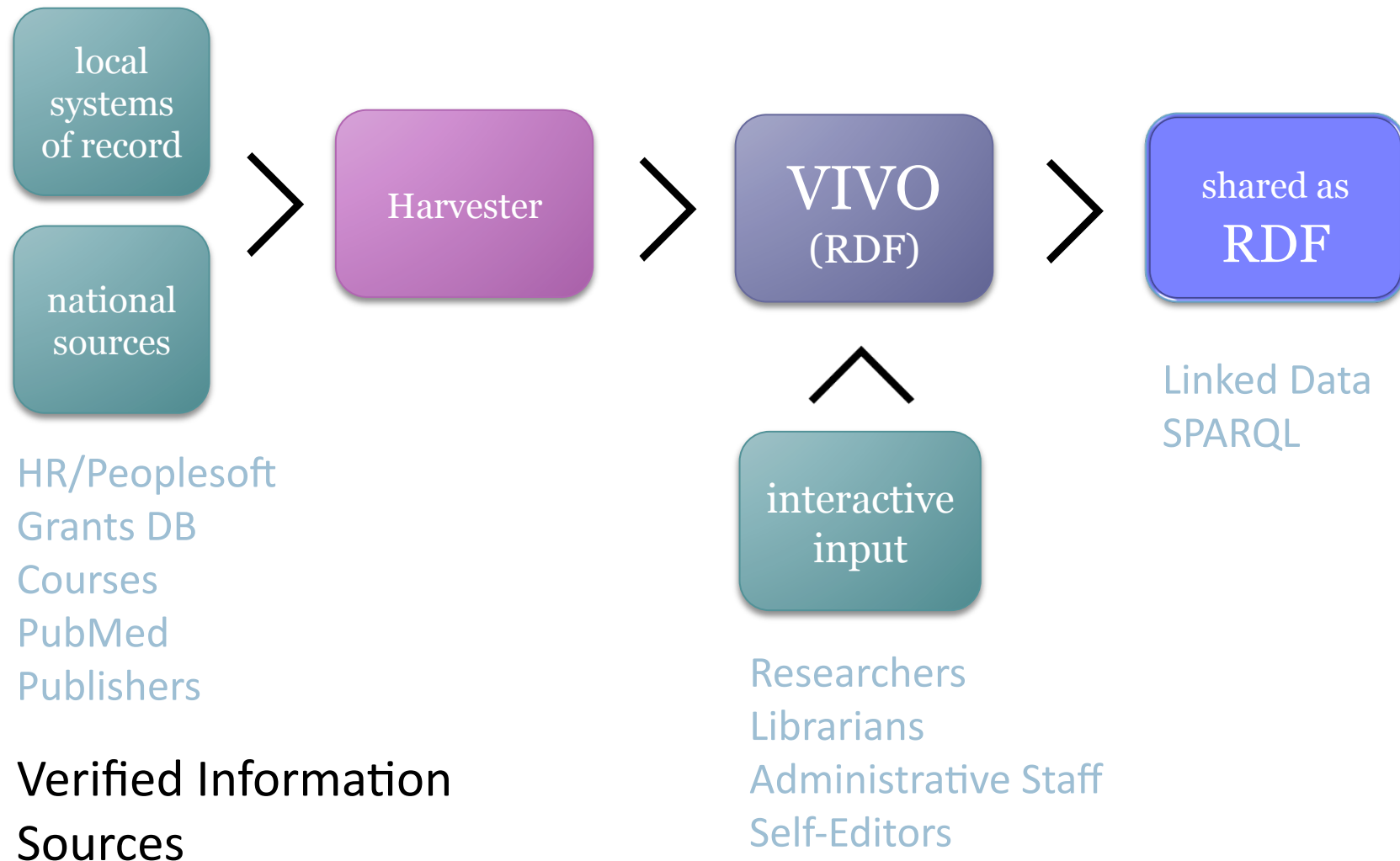
# Cornell Strategic Plan, 2010

- The central theme of this plan can be captured by a single phrase, **One Cornell**. Think of Cornell University as a single entity, embedded in but transcending and overarching colleges and units. The “greater sum” that represents this One Cornell is the primary focus of this plan.
- [Achieving Cornell’s aspirations] will require ... more developed connections among and between the impressive strengths that are distributed across academic units on campus.

# Transitioning VIVO to the Semantic Web

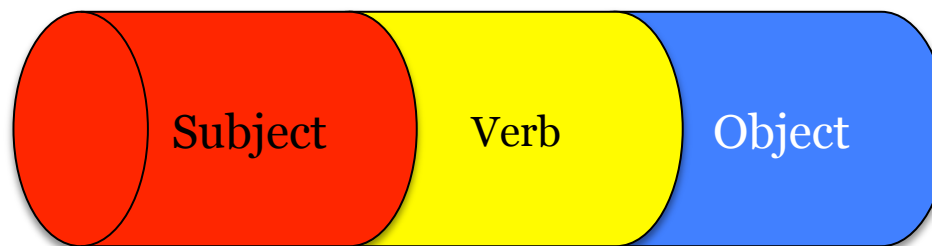
- Motivations
  - Using and extending standard ontologies (AKT, SWRC)
  - Ability to import and export a standard data format
  - Ability to use reasoning to reduce dependence on hand classification
  - Ability to leverage SPARQL for queries
    - Query the data, not the model
- Approach to conversion (2007)
  - Leave the interface largely the same
  - Modify editor to use OWL classes, properties, and axioms
  - Transplant app onto Jena open source libraries

# VIVO conceptual architecture



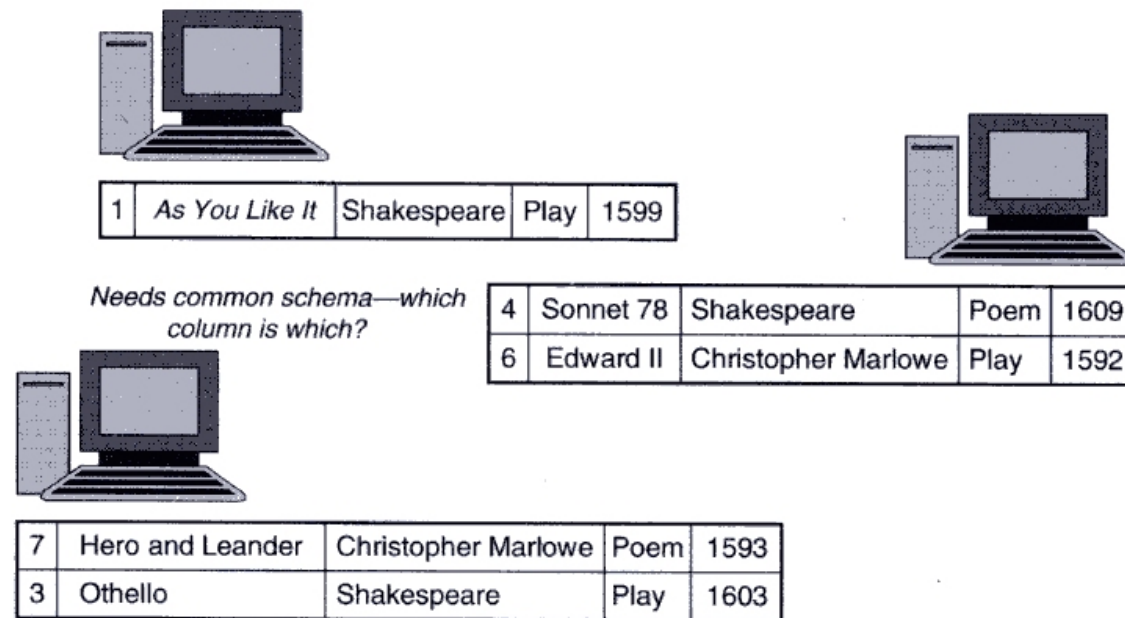
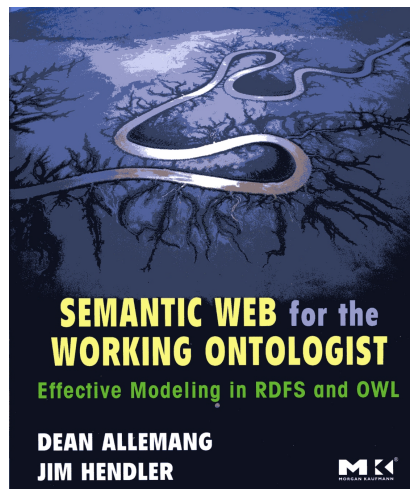


# Why RDF?



# Data as rows in one table

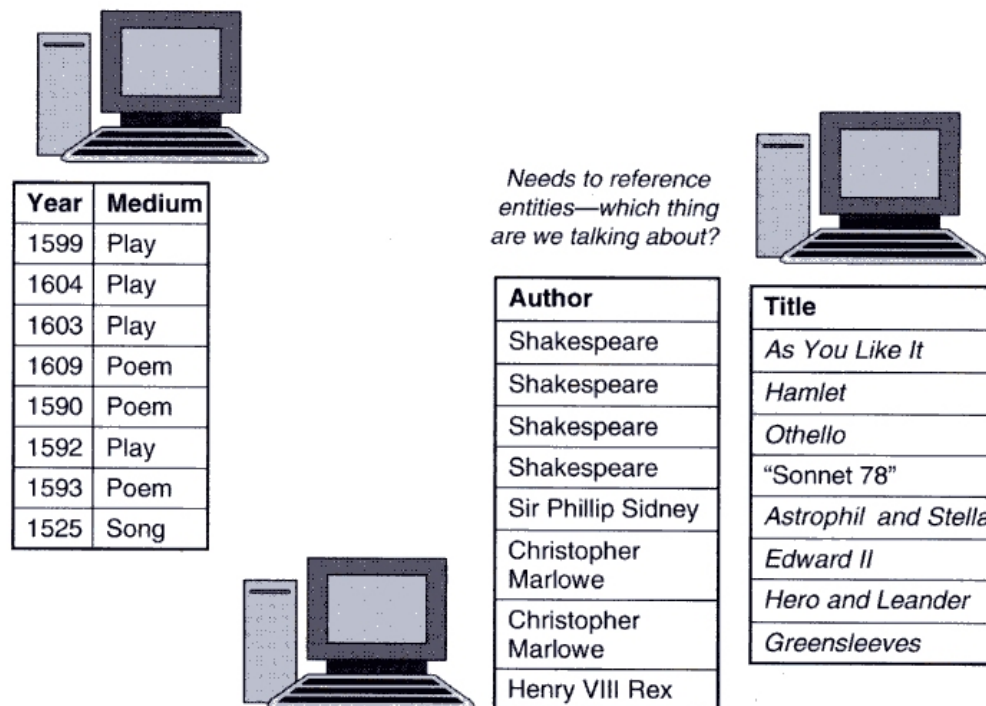
- Value pairs sharing an identifier per row
- Each table in each application has own schema



**FIGURE 3-1**

Distributing data across the Web, row by row.

