

UITS/RT Data, Analytics, and Visualization
Workshop Series: "Getting more from your research data"

Databases, Enclaves and Repositories for Research

Esen Tuna / Alan Walsh
Research Data Services
Indiana University

February 20, 2018



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Overview

- Getting to know your RDS experts
- Data management in research workflows
- The Research Database Complex (RDC)
- RADaRS & other data enclaves at IU (HTRC, WoS, REDcap)
- Storage options: UITS infrastructure, Box & others
- Data intensive RDS projects:
 - Stampede (XSEDE)
 - Scalable text analytics workflows
 - Scalable photogrammetry service



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People

Nancy Long



RDC

In RT since 2005
EE, MBA, MFA
PMI Certified
Business Intelligence
Mobile/Web App Dev.
MEAN Stack Dev.

James McCombs



Stampede

In RT since Aug 2016
CompSci PhD, College
of William & Mary
Numerical algos for
large-scale linear sys.
Mission-critical
distributed systems
engineering
Scalability of solvers
for large, sparse
eigenvalue problems
Production-grade
numerical software

Dimitar Nikolov



Data Management & Workflows

In RT since Aug 2017

- CompSci PhD cand., IU
 - Workflow automation on HPC and Cloud systems
- Data management
 - Web Mining
- Network analysis
- Python for data analytics

Guangchen Ruan



Media Analytics

In RT since Sep 2016
CompSci PhD, IU
Non-Consumptive
Research
Large-scale data
analytics
Distributed systems
design and
development
Data-intensive and
compute intensive
computing

Esen Tuna



Manager, RDS

In RT since Jan 2016
IU Grad '91 '93
Data & Database
Services
Big Data Analytics
Cloud Services
Application
Development
Compilers
Formal Methods

Alan Walsh



• RDC

- In UITs since 1992
 - IU Grad '89
 - Databases
- Enterprise Software
- Commercial Cloud
- Adjunct Instructor, SPEA



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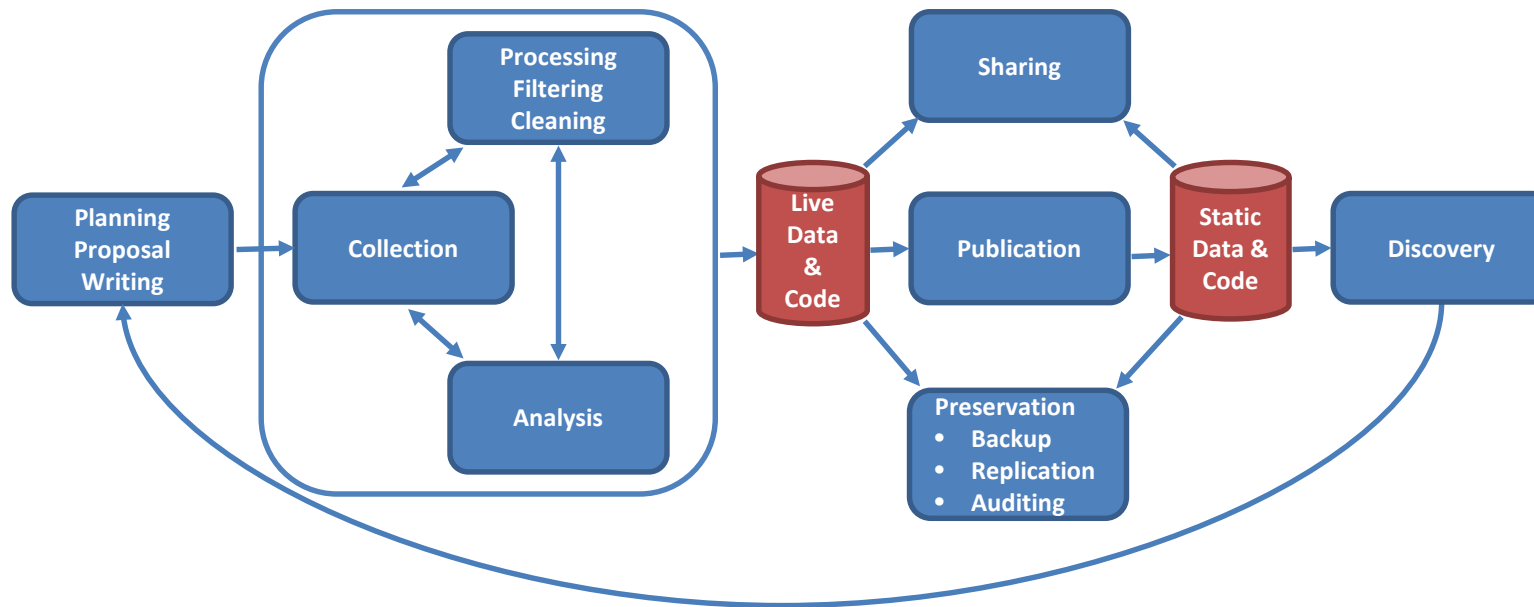
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Research Data & Workflow Management

- The Data Lifecycle in a "typical" Research Project



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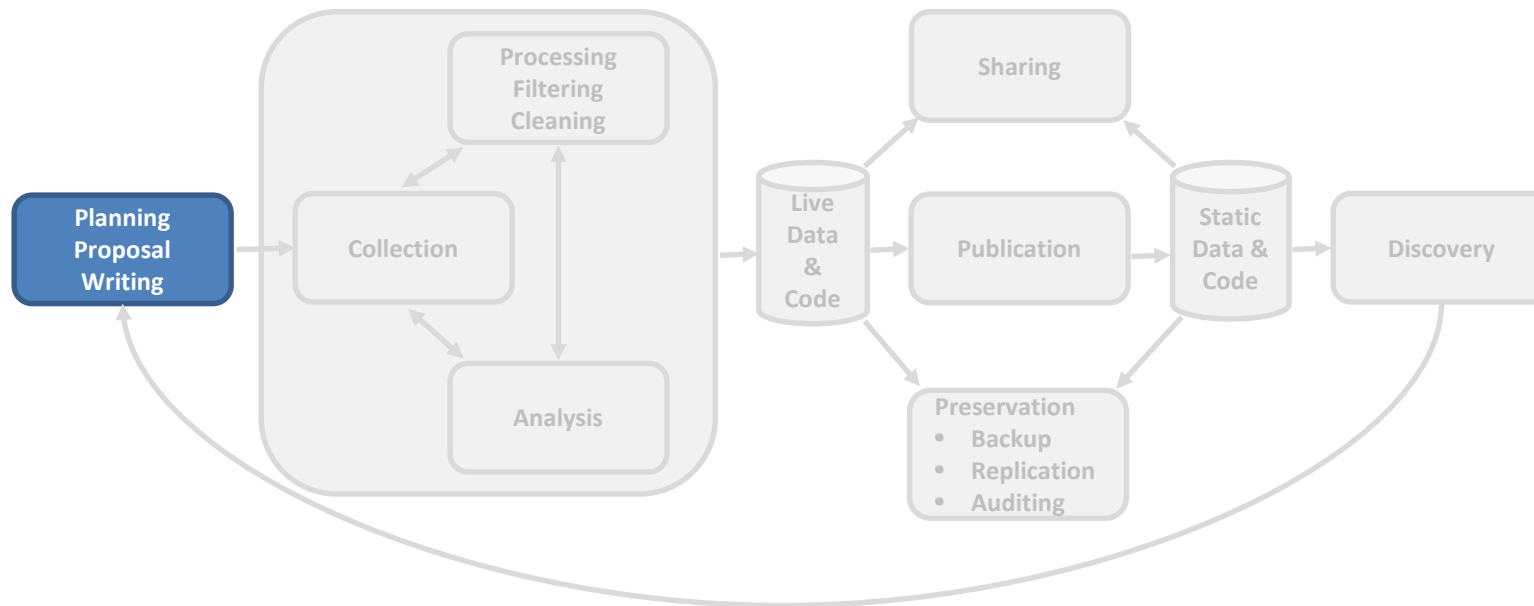
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Research Data & Workflow Management

- The Data Lifecycle – Planning Phase



Need:

- **Data Management Plans (DMPs)** required by major funders like [NSF GPG II.C.2.j](#), [NIH Data Sharing Guide](#)

At IU:

- <https://openscholarship.indiana.edu/data>



Data management plans



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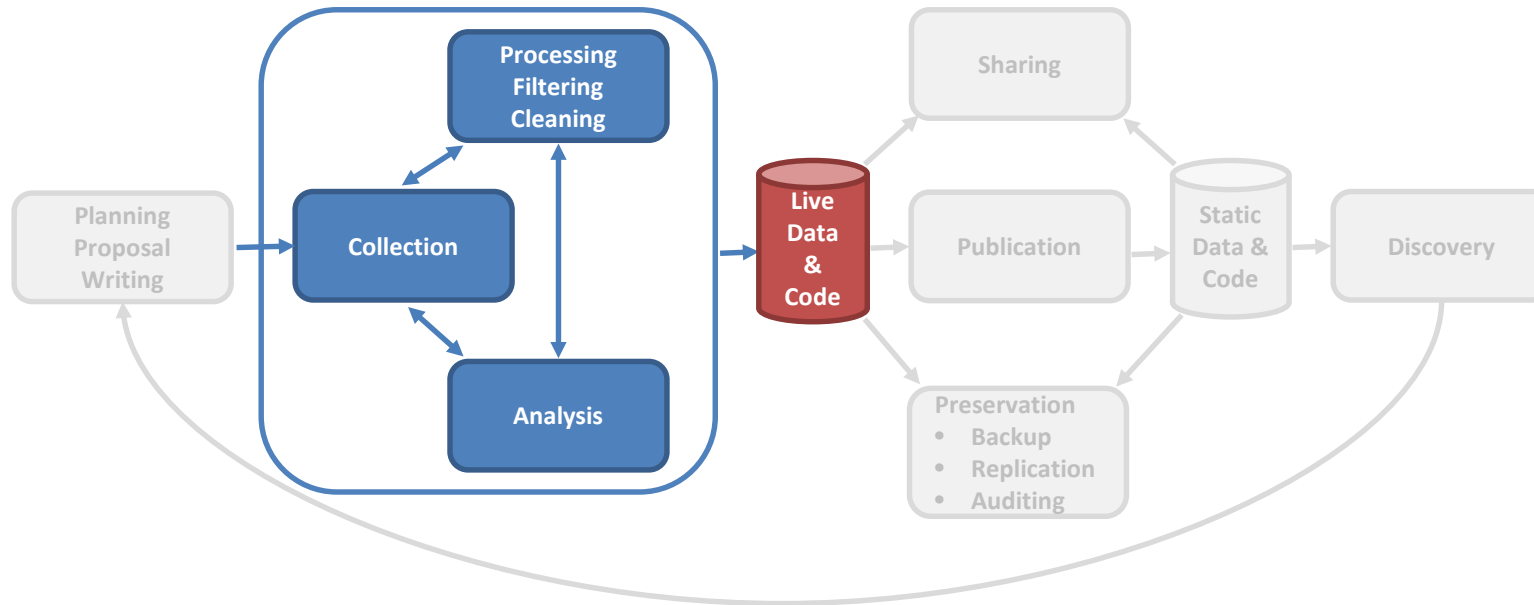
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Research Data & Workflow Management

- The Data Lifecycle – Research Infrastructure



Need:

- Data Storage
- Compute Infrastructure

At IU:

- Geode, DC2
- Big Red 2, Karst, Carbonate
- XSEDE Resources (allocation request & approval required)
- Cloud storage (**Box**, Google, One Drive), IU Github
- **RDC**
- **RADaRS**



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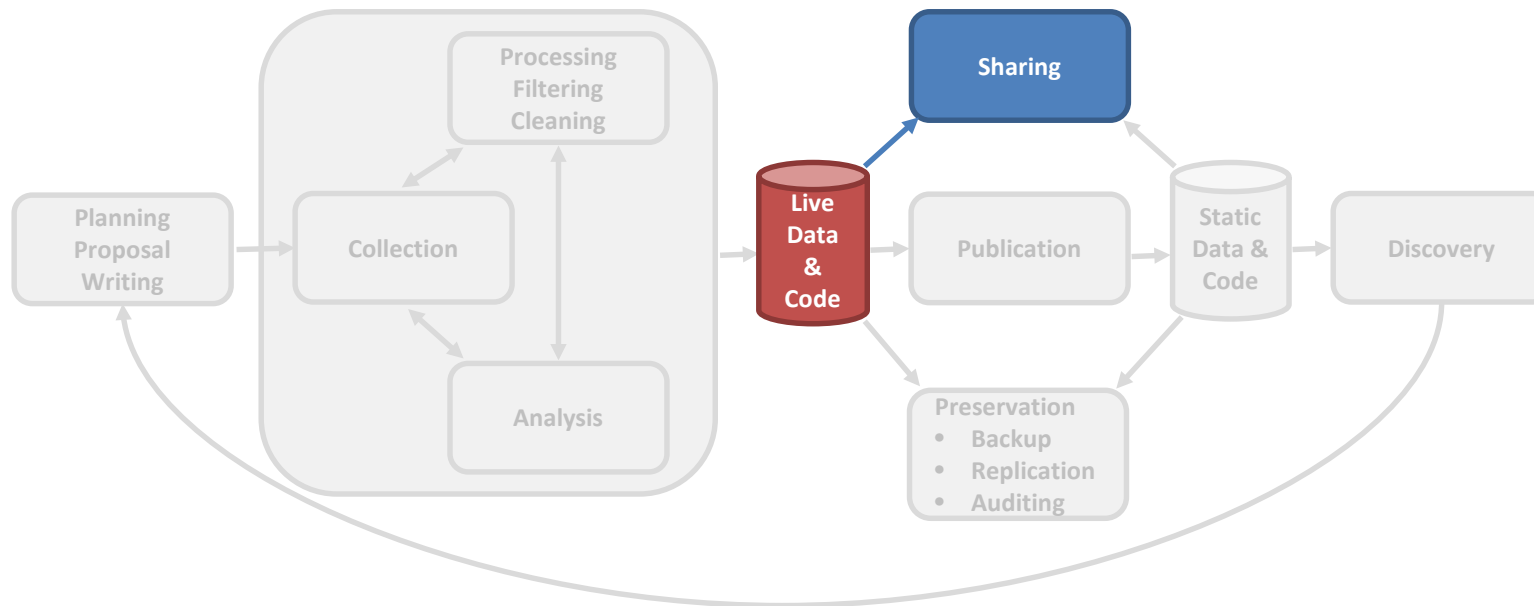
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Research Data & Workflow Management

- The Data Lifecycle – Sharing Live Data



Need:

- Easily share files with **internal** and **external** collaborators;
- including [sensitive data](#) or **big data**.