# Data as columns in tables (silos)

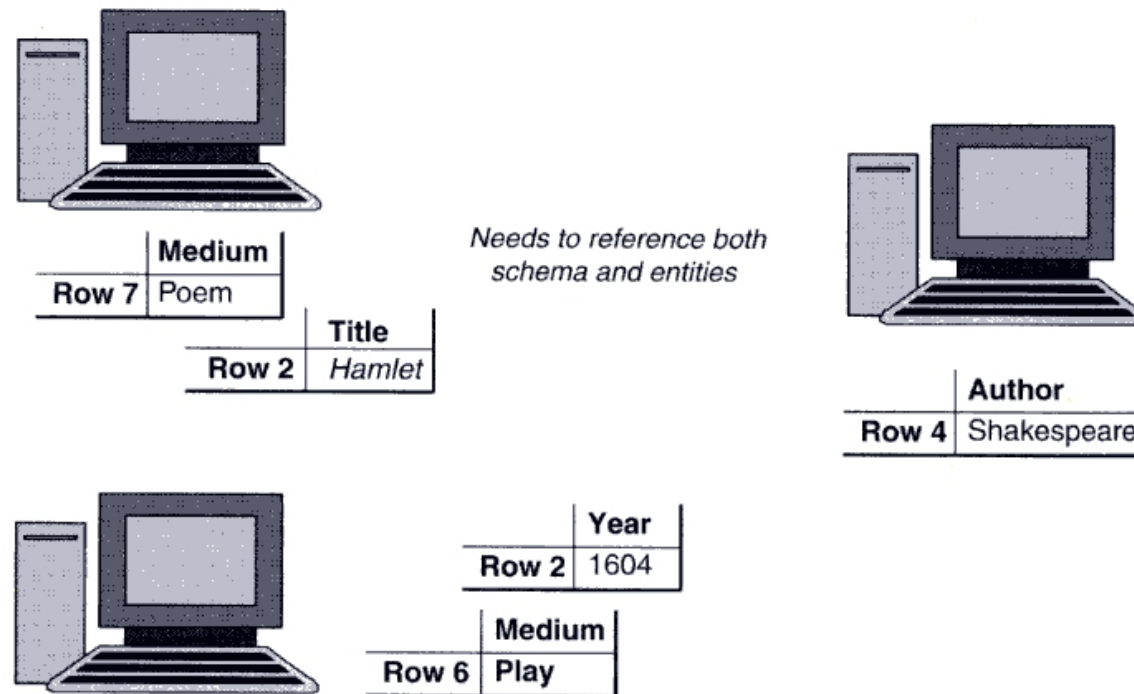


**FIGURE 3-2**

Distributing data across the Web, column by column.

www.it-ebooks.info

# Data as self-contained cells



**FIGURE 3-3**

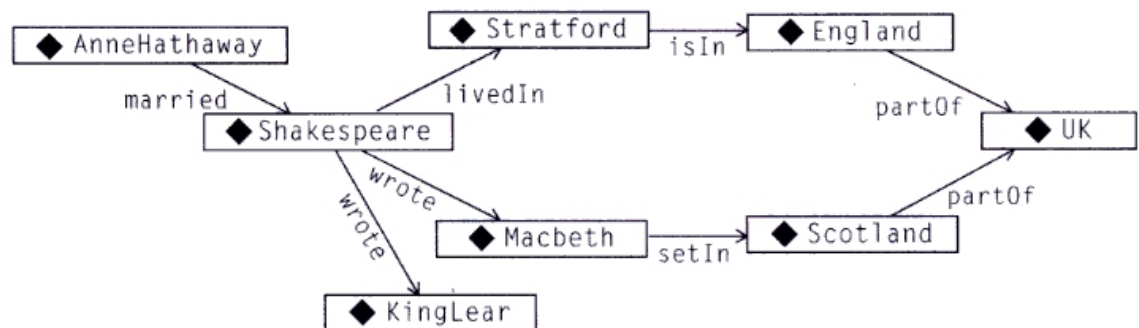
Distributing data across the Web, cell by cell.

# Cells as triples

**Table 3-3** Sample Triples

Subject	Predicate	Object
Shakespeare	Wrote	King Lear
Shakespeare	Wrote	Macbeth
Anne Hathaway	Married	Shakespeare
Shakespeare	Lived In	Stratford
Stratford	Is in	England
Macbeth	Set in	Scotland
England	Part of	The UK
Scotland	Part of	The UK

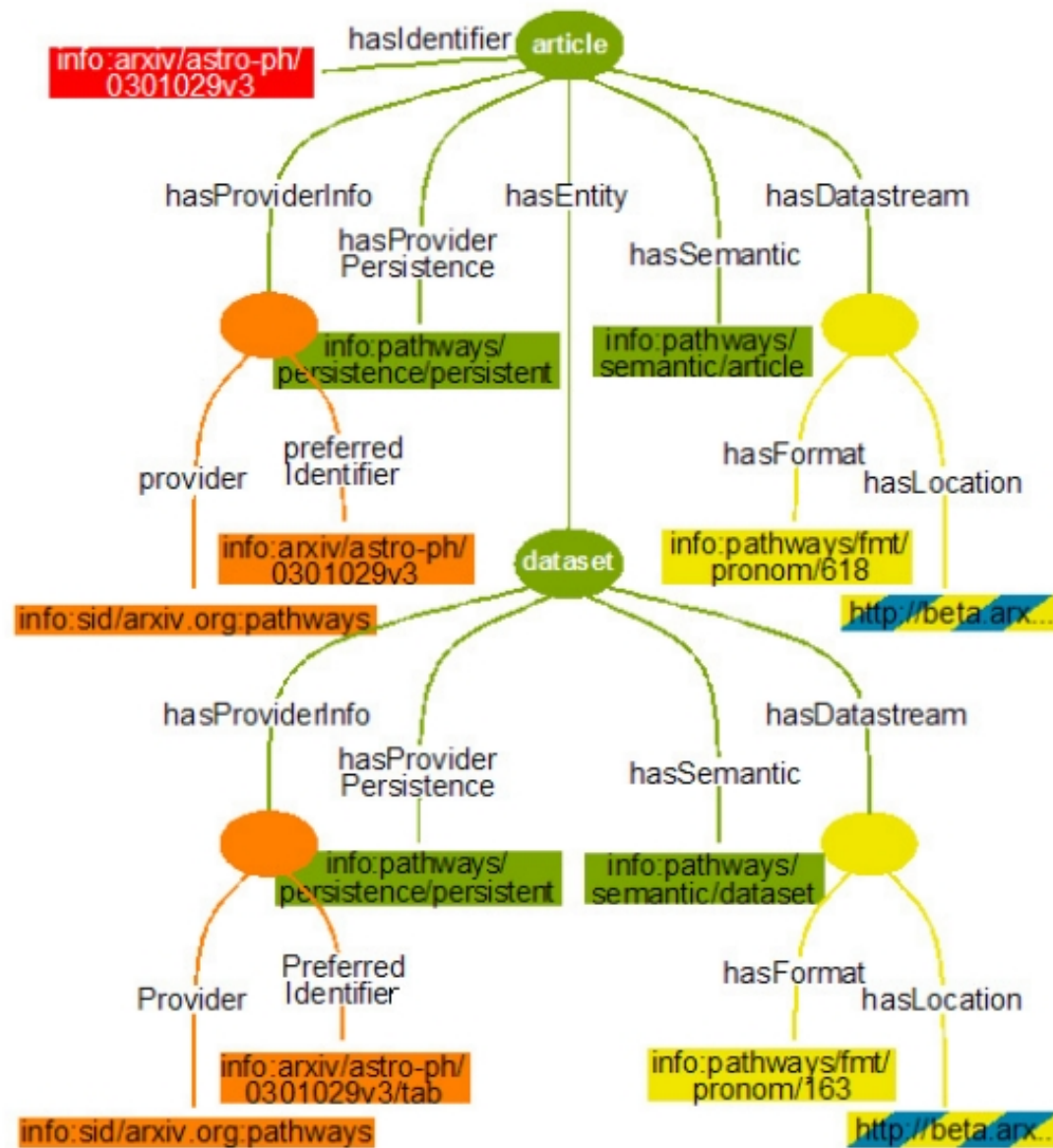
... and as a graph



**FIGURE 3-4**

Graph display of triples from Table 3-3. Eight triples appear as eight labeled edges.