At IU:

- Box @ IU
- Google @ IU
- One Drive @ IU
- Github.iu.edu
- SlashTmp.iu.edu
- OnBase



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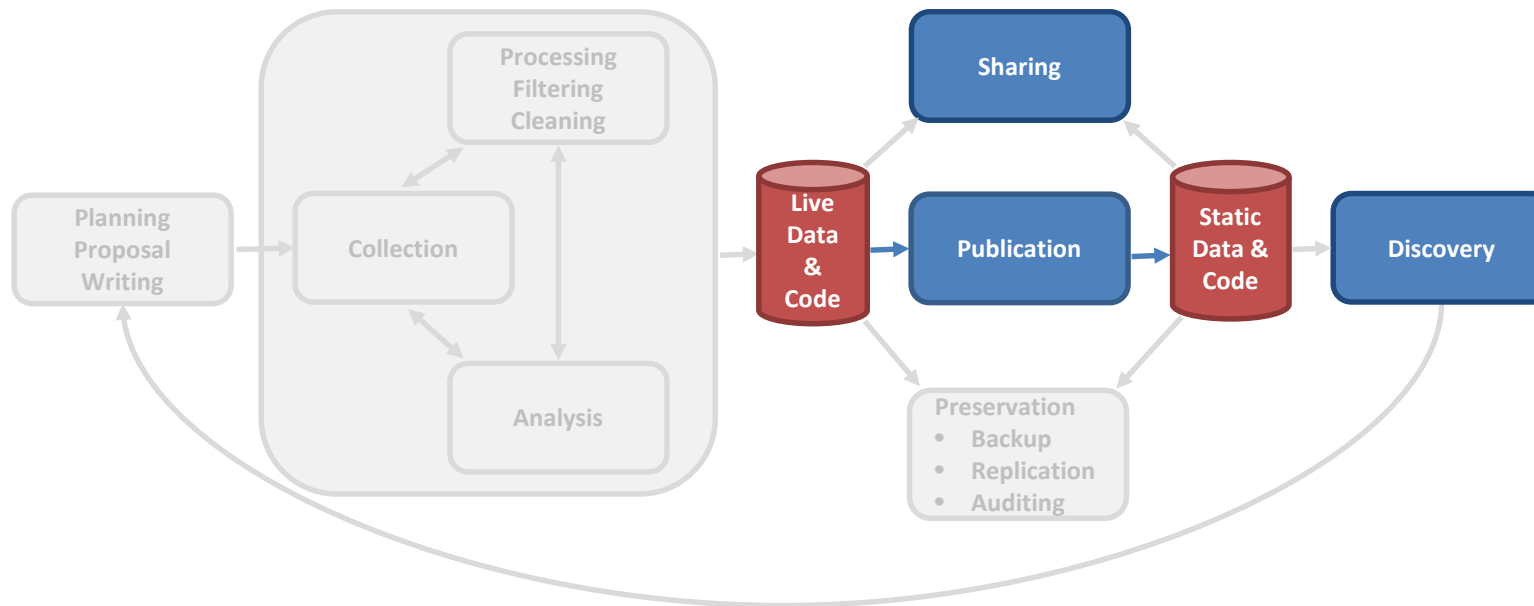
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Research Data & Workflow Management

- The Data Lifecycle – Publishing Data



Need:

- Publish a **permanent** data object with a **PID** for **outside access**
- Ensure the **preservation** and easy **discovery** of permanent data

At IU:

-  IUScholarWorks



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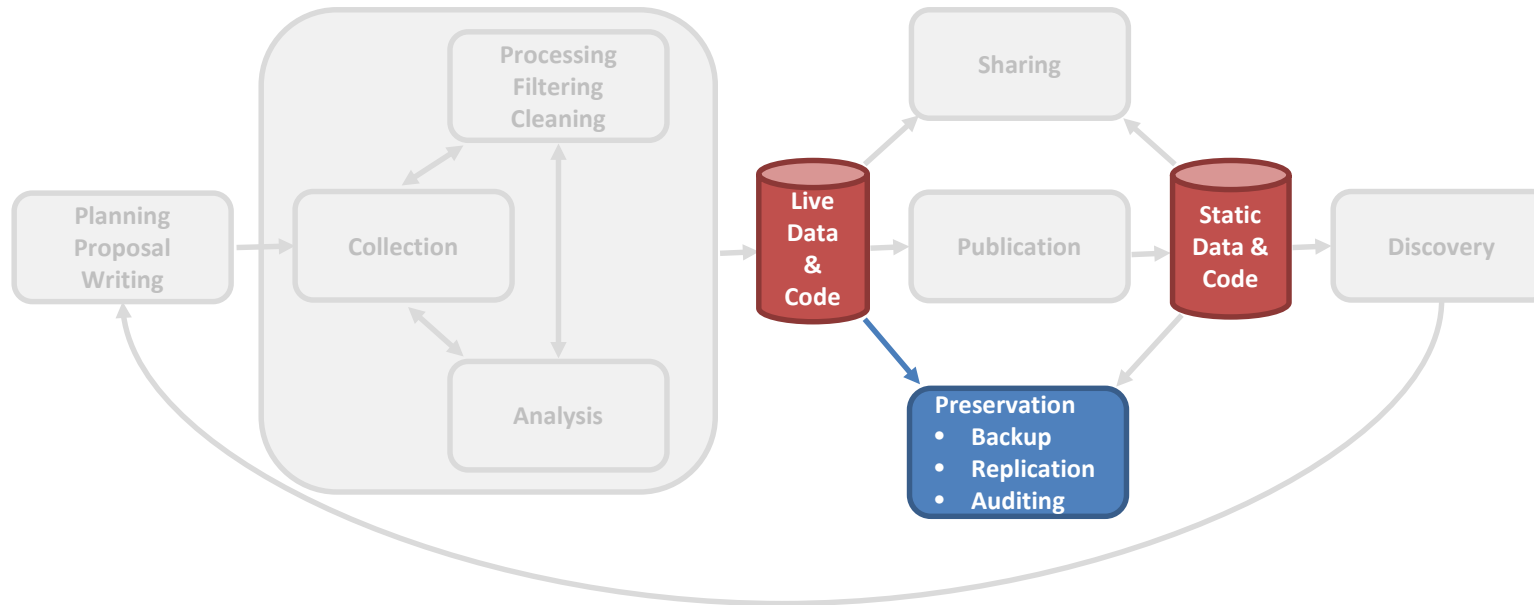
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Research Data & Workflow Management

- The Data Lifecycle – Data Preservation



Need:

- Backup
- Replication

At IU:

- SDA for manual backups
- Geode and SDA are replicated



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Research Database Complex (RDC)

- Support **research-related databases** (MySQL & Oracle)
- Support **data-intensive applications** on databases
- Provide for **database-driven web applications** focusing on research

- Key Metrics
 - **10 TB of active research data**
 - **40 active clients with 115 DB instances** at Indiana University and its affiliates
 - Hundreds of users
 - Millions of logins annually
 - Billions of database operations each year
 - 9 long-term database consults, and 170 total tickets resolved in FY17



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RDC by Numbers (FY17)

RDC (FY2015/2016)	Oracle	MySQL	Total
# of Database Instances	15	100	115
# of Schemas	112	417	529
# of User Logins	2,545,331	1,369,154	3,914,485
Storage - Allocated (TB)	16	8	24
Storage - Used (TB)	3	6	9
Database Growth	-13%	19%	-
Largest DB - Instance size (TB)	1	2.6	-
Average DB Size (GB)	297	51	-
Median DB Size (GB)	59	0.25	-
Backup Utilization - Disk (TB)	24	2	-
Backup Utilization - SDA (TB)	14	8	-



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RDC Clients (FY17)

Anthropology	Epidemiology and Biostatistics	Libraries
Applied Health Science	Family Medicine	Medical & Molecular Genetics
Biology	Gender Studies	Otolaryngology & H/N Surgery
Bursar Office	Health Policy & Management	Ped-Cardiology
Business	History	Ped-Health Services Research
Cancer Center	History & Philosophy of Science	Physics
Cognitive Science	Informatics	Political Science
Computer Science	Information and Library Science	Psychiatry
Department of Informatics	IU Foundation	Public & Environmental Affairs
Dept of Biostatistics	IU Network Science Institute	Research Computing Center
Earth and Atmospheric Sciences	Jewish Studies	SICE Administration
Education	Kelley School Of Business	Vice Pres Information Technology
Engineering & Technology	Kinesiology	Vice Pres/Academic Support



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RDC Use Case: Digital Humanities

- Kalani Craig, History Professor, Co-Director Institute for Digital Arts and Humanities
- Mining medieval Latin texts for change in the language used to describe conflict resolution
- Learning applications of network analysis and Twitter in humanities classrooms



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RDC Use Case: Northwest Indiana Restoration Monitoring Inventory (NIRMI)

- Peter Avis, Assistant Professor of Biology, IU Northwest
- Web-based, open-access, real-time inventory of restoration progress in the Calumet region
- Provides researchers with consistent data across projects and sites
- Enables researcher training and education opportunities at multiple institutions

nirmi Northwest Indiana Restoration Monitoring Inventory

Data

To examine species lists, maps, and data analysis for a particular site, please select from the map below or by name from the list.

To explore data patterns across multiple sites, please choose an option for the map below.

Site List

- Ambler Expansion
- Arcelor Mittal Burns Harbor
- Barker Woods
- Beaver Dam
- Bock-Higgins
- Buckeye
- Bur Oak Woods
- Calumet Prairie
- Charter School of the Dunes
- Coffee Creek
- Cressmoor Prairie
- ExxonMobil Hammond Terminal
- Fesko
- Fox Run
- Gibson Woods Nature Preserve
- Great Marsh North
- Greiner
- Hegewisch Marsh
- Hidden Prairie
- Indian Ridge Marsh
- INDU - Central Beach West
- INDU Great Marsh, Brown Kintzele Ditch West
- INDU Great Marsh, Cowles Wetland Complex West
- INDU Great Marsh, Derby Ditch East
- INDU Great Marsh, Tansley Marsh

Regional Patterns

-- select --

Map labels: Lake, Porter, La Porte



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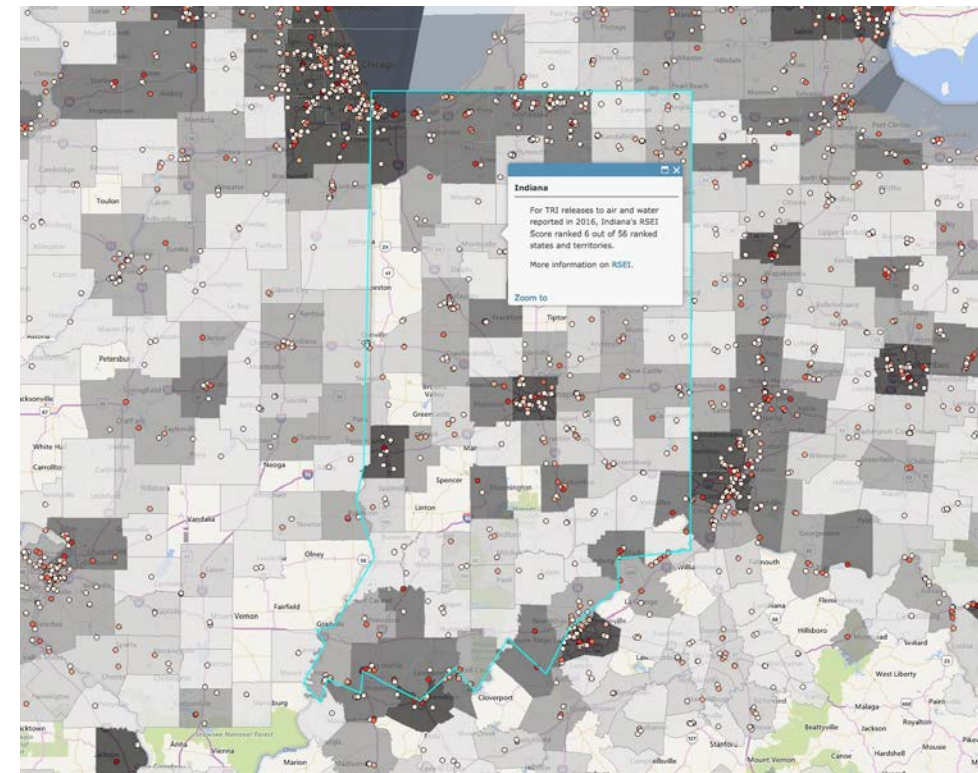
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RDC Use Case: Risk-Screening Environmental Indicators (RSEI)

- Michael Ash, Chair, Department of Economics, Professor of Economics and Public Policy at University of Massachusetts, Amherst
- RSEI databases consist of the Public Release Data and the Geographic Microdata.
- The data management and analysis, carried out in MySQL and R require complex joins on these datasets and associated, geocoded socioeconomic data from the U.S. Bureau of the Census.
- The project has received several rounds of NSF support including currently via the National Socio-Environmental Synthesis Center (SESYNC) which brings together the science of the natural world with the science of human behavior.