# A populated graph of triples



Van de Sompel, H., Lagoze, C., Bekaert, J.,  
Liu, X., Payette, S., Warner, S., An  
Interoperable Fabric for Scholarly Value  
Chains, D-Lib Magazine, October, 2006



# Querying triples

- By individual URI (subject or object)
  - Everything about one event, a grant, a person
- By property relationship (verb)
  - All organizations that are *part of* another
- By type
  - Everything with an `rdf:type` of Event, Grant, or Project
- By combinations of the above
- SPARQL leverages the RDF format to focus on data rather than schema

# Data integration without a common format



*Log jam, looking up the dalles, Taylor's Falls, St. Croix River, MN. Photo by F.E. Loomis*

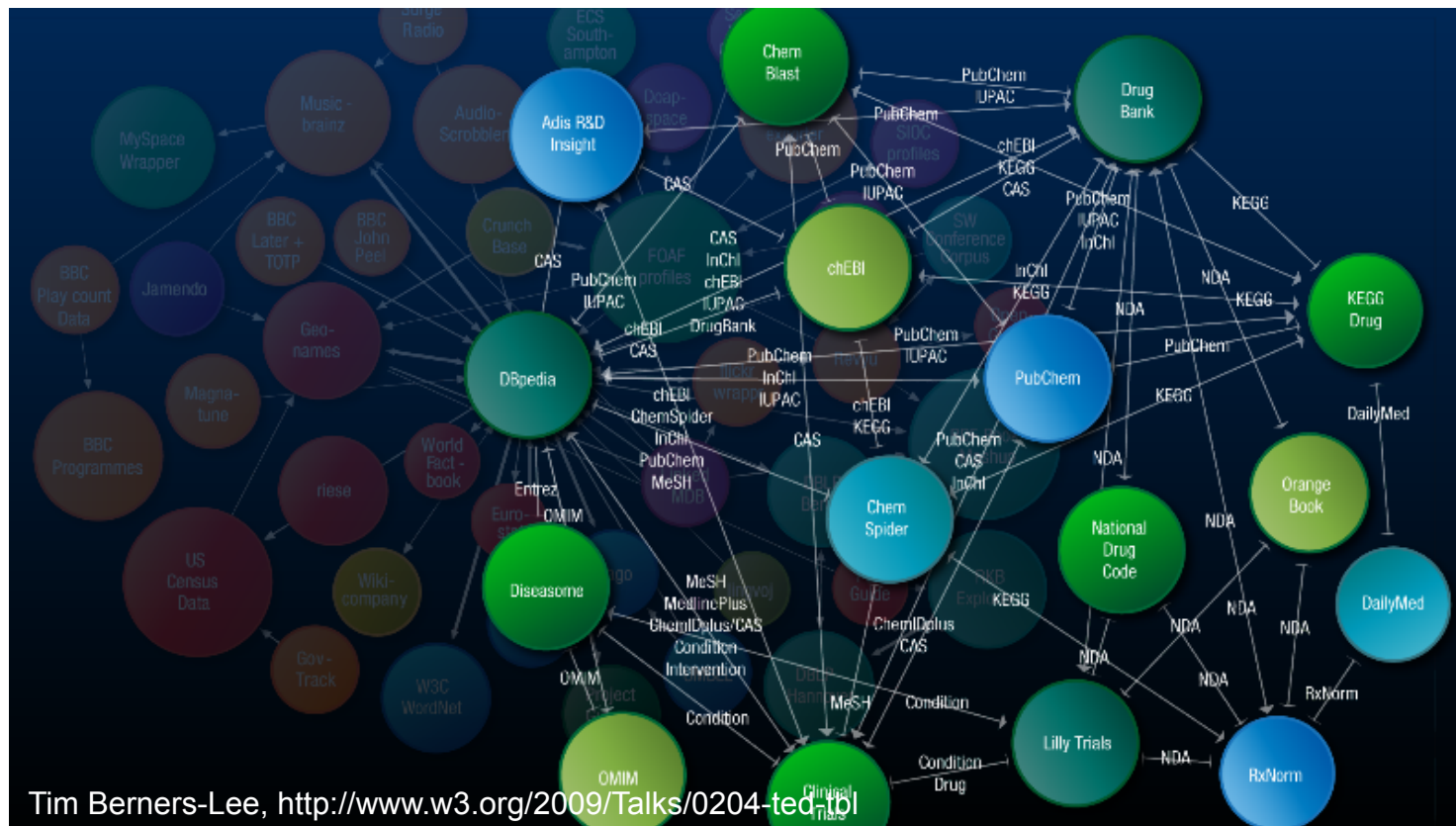


# Benefits of the Linked Data approach

	Traditional data integration	Linked data approach
Data structure	Predominantly relational; <b>focus is on sets of similar data</b>	More flexible: <b>focus is on relationships</b> between things <b>regardless of similarity</b>
Data integration method	<b>Extract</b> from original source, <b>transform</b> to local data	<b>Link to source</b> of data using data definitions in shared ontology
Data integration scalability	Each new data source expands costs exponentially	New data sources are accessible at minimal cost, and business domains share the federation cost
Contextual richness	Constrained by costs and central staff workloads	Benefits from the network effect: <b>context gets added with new data and linkages</b>
Information source bias	Internal	Internal and external
Business unit involvement	Report requestors	Managers of their own ontology and external data-linking activities
Standardization method	One standard, no exceptions, loss of valuable information context	Explicitly allows both standard data and contextual information

PricewaterhouseCoopers, *Spinning a Data Web*,  
<http://www.pwc.com/extweb/pwcpublications.nsf/docid/C85F6867F37F5307852575BA00633F F7>.  
Accessed June 25, 2009.

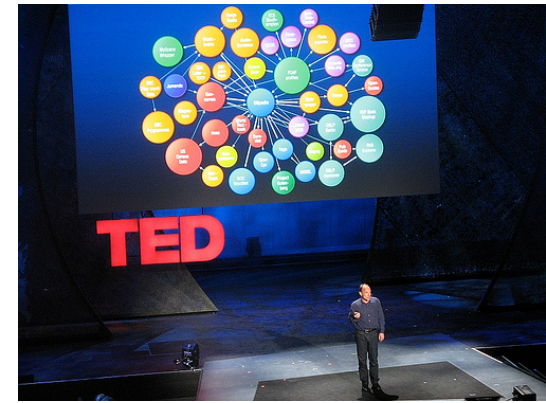
- VIVO enables authoritative data about researchers to become part of the Linked Open Data (LOD) cloud



# Linked Data principles

Tim Berners-Lee:

- Use URIs as names for things
- Use HTTP URIs so that people can look up those names
- When someone looks up a URI, provide useful information, using the standards (RDF, SPARQL)
- Include links to other URIs so that people can discover more things



<http://www.w3.org/DesignIssues/LinkedData.html>

<http://linkeddata.org>

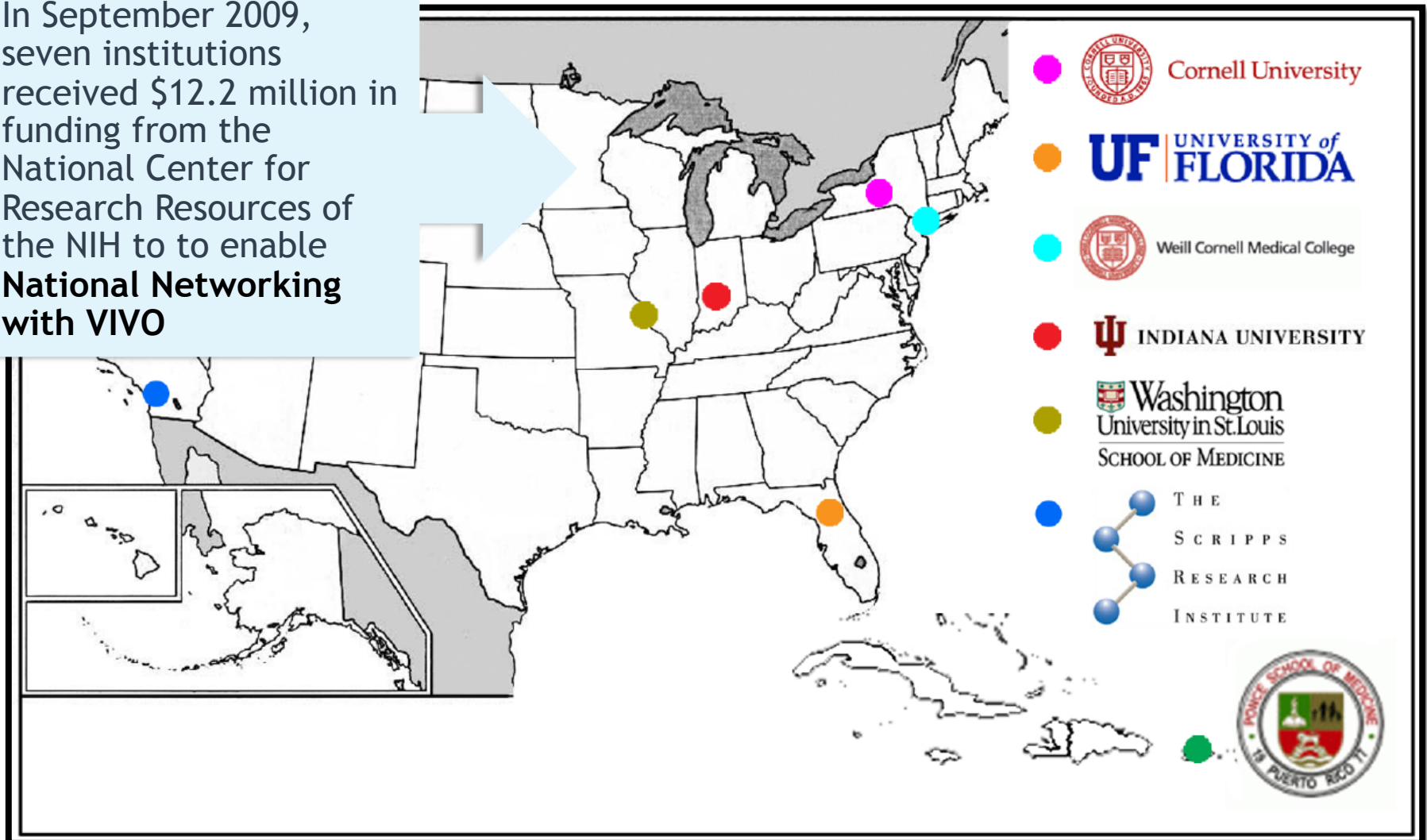
1. **Introduction**  
 2. **Background**  
 3. **Methodology**  
 4. **Results**  
 5. **Conclusion**  
 6. **References**