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RDC Use Case: RuffLab

- Dr. Chad Ruffin, Otologic Research Fellow, Indiana University
- Experiments that assess the interactions between speech perception and cognition
- Matlab GUI
- The only laboratory that houses hearing loss experiments in a relational database
- Benefits:
 - Easy administration and analysis
 - Multi-lab setup
 - Verbose “tagging” of data points
 - Secure, remote data access



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RDC Use Case: Tissue Bank @ IU Simon Cancer Center

- Public-facing Virtual Tissue Bank serving data for researchers
 - 124 researcher projects
 - 37 studies
- Internal sample/donor management
 - 11,467 women who have donated healthy breast tissue
 - Event logistics
 - Follow-ups
- Public facing website
 - <https://komentissuebank.iu.edu>



**TISSUE BANK AT THE
IU SIMON CANCER CENTER**



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RDC Directions

- **Efficiency**
 - 15 TB of storage were reclaimed
 - Retired 69 inactive databases and 524 inactive schemas
 - **Infrastructure update: Use II servers and ESDBA support.**
- **Utility**
 - 28 new MySQL databases instances
 - 19 Oracle schemas were added
- **Support for Additional Database Technologies**
 - Support and consult on NoSQL and NewSQL databases
 - Data Management Consulting



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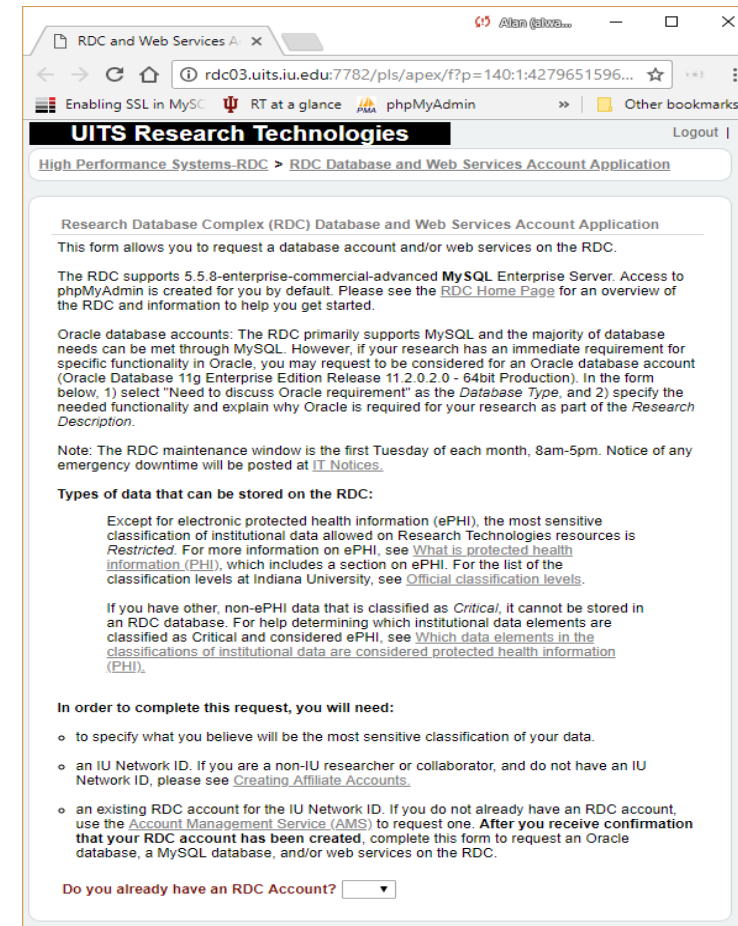
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Getting Started with the RDC

- (optional) Create a new group account
 - <https://kb.iu.edu/d/acyi#create>
 - This is a really good idea if you have collaborators!
- Request an RDC account and database
 - <https://kb.iu.edu/d/amuw#request>



The screenshot shows a web browser window displaying the "RDC Database and Web Services Account Application" page. The page header includes "UITS Research Technologies" and "Logout". The main content area contains the following text:

Research Database Complex (RDC) Database and Web Services Account Application
This form allows you to request a database account and/or web services on the RDC.

The RDC supports 5.5.8-enterprise-commercial-advanced **MySQL** Enterprise Server. Access to phpMyAdmin is created for you by default. Please see the [RDC Home Page](#) for an overview of the RDC and information to help you get started.

Oracle database accounts: The RDC primarily supports MySQL and the majority of database needs can be met through MySQL. However, if your research has an immediate requirement for specific functionality in Oracle, you may request to be considered for an Oracle database account (Oracle Database 11g Enterprise Edition Release 11.2.0.2.0 - 64bit Production). In the form below, 1) select "Need to discuss Oracle requirement" as the *Database Type*, and 2) specify the needed functionality and explain why Oracle is required for your research as part of the *Research Description*.

Note: The RDC maintenance window is the first Tuesday of each month, 8am-5pm. Notice of any emergency downtime will be posted at [IT Notices](#).

Types of data that can be stored on the RDC:

Except for electronic protected health information (ePHI), the most sensitive classification of institutional data allowed on Research Technologies resources is *Restricted*. For more information on ePHI, see [What is protected health information \(PHI\)](#), which includes a section on ePHI. For the list of the classification levels at Indiana University, see [Official classification levels](#).

If you have other, non-ePHI data that is classified as *Critical*, it cannot be stored in an RDC database. For help determining which institutional data elements are classified as Critical and considered ePHI, see [Which data elements in the classifications of institutional data are considered protected health information \(PHI\)](#).

In order to complete this request, you will need:

- to specify what you believe will be the most sensitive classification of your data.
- an IU Network ID. If you are a non-IU researcher or collaborator, and do not have an IU Network ID, please see [Creating Affiliate Accounts](#).
- an existing RDC account for the IU Network ID. If you do not already have an RDC account, use the [Account Management Service \(AMS\)](#) to request one. **After you receive confirmation that your RDC account has been created**, complete this form to request an Oracle database, a MySQL database, and/or web services on the RDC.

Do you already have an RDC Account?



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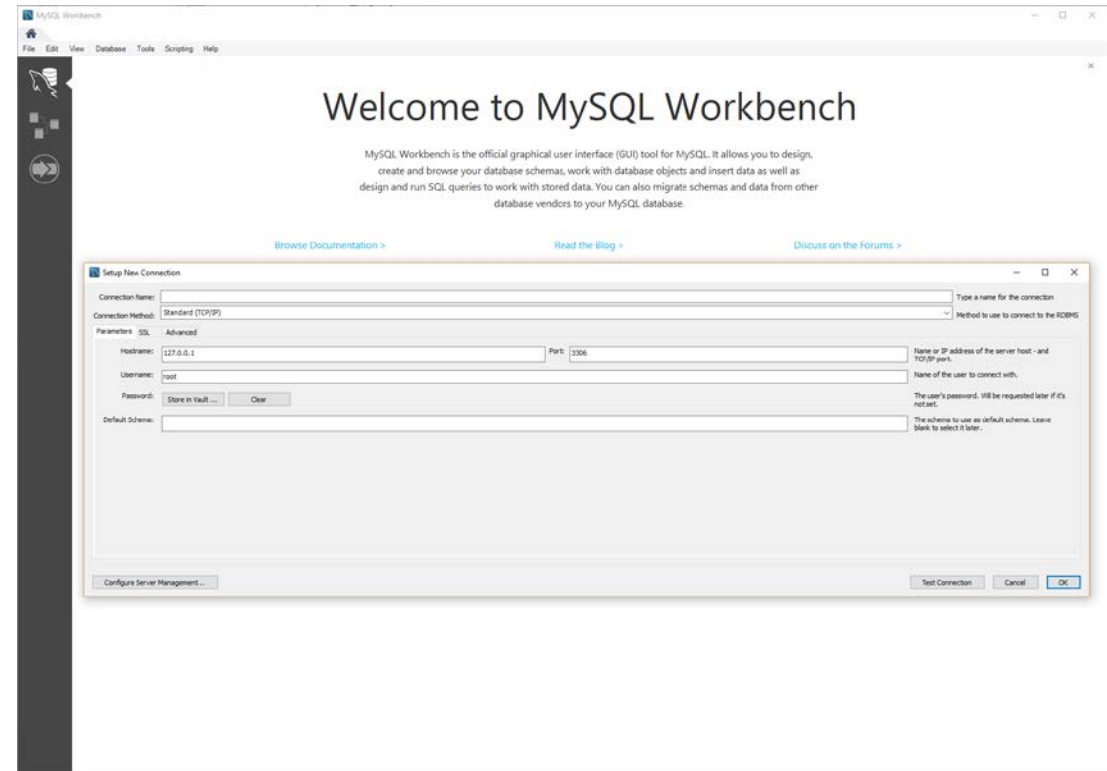
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Accessing your RDC database