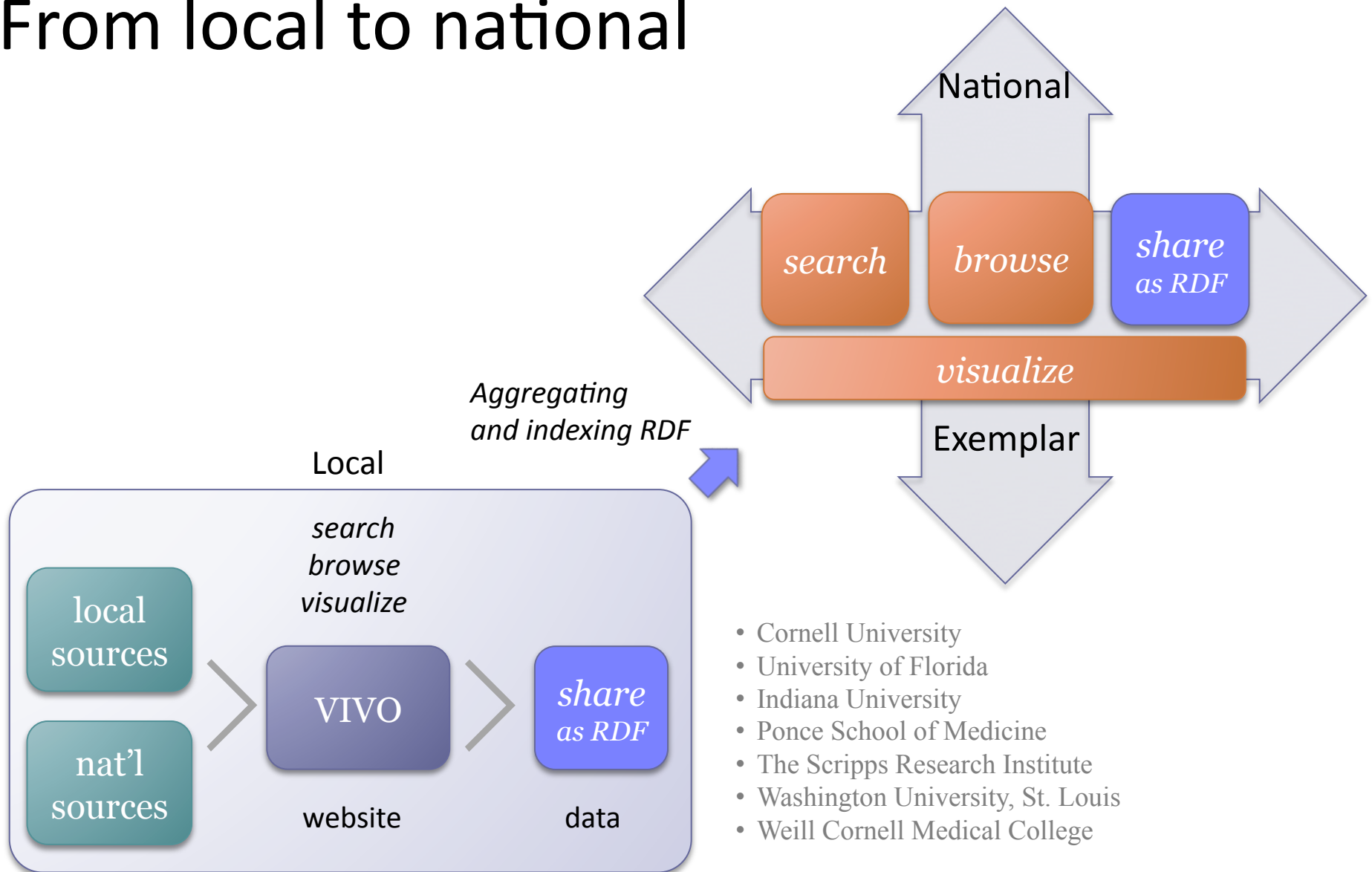


# Enabling National Networking of Scientists

In September 2009, seven institutions received \$12.2 million in funding from the National Center for Research Resources of the NIH to enable **National Networking with VIVO**




# From local to national



Development of an Observational Instrument to Measure Mother-Infant Separation Post Birth article 2004  
DellenStat: Statistical Software to Accompany A Course in Modern Business Statistics book 1991

# Mike Conlon's profile as Linked Data




Conlon, Michael

**VIVO** Enabling National Networking of Scientists

Home People Academic Units Research Events & Seminars


**Conlon, Michael** Associate CIO, IT Architecture

[Personal web page](#) | [Clinical and Translational Science Institute Home](#)



**description**

Dr. Conlon is Associate CIO for IT Architecture, interim Director of Biomedical Associate Director of the university's Clinical and Translational Science Institute National Networking of Scientists. His responsibilities include development of integration of research and clinical information resources as well as strategic Previously Dr. Conlon served as Chief Information Officer of the University of



marbles

Open

**Conlon, Michael**

**type**

- [Person](#)
- [Thing](#)
- [Agent](#)
- <http://vivoweb.org/ontology/core#FacultyMember>
- <http://vivoweb.org/ontology/core#Faculty>

**label**

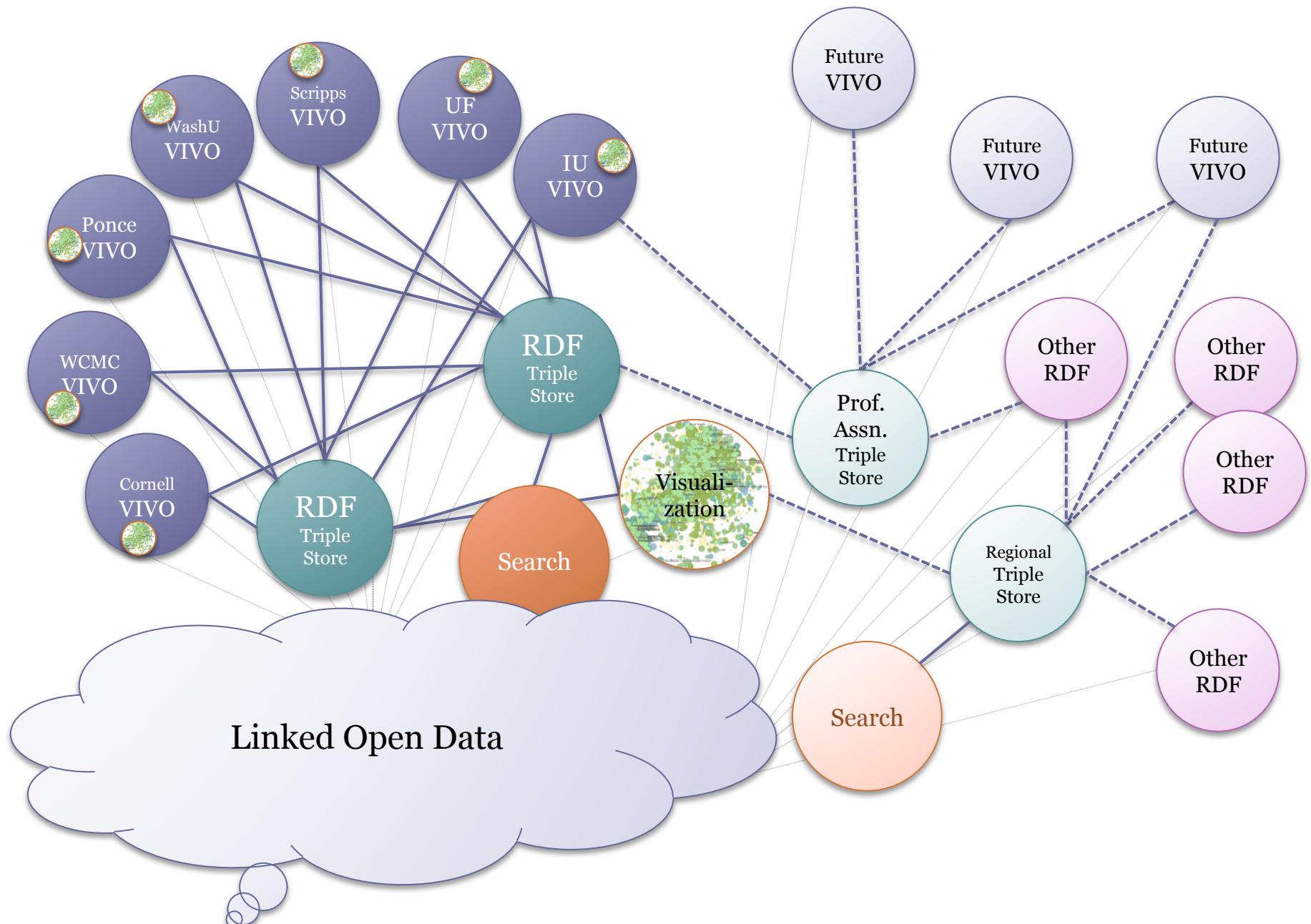
- Conlon, Michael

<http://vivoweb.org/ontology/core#featuredIn>


- <http://vivo.ufl.edu/individual/n6868>
- <http://vivo.ufl.edu/individual/n3884>
- <http://vivo.ufl.edu/individual/n6584>
- <http://vivo.ufl.edu/individual/n180>
- <http://vivo.ufl.edu/individual/n1162>
- <http://vivo.ufl.edu/individual/n19995>
- <http://vivo.ufl.edu/individual/n3594>
- <http://vivo.ufl.edu/individual/n32542>
- <http://vivo.ufl.edu/individual/n5977>
- <http://vivo.ufl.edu/individual/n6415>
- <http://vivo.ufl.edu/individual/n2663>
- <http://vivo.ufl.edu/individual/n2833>
- <http://vivo.ufl.edu/individual/n5984>
- <http://vivo.ufl.edu/individual/n2008>
- <http://vivo.ufl.edu/individual/n2514>
- <http://vivo.ufl.edu/individual/n5391>
- <http://vivo.ufl.edu/individual/n3188>



# National networking



# National network search



## VIVO FACULTY SEARCH DEMO

Using Apache Solr for federated search

HOMEABOUT

HOME

SEARCH FACULTY ACROSS INSTITUTIONS

Examples: [\*drosophila\*](#), [\*conference japan\*](#), [\*Washington\*](#)


This site demonstrates the distributed search capabilities of Apache Solr, using Drupal 6 as a front end. Distributed search and search faceting are part of Solr itself, so this is also possible with other platforms.

### Overview

- There are three separate search indexes on three separate servers.
- Each index contains content about faculty from a single VIVO instance.
- VIVO instances indexed are: Cornell University, University of Florida and The Scripps Research Institute.
- This demo site does not host any of the content.

See the [about page](#) for more details on how things are configured.

# Solr/Drupal prototype



## VIVO FACULTY SEARCH DEMO

Using Apache Solr for federated search

HOMEABOUT

### SEARCH

Enter your keywords:

### Search results

[Nemazee, David](#)

THE SCRIPPS RESEARCH INSTITUTE

**recombination.** ...

<http://vivo.scripps.edu/individual/NemazeeDavid>

[Pawlowski, Wojciech](#)

CORNELL UNIVERSITY

Meiosis and meiotic **recombination** in plants Meiosis and meiotic **recombination** in plants Meiosis and **recombination** in plants. Ph ...

<http://vivo.cornell.edu/individual/individual7334>

[Saxena, Brij B.](#)

CORNELL UNIVERSITY

. Clones containing bovine LH-R cDNA inserts are expressed to obtain **recombinant** LH-R for epitope mapping. We propose to develop a stable cell line for the expression and purification of the **recombinant** LH ... the structure-function relationships, immuno-, and molecular biology of **recombinant** LH-R, as well ...