- GUI clients
 - MySQL Workbench
 - Free download and also available on Karst Desktop and IUAnyWare
 - HeidiSQL
 - Sequel Pro
 - Aqua Data Studio
- MySQL command-line clients on HPC
 - Karst
 - Carbonate
 - Big Red II



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RADaRS (**R**estricted **A**ccess **D**ata **R**emote **S**erver)

- Secure data enclave for social sciences and beyond
- Enable data custodians to upload datasets securely
 - Established relationship with prestigious data providers
 - Well-defined data-enclave workflow
- Allow researchers to access the server remotely through VPN connection
- Restrict researchers to analysis only
 - No user-initiated data transfers in or out
 - No copy, paste, or print
 - No web access
- Provide common analysis tools by default
 - SAS, SPSS, Stata, R, Microsoft Office, etc.



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RADaRS Sample Datasets

A few of the **data vendors** that researchers are working with:

BLS	Bureau of Labor Statistics
CPC	Carolina Population Center (UNC)
FaHCSIA	Australian Dep. of Families, Housing, Community Services and Indigenous Affairs
ICPSR	Interuniversity Consortium for Political and Social Research (Univ. of Michigan)
IDOE	Indiana Department of Education
NAPHSIS	The National Association for Public Health Statistics and Information Systems
NDACAN	National Data Archive on Child Abuse and Neglect (Cornell University)
NORC	National Opinion Research Center (University of Chicago)
NYSDH	New York State Department of Health
OSHPD	California Office of Statewide Health Planning and Development



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RADaRS Service

Role	Organization
Researchers	Mostly IUB & IUPUI
Data Custodians	SSRC (Social Science Research Commons) + RDS (Research Data Services, UITS)
Service Owner	RDS
Technical Advisor	RDS
Servers	II (Intelligent Infrastructure, UITS)
System Admin + SW	HELPnet + Research Analytics (UITS)



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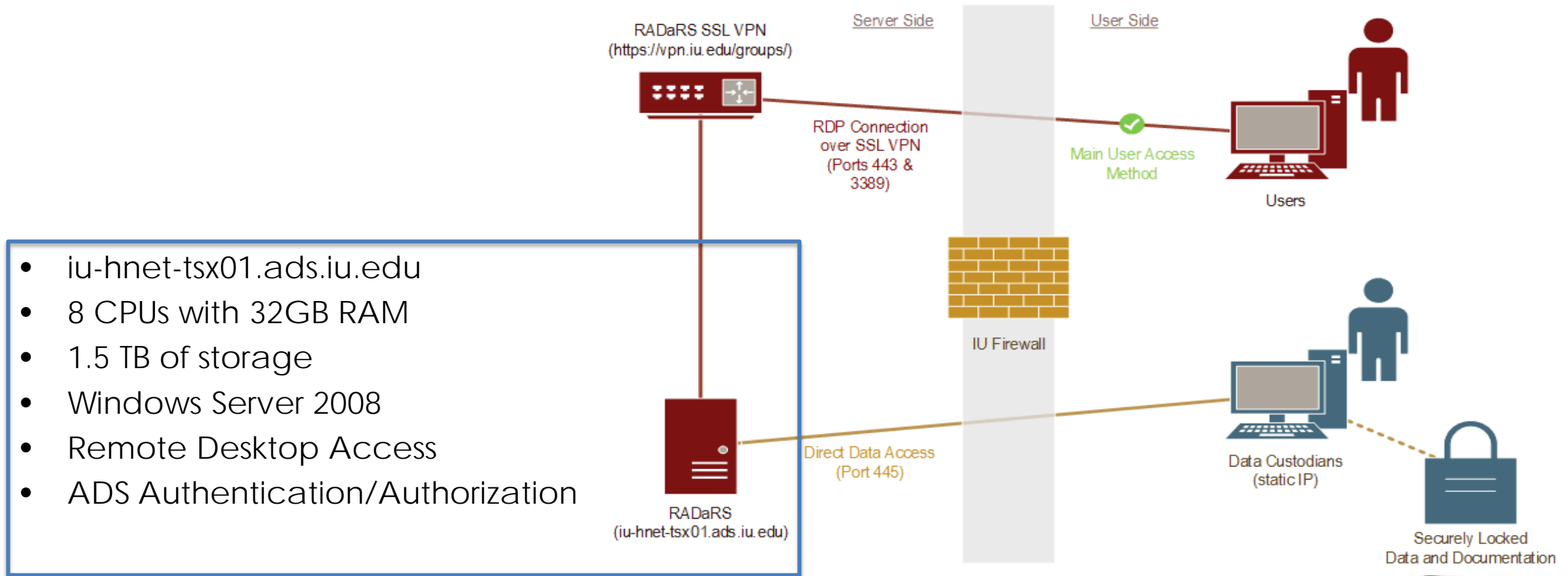


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RADaRS Infrastructure



- iu-hnet-tsx01.ads.iu.edu
- 8 CPUs with 32GB RAM
- 1.5 TB of storage
- Windows Server 2008
- Remote Desktop Access
- ADS Authentication/Authorization



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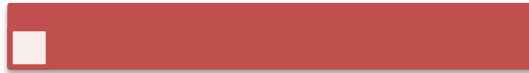
RADaRS Workflow

New Data Application



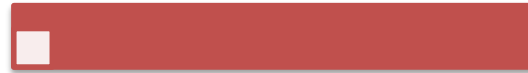
- IRB/ORI Approvals
- RADaRS Agreement
- Project folder created
- Users added to groups
- Physical data stored by data custodian (DC)
- Data uploaded by DC

Adding a Collaborator



- Confidentiality Affidavit
- RADaRS Agreement updated
- SysAdmin adds new users

Updates & Results



- DC stores/uploads new data
- Results are inspected by DC
- Aggregate results are downloaded by DC
- Results are given to researcher

Returning of Data



- Purge data securely
- Remove users
- IT & DC sign-off

<http://go.iu.edu/radars>



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Data Enclaves at IU

- HTRC (HathiTrust Research Center)
 - HathiTrust Digital Library is an extensive collaborative digital library of nearly 14 million volumes and over 5 billion pages of material maintained by major research institutions and libraries worldwide.
 - HathiTrust Research Center enables analytical access for non-profit and scholarship use.
 - <https://analytics.hathitrust.org/>
- WoS (Web of Science by IUNI's Science of Science Hub)
 - The complete set of Thomson Reuters' Web of Science XML raw data.
 - # of total items from 1900 through 2015 is 61,222,536
 - # of article/reference links is 1,151,161,601
 - PostgreSQL database accessible via a Karst data enclave
 - <https://iuni.iu.edu/resources/tools-and-data>
- REDcap (Research Electronic Data Capture)
 - <https://www.indianactsi.org/translational-informatics/tools/redcap/>
 - Self-managed, secure, web-based platform
 - Support data collection and data management for research, operations support and quality improvement projects



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Storage Options

- Research Technologies Storage
 - Geode (Home directories for HPC accounts), 100 GB / user
 - DC2 (HPC temporary project folders), 10 TB / user
 - SDA (Tape archive), 50 TB / user
- Box @ IU
 - 100K users at IU
 - *Unlimited* quotas
 - Restricted data approved on Entrusted Data Accounts, PHI on Health Data Accounts
- Google Drive @ IU
- OneDrive @ IU
- CDI (Critical Data Infrastructure) by HELPnet
- OnBase @ IU
- SlashTmp @ IU (data sharing including critical data)



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DATA INTENSIVE PROJECTS



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HPC Workflows on Stampede

- An High Performance Compute cluster operated an XSEDE resource by TACC
 - for parallel applications scalable to tens of thousands of cores
 - **Stampede 2** has 18 petaflop peak performance
 - 4,200 Intel Knights Landing (KNL) nodes, 68 cores per node
 - 1,736 Intel Xeon Skylake nodes, 48 cores per node
 - 100 GB/s Omnipath interconnect
 - Dual 31 PB Lustre file systems
- **RT role in the project**
 - Intel KNL configuration benchmarks
 - Identify and resolve SW stack issues
 - Optimize for the new architecture in Stampede 2
 - R, Matlab, Python application optimization
 - Performance Benchmarking of the R Programming Env.



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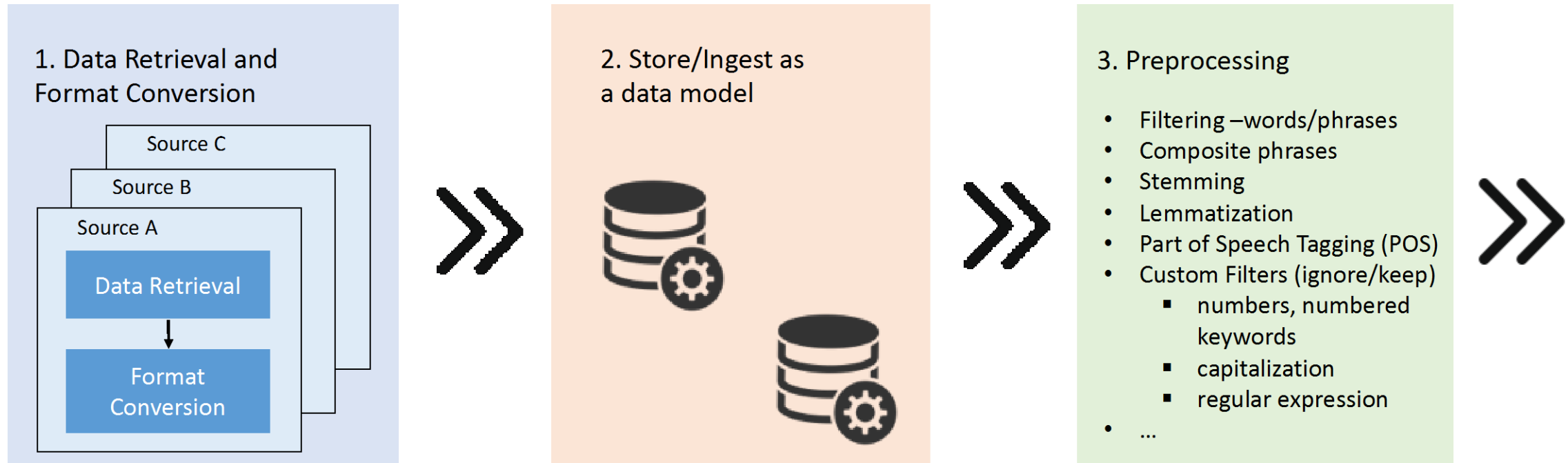
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Scalable Text Analytics

– Modularized Text Analytics Workflow



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Scalable Text Analytics

- Scale-out Text Analytics Capabilities for Digital Humanities



4. Analysis

- Language detection
- Named entity extraction
- Frequency analysis (word cloud)
- Semantic analysis (LDA, LSA)
- Custom algorithms



5. Visualization

The visualization section contains three circular icons: an orange circle with a bar chart, a light blue circle with a pie chart, and a dark blue circle with a line graph.



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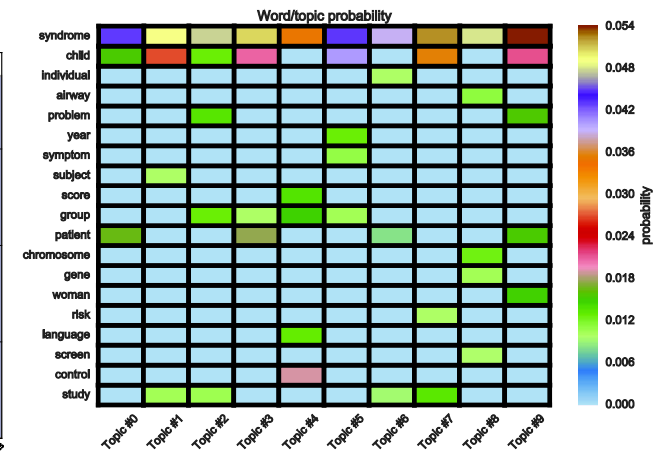
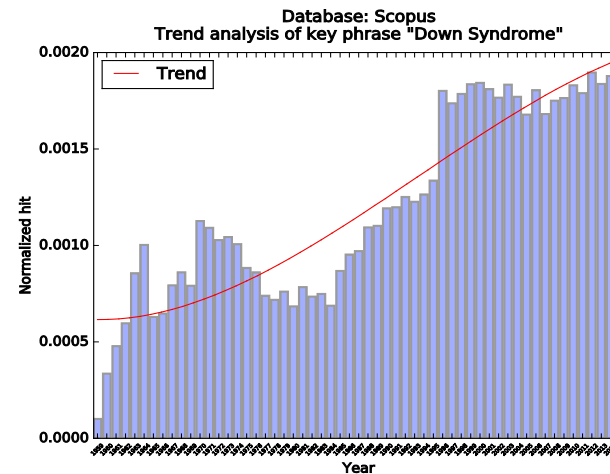
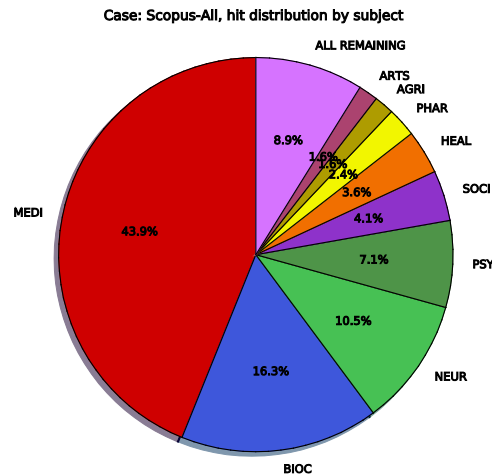
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Scalable Text Analytics