<http://vivo.cornell.edu/individual/individual11873>

### FILTER BY INSTITUTION

- Cornell University (56)
- The Scripps Research Institute (2)
- University of Florida (1)

### NOTES

Not all content about faculty is indexed. Some properties, such as publications, were not indexed.

# The Semantic Web: big pile o' triples

S – P – O  
S – P – O  
S – P – O  
S – P – O  
S – P – O

- You don't need a schema to start storing data
- Just add triples
- If you can write it as a simple statement, you can say it in RDF.



# The Semantic Web: Linked Data ideas

- Use established, widely-recognized vocabularies (ontologies) wherever possible

BUT

- Get your data out there! Turn it into triples.
- We don't all need perfect agreement on perfect ontologies to start sharing data.

# Integration without complete transformation

cornell:individual19133 core:teaches cornell:class10666 .

cornell:class10666 rdfs:label "MSE 2920 – Research Involvement  
IIB" .

cornell:class10666 stars:class\_CourseIdandClassNbr  
"353880-16764" .

cornell:class10666 stars:class\_classCourseId "353880" .

# Integration by linking: one approach

cornell:individual19133 core:teaches cornell:class10666 .

cornell:class10666 rdfs:label "MSE 2920 – Research Involvement  
IIB" .

cornell:class10666 owl:sameAs  
<<http://courses.cornell.edu/class-353880-16764>>

# Integration by linking: another approach

cornell:individual19133 core:teaches

<<http://courses.cornell.edu/class-353880-16764>> .





# The Semantic Web: VIVO core ontology

- Helps us build a national network
- Query data consistently across institutions
- For integrating data, not prescribing how things should be
- Institution retains control over details of how its people and organizations are represented

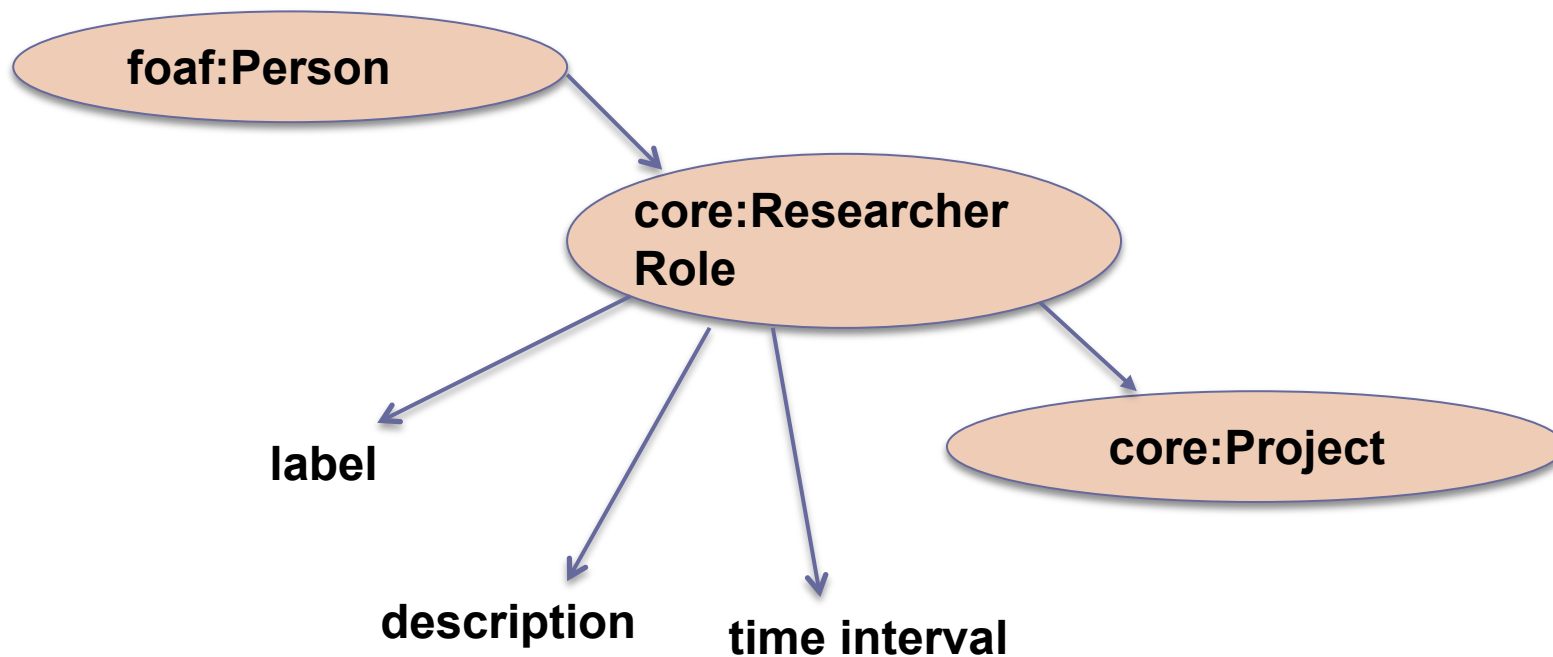
# VIVO core ontology

- Main areas of information modeled:

People –	Grants/Contracts
- Background	Courses
- Research Activities	Organizations
- Publications	Events

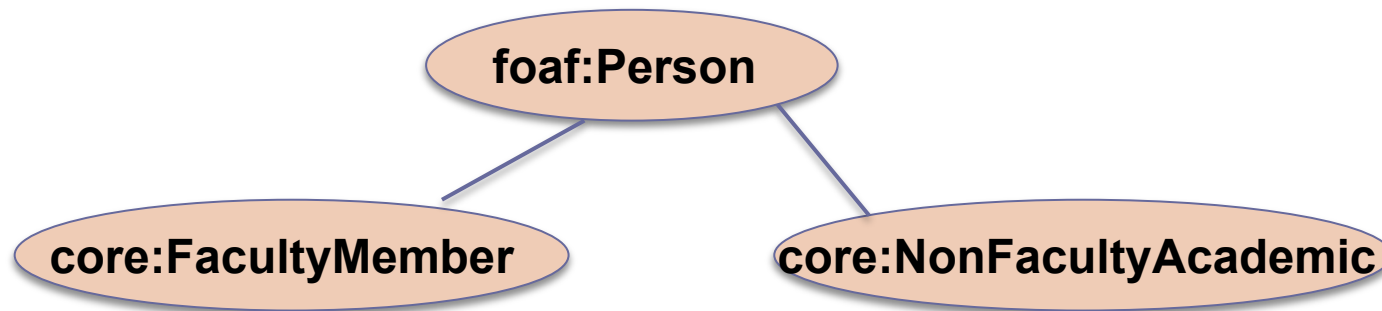
# VIVO core ontology: roles and context

- Sometimes need more than just a simple triple.



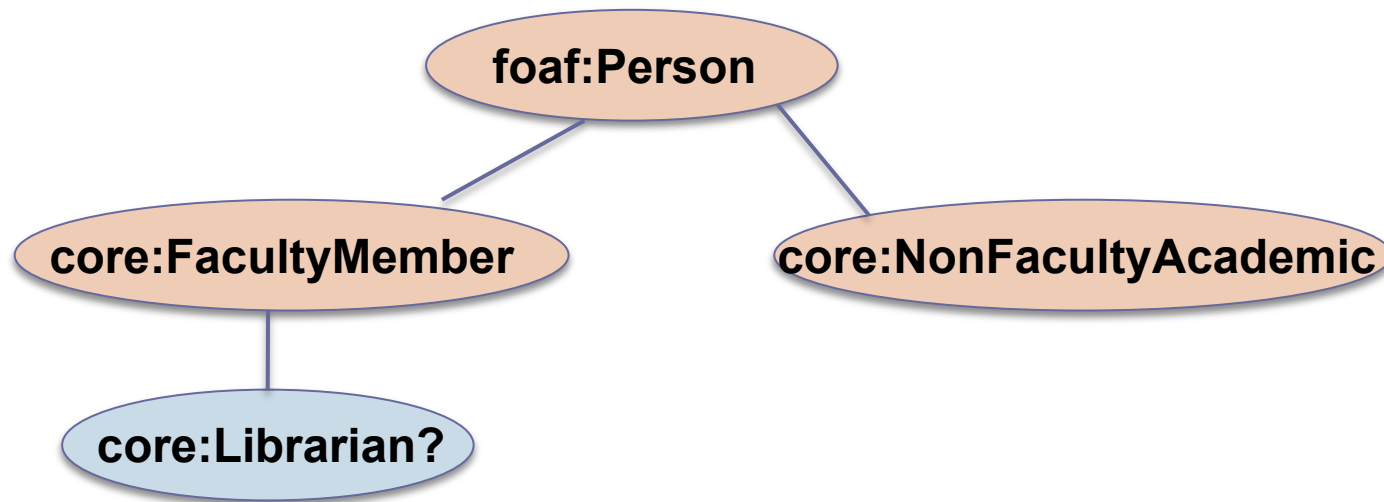
# VIVO core ontology: the librarian problem

- Many academic institutions have librarians, but where do we represent them in the ontology?



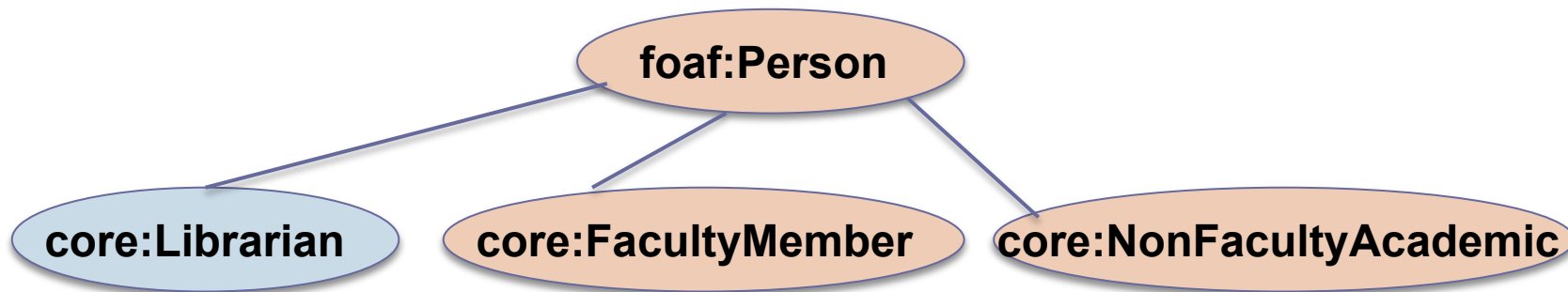
# VIVO core ontology: the librarian problem

- Many academic institutions have librarians, but where do we represent them in the ontology?