- Use Case: Evolution of "Downs Syndrome" in Science Direct and Scopus collections since 1980 (w/ Dr. Winona Snapp-Childs)
- Use Case: Vonnegut collection in HTRC

Code	Subject	Rank
MEDI	Medicine	1 st
BIOC	Biochemistry	2 nd
NEUR	Neuroscience	3 rd
PSYC	Psychology	4 th
HEAL	Health Professions	5 th
SOCI	Social Sciences	6 th
PHAR	Pharmacology	7 th
ARTS	Arts and Humanities	8 th
NURS	Nursing	9 th



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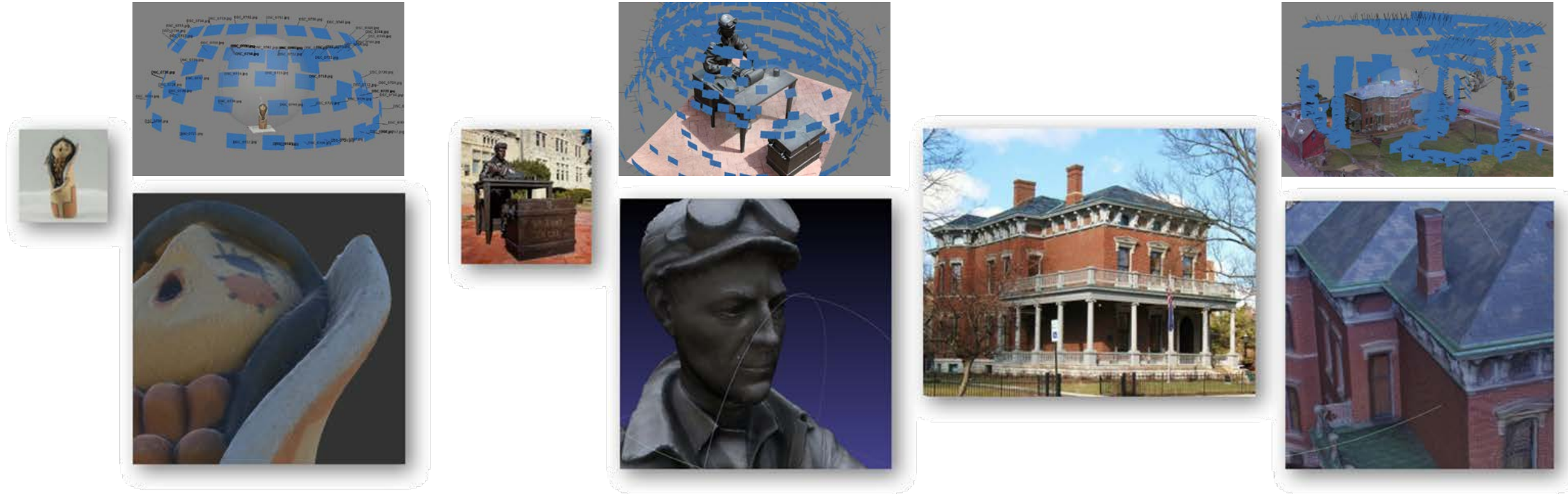


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Scalable Photogrammetry



Small Medium, and Large Datasets



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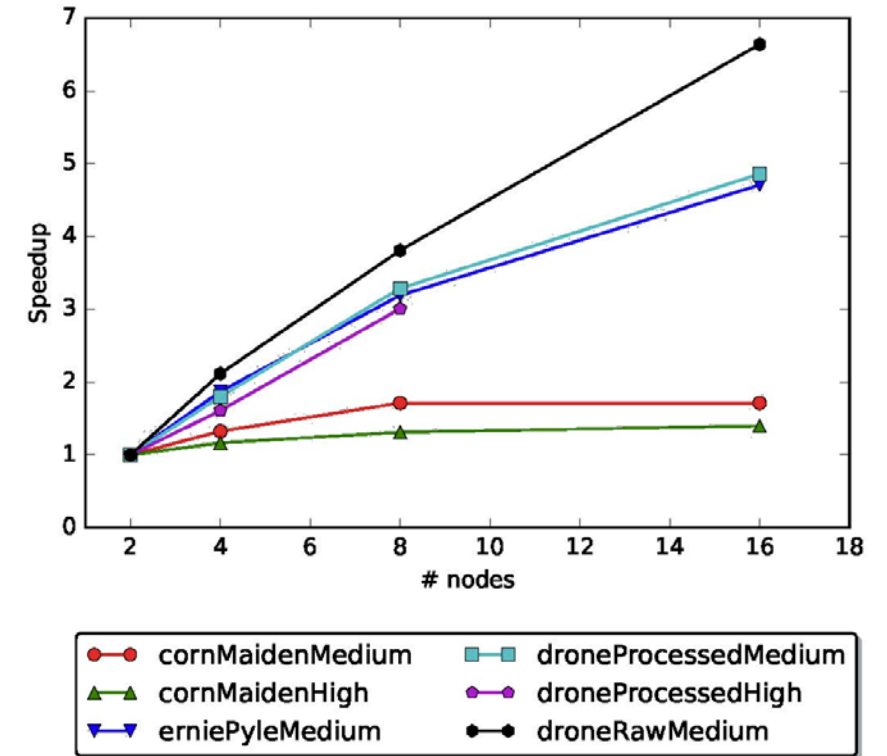
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Scalable Photogrammetry

- Portable workflow on HPC clusters
- Scalability study of Agisoft PhotoScan on Karst

Dataset	# Photos	Median Photo Size (MB)	Total Photo Set Size (MB)	Quality	# Nodes				# 3D Dense Cloud Points
					2	4	8	16	
					Processing Time (Minutes)				
Corn Maiden	63	9.5	580	medium	12.0	9.1	7.0	7.0	123,016
				high	21.0	18.0	16.0	7.0	493,703
Ernie Pyle	389	14.4	5,470	medium	466.4	249.2	146.1	99.1	1,524,620
Drone Processed	827	2.5	2,130	medium	447.8	248.2	136.1	92.1	441,646
				high	871.8	541.5	289.8	N/A	1,168,014
Drone Raw	1122	3.8	4,260	medium	2326.0	1099.0	610.5	350.3	1,011,894



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- More information
 - Email: rtrds@iu.edu
 - Search the KB (kb.iu.edu) for “RDC”, “Research Database Complex”, or “RADaRS”
 - go.iu.edu/radars
- Workshop Recording and Slides
 - <https://ssrc.indiana.edu/seminars/uitsrtworkshops.html>



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