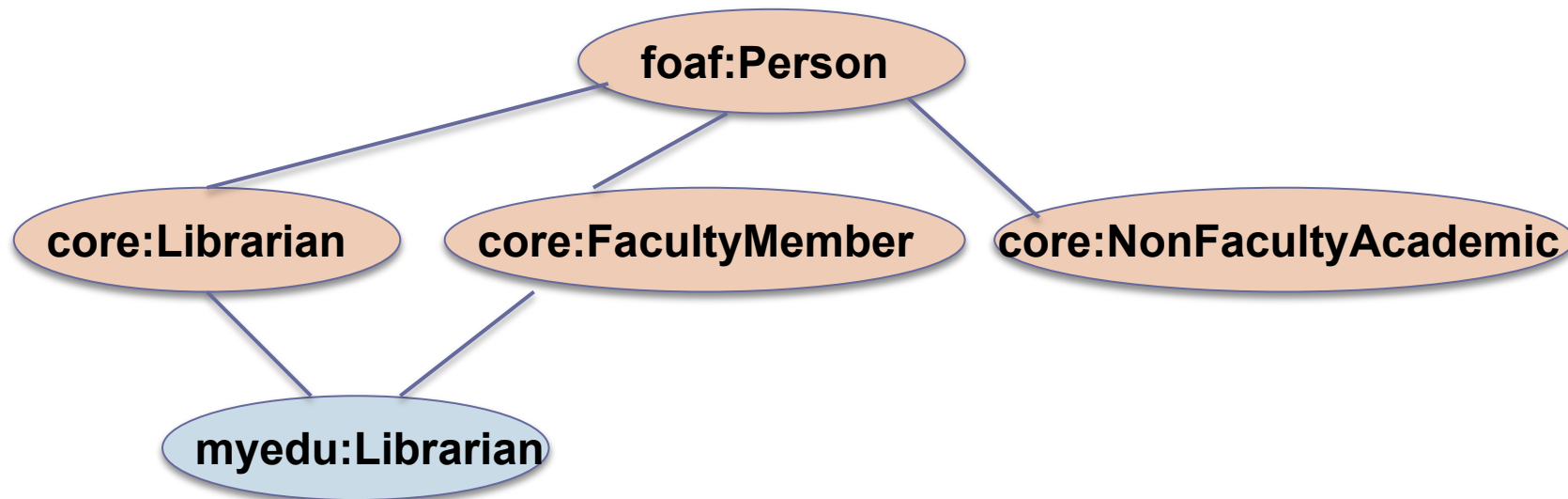
# VIVO core ontology: the librarian problem

- This arrangement should work across institutions.



# VIVO core ontology: the librarian problem

- Local extension avoids asserting multiple types.



# The Semantic Web: ontologies

- Ontologies help us make sense of the triples
- Tell us what a triple “means” (and what’s implied – but not explicitly stated – by that triple)
- Ontologies don’t tell us what triples we’re “allowed” to write



# Role of the ontology

- ObjectProperty ex:hasPet
  - Domain foaf:Person
  - Range ex:Animal

```
:JohnDoe ex:hasPet ex:fuelInjector2397 .  
ex:fuelInjector rdf:type  
  ex:FuelInjector .
```

Is this an error? *Well, maybe.*

# Role of the ontology


- The ontology becomes *inconsistent* if ex:Animal and ex:FuelInjector are declared to be *disjoint*.  
(Or if disjointness is asserted further up the hierarchy, e.g. LivingThing disjointWith CarPart)
- Otherwise, we just get an inference that the fuel injector is also an animal.


DataStaR

http://datastar.mannlib.cornell.edu/

Google

AppleGoogle MapsiGoogleNews (463)Thinking ClearlyMTSR 2009 -...c Research

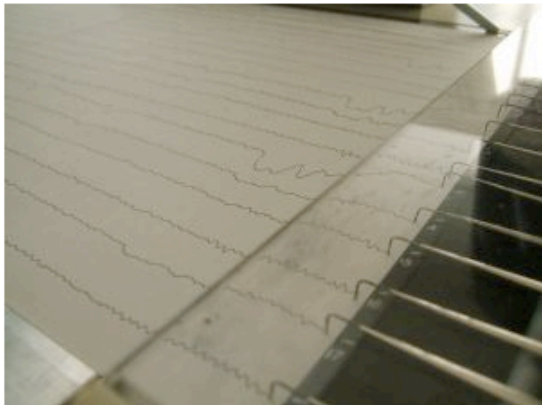
Cornell University



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## Home



**Welcome to DataStaR**, a [Data Staging Repository](#) hosted by [Albert R. Mann Library](#), at Cornell University.

The purpose of DataStaR is to support collaboration and data sharing among researchers during the research process, and to promote publishing or archiving data and high-quality metadata to discipline-specific data centers, and/or to Cornell's own digital repository ([eCommons@Cornell](#)). [Read more about DataStaR](#).

Are you a Cornell researcher with data you'd like to share with collaborators, or make publicly available? [Contact us](#).

[About](#) | [Contact Us](#)

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All Rights Reserved. [Terms of Use](#)

## Limnological summary and depth profile for six standard sampling sites on Oneida Lake, New York, 1975 - 2006 *data set*

[download from eCommons](#) | [download from KNB](#)

### title

Limnological summary and depth profile for six standard sampling sites on Oneida Lake, New York, 1975 - 2006

### abstract

The Cornell Biological Field Station (CBFS) serves as a primary field site for aquatic research at Cornell University (more information can be found at <http://www.dnr.cornell.edu/fieldst/cbfs.htm>) and is part of the Department of Natural Resources, College of Agriculture and Life Sciences. The centerpiece of the station's research program is a 50-year database on the food web of Oneida Lake, New York, that has been collected with support from the Cornell University Brown Endowment and from the New York State Department of Environmental Conservation. The data are collected by personnel from the Cornell Biological Field Station and include limnology, benthos, zooplankton, phytoplankton, and fish survey data, primarily from Oneida Lake and spanning 1957 to the present. This data package includes three tables. The first is a summary of limnological data gathered during standard sampling of Oneida Lake from 1975 - 2006. The second provides profile data by depth for temperature, dissolved oxygen, pH, and conductivity. A supplemental table provides the coordinates of the six sampling sites.

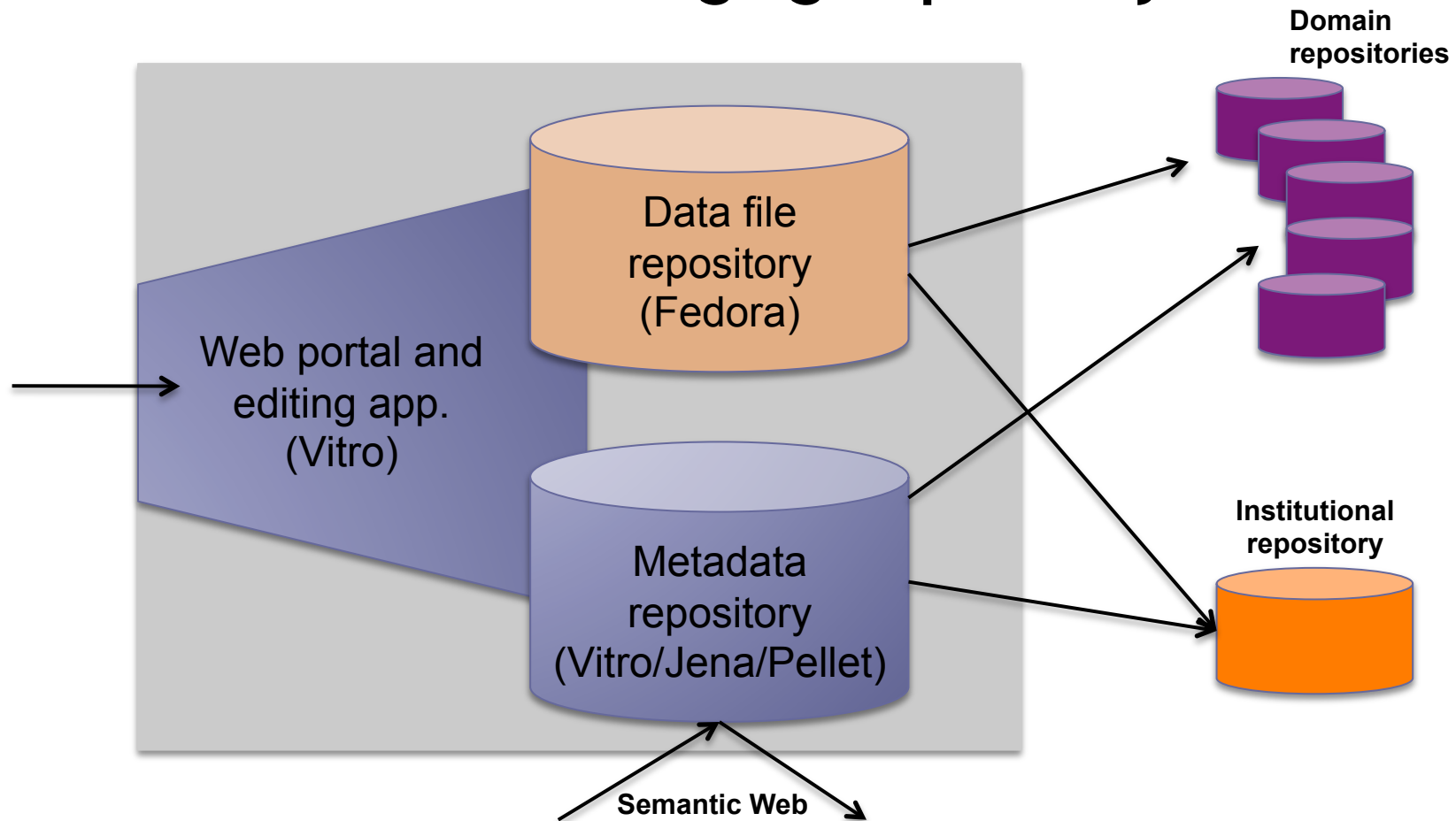
### owner

[Mills, Edward](#)  
[Rudstam, Lars](#)

### primary contact person

[Holeck, Kristen](#)

## DataStaR: A Data Staging Repository



# VIVO in Australia

- Australian universities also using VIVO for metadata about research data
- VIVO attractive to local institutions because the data is managed in the context of a researcher's other activities (publications, etc.)
- OAI repository add-on creates a more traditional “metadata record” for national commons

# VIVO: parallel goals

- Build **ontology** and **linked data** to enable national network and external applications
- Build web application for human consumption on traditional web pages
- Rich web of data is filtered and constrained only where necessary for a particular application



# Visualization

- Completed Work
  - Co-Author visualization
  - Sparklines
  - VIVO world activity map

**Borner, Katy**

Person

This information is based solely on publications which have been loaded into the VIVO system. Th

## General Statistics



36 publication(s) from 2001 to 2010 ([.CSV File](#))

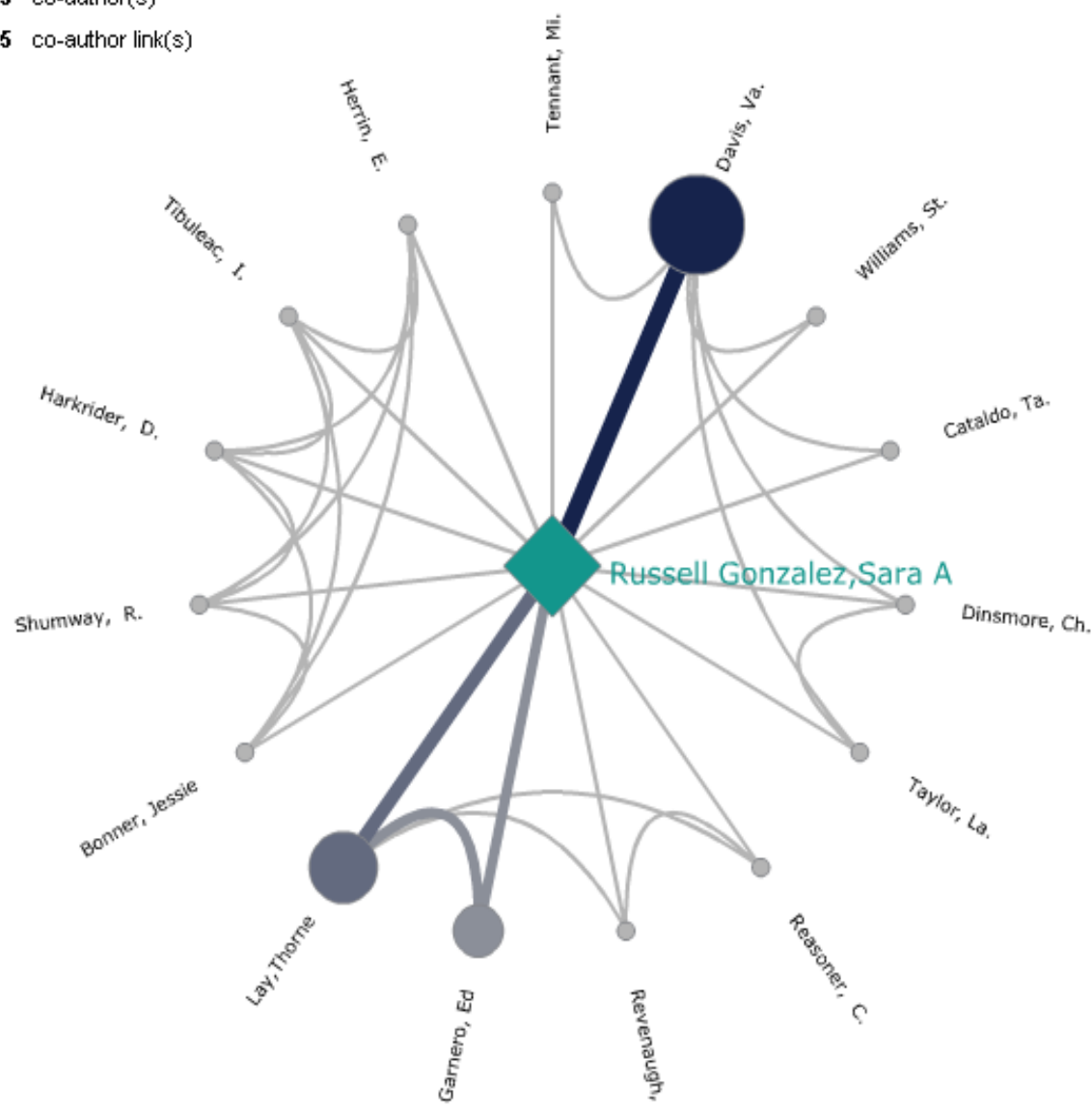


80 co-author(s) from 2001 to 2010 ([.CSV File](#))

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

15 co-author(s)

35 co-author link(s)



**Russell Gonzalez, Sara A**

*Physical Sciences Librarian*

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

9 Publication(s)

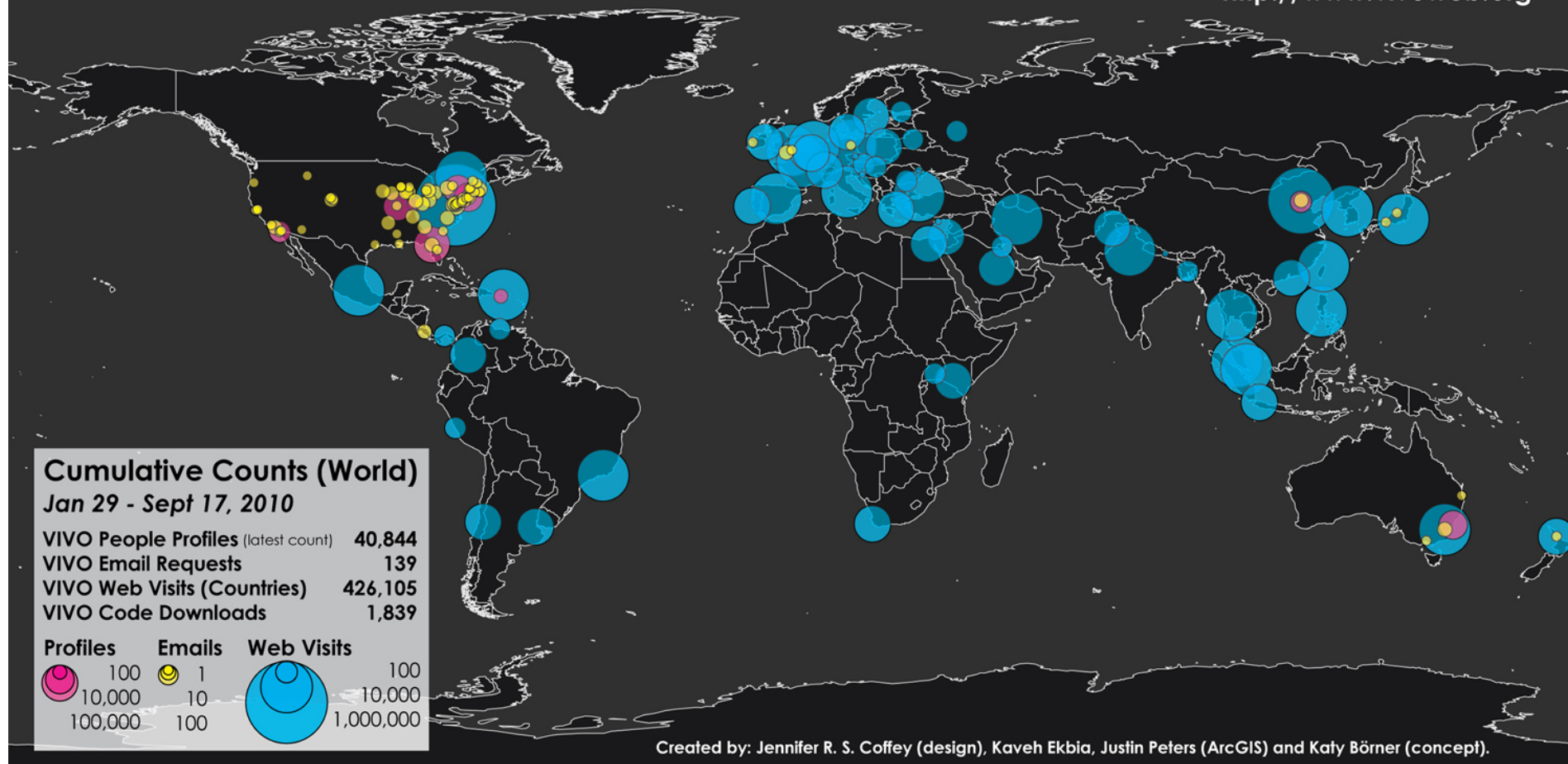
15 Co-author(s)

1998 First Publication

2010 Last Publication

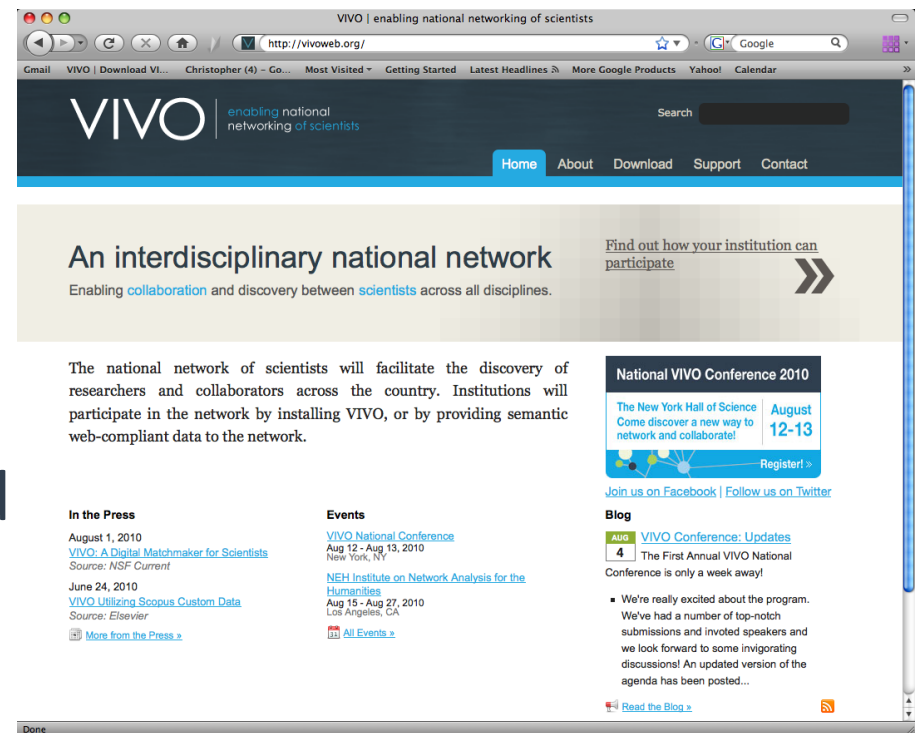
# VIVO Enabling National Networking of Scientists

<http://www.vivoweb.org>



## Get involved with VIVO

- As an:
  - adopter,
  - data provider, or
  - application developer
- Open source code (BSD) and ontology available via



<http://vivoweb.org>

# Get involved with VIVO

## Goals:

Open development community

Full transparency

- Design documents
- Goals / future direction
- Documentation
- Bugs
- Source code access
- Ontology access
- Utilities and community
- Developed tools for VIVO

<http://sourceforge.net/projects/vivo/>

The screenshot shows the SourceForge project page for VIVO. At the top, the SourceForge logo is followed by the tagline "FIND AND DEVELOP OPEN SOURCE SOFTWARE". Navigation links include "Find Software", "Develop", "Create Project", "Blog", "Site Support", and "About". The breadcrumb trail reads "SourceForge.net > Find Software > VIVO". The project name "VIVO" is displayed with a list of contributors: "briancarus, conlon, cpb07, drspeedo, ejc12, ...". Below this are tabs for "Summary", "Files", "Support", and "Develop". The "Summary" tab is active, showing a description: "VIVO: Enabling National Networking of Scientists. The national network of scientists will facilitate the discovery of researchers and collaborators across the country. VIVO is a semantic web project running JENA. [www.vivoweb.org](http://www.vivoweb.org)". A green "Download Now!" button is present, along with a link to "View all files". Below the description, there is a "URL" field with "http://www.vivoweb.org" and a "TAGS" field with "down", "java", "rdf", "semantic", and "sparql". A "Show project details" link is at the bottom right of the summary section. The "Ratings and Reviews" section shows "100% of 6 users recommend this project" with a bar chart showing 6 thumbs up and 0 thumbs down. A review from an anonymous user 71 days ago is displayed, praising the project's structure and data layer. A link to "log in" is provided for rating the review.

## Get involved with VIVO

- `irc.freenode.net #vivo`
- Ask questions
- Get answers
- Submit feedback
- Collaborate with other VIVO community developers

### Live VIVO Developers

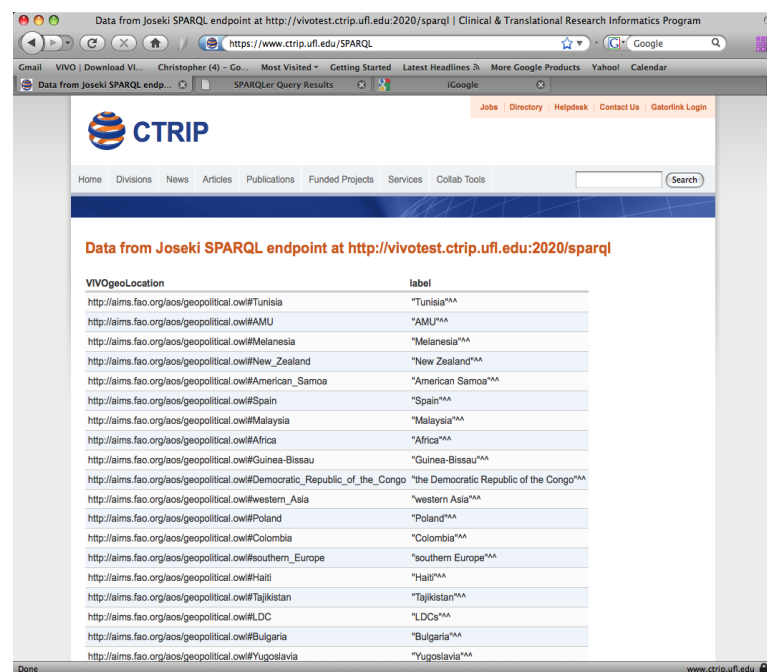


<http://webchat.freenode.net/?channels=VIVO>

## Get involved with VIVO

- Collaborate
- Use our Linked Data
- Consume VIVO data for your own tools

### VIVO data in DRUPAL portal



VIVOGeoLocation	label
http://aims.fao.org/aims/geopolitical.owl#Tunisia	"Tunisia"^^
http://aims.fao.org/aims/geopolitical.owl#AMU	"AMU"^^
http://aims.fao.org/aims/geopolitical.owl#Melanesia	"Melanesia"^^
http://aims.fao.org/aims/geopolitical.owl#New_Zealand	"New Zealand"^^
http://aims.fao.org/aims/geopolitical.owl#American_Samoa	"American Samoa"^^
http://aims.fao.org/aims/geopolitical.owl#Spain	"Spain"^^
http://aims.fao.org/aims/geopolitical.owl#Malaysia	"Malaysia"^^
http://aims.fao.org/aims/geopolitical.owl#Africa	"Africa"^^
http://aims.fao.org/aims/geopolitical.owl#Guinea-Bissau	"Guinea-Bissau"^^
http://aims.fao.org/aims/geopolitical.owl#Democratic_Republic_of_the_Congo	"the Democratic Republic of the Congo"^^
http://aims.fao.org/aims/geopolitical.owl#western_Asia	"western Asia"^^
http://aims.fao.org/aims/geopolitical.owl#Poland	"Poland"^^
http://aims.fao.org/aims/geopolitical.owl#Colombia	"Colombia"^^
http://aims.fao.org/aims/geopolitical.owl#southern_Europe	"southern Europe"^^
http://aims.fao.org/aims/geopolitical.owl#Haiti	"Haiti"^^
http://aims.fao.org/aims/geopolitical.owl#Tajikistan	"Tajikistan"^^
http://aims.fao.org/aims/geopolitical.owl#LDC	"LDCs"^^
http://aims.fao.org/aims/geopolitical.owl#Bulgaria	"Bulgaria"^^
http://aims.fao.org/aims/geopolitical.owl#Yugoslavia	"Yugoslavia"^^

From SPARQL endpoint

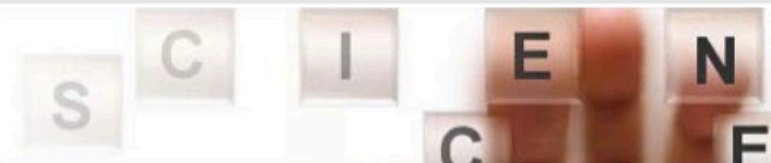


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Subject knowledge Environment, CAS



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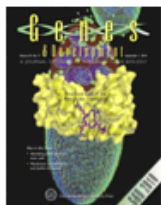
当前位置: 中科院专业领域知识环境

搜索:  [SKE](#) [Google](#)

## 科研动态

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### 2016年太阳黑子或对人类“说再见”



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### 水体污染与控制治理知识环境建成了

陈德桂研究组发现新组蛋白去甲基化酶及其调控机理 | 2010-6-25

西双版纳植物园热带榕树生理研究新进展 | 2010-6-25

半导体/绝缘高分子复合材料研究取得重大突破 | 2010-6-25

山地所在崩塌滚石灾害研究中取得重要突破 | 2010-6-25

Nature发表上海药物所与美国弗吉尼亚联邦大学合作鞘氨醇磷酸酯调控机制研究成果 | 2010-6-24

我国在Leber遗传性视神经病变发病风险研究取得重要突破

## 公告

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### 昆明植物所公共技术服务中心将正式启用

关于组团参加“第十七届中国杨凌农业高新科技成果博览会”的通知



昆明植物所所长李德铎出席上海世博会英国国家馆日活动并被授予皇室勋章

2010年国际遗传工程与生物技术中心(ICGEB) RNA Processing in Biology and Medicine 会议新一轮通知

植物所植物水分养分生物学创新研究组博士后招聘启事 | 2010-08-25 | [中国科学院植物研究所](#)

武汉物理和数学研究所生物分子核磁共振研究组招聘启事 | 2010-6-28

紫金山天文台招聘启事 | 2010-6-25

关于中国博士后低碳经济与清洁能源的科技与发展学术论坛的征文通知 | 2010-6-22

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## 业界新闻

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南京古生物所举办“地球环境的过去与今天”高端科学论坛

### 我国专家提出晚期肝癌化疗新方案



中国第四次北极科学考察创造多项新纪录 | 2010-09-13

3D技术成为国际广播电视博览会“主角” | 2010-09-13

中国云计算风起云涌 | 2010-6-25

星体极端引力效应首次以氧原子形式被揭露 | 2010-6-25

德研究质疑古埃及法老图坦卡蒙死因说 | 2010-6-25

科学家模拟出希格斯玻色子数据信号的乐曲 | 2010-6-25

第四次北极科考7月1日开始 全程85天 | 2010-6-25

迎接“第五媒体”新挑战 未来主导作用不可逆转 | 2010-6-24



# Biomedical and Health Knowledge Environment

## 生物医学与健康知识环境

### Biomedical and Health Knowledge Environment

☒ SKE ☐ Google

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中科院应用微生物研究网络农业微生物研究中心启动会暨学术研讨会召开

广州生物院获中科院批准为干细胞与再生医学产业技术创新战略联盟筹建与挂靠单位

武汉病毒所与加拿大卡尔加里大学合作论文获Faculty of 1000 Biology推荐

武汉病毒所召开微生物降解技术研究项目验收会

武汉病毒所广谱昆虫病毒杀虫剂专利技术在江西许可实施

武汉病毒所获得农药登记田间药效试验单位资质

武汉病毒研究所召开2009年年度学术报告会



武汉病毒研究所召开973计划“重要病毒的人侵机制研究”实施交流会



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我院组蛋白去乙酰化酶抑制剂研究方面获重要突破

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SCIENCE: 蛋白的数量与mRNA的数量在各个细胞中有很大差异

JAMA: 早期个性化抗逆转录病毒治疗HIV的重要性



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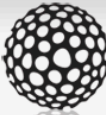
[Arthur Capell \(1902-1986\) Guide to Records](#)

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[CSIRO, Division of Chemicals and Polymers, Currency Note Research and Development Project Guide to Records](#)

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