



Introduction to Research Data Management

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Steven Van Tuyl
OSU Libraries

GOAL:

Achievable habits for implementing
data management best practices into
your workflow





What are data?

Research data is:

“...the recorded factual material commonly accepted in the scientific community as necessary to **validate** research findings.”

U.S. Office of Management and Budget, Circular A-110



Research data is:

“Unlike other types of information, research data are collected, observed, or created, for the **purposes of analysis to produce and validate original research results.**”

University of Edinburgh
MANTRA Research Data Management Training,
'Research Data Explained'



Data management:



Actions that contribute to effective **storage**, **preservation** and **reuse** of data and documentation throughout the research lifecycle.

What data management is not:

Data/computational science

Database administration

A research method:

- what data to collect
- how to collect them
- how to design an experiment

Why data management?

Further your field

Increase visibility & impact

Saves time

Protects investment

Increases research efficiency

Preservation

Funding agency requirements

Further your field



Atul Butte
@atulbutte



Following

New markers for preeclampsia, found using #opendata from @NCBI GEO: ncbi.nlm.nih.gov/pubmed/24195779 #ISMB @Carment

Reply Retweet Favorite

RETWEETS FAVORITE

11

1



12:42 PM - 14 Jul 2014

PubMed.gov
US National Library of Medicine
National Institutes of Health

PubMed | Advanced

Display Settings: Abstract

[BMC Med.](#) 2013 Nov 6;11:236. doi: 10.1186/1741-7015-11-236.

Integrating multiple 'omics' analyses identifies serological protein biomarkers for preeclampsia.

[Liu LY](#), [Yang T](#), [Ji J](#), [Wen Q](#), [Morgan AA](#), [Jin B](#), [Chen G](#), [Lyell DJ](#), [Stevenson DK](#), [Ling XB](#)¹, [Butte AJ](#).

Author information

Abstract

BACKGROUND: Preeclampsia (PE) is a pregnancy-related vascular disorder which is the leading cause of maternal morbidity and mortality. We identified novel serological protein markers to diagnose PE with a multi-'omics' based discovery approach.

METHODS: Seven previous placental expression studies were combined for a multiplex analysis, and in parallel, two-dimensional gel electrophoresis was used to compare serum proteomes in PE and control subjects. The combined biomarker candidates were validated with available ELISA assays using PE (n=32) and control (n=32) samples. With the validated biomarkers, a genetic algorithm was then used to construct and optimize biomarker panels.

RESULTS: In addition to the previously identified biomarkers, the angiogenic and antiangiogenic factors (soluble fms-like tyrosine kinase-1 ligand (sFlt-1) and soluble endoglin (sEng)), we found 3 up-regulated and 6 down-regulated biomarkers in PE sera. Two optimal biomarker panels were developed for clinical assessment, respectively.

CONCLUSIONS: Both early and late onset PE diagnostic panels, constructed with our PE biomarkers, were superior over sFit-1/PlGF. The functional significance of these PE biomarkers and their associated pathways were analyzed which may provide new insights into the pathogenesis of PE.

PMID: 24195779 [PubMed - indexed for MEDLINE] [Free full text](#)

Increase visibility & impact

 OPEN ACCESS  PEER-REVIEWED

RESEARCH ARTICLE

34,276

VIEWS

97

CITATIONS

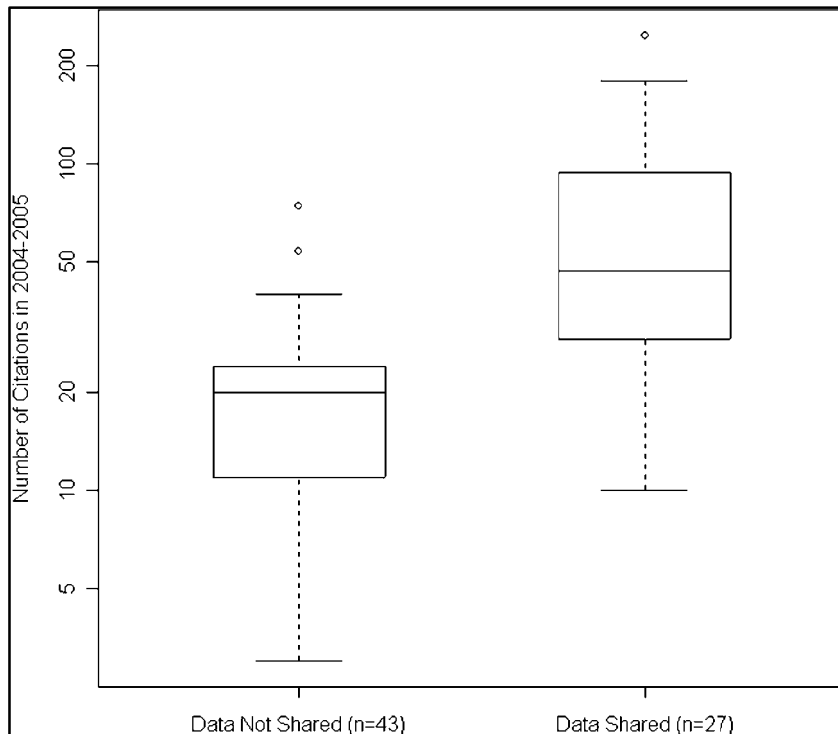
359

SAVES

Sharing Detailed Research Data Is Associated with Increased Citation Rate

Heather A. Piwowar , Roger S. Day, Douglas B. Fridsma

Published: Mar 21, 2007 • DOI: [10.1371/journal.pone.0000308](https://doi.org/10.1371/journal.pone.0000308) • Featured in [PLOS Collections](#)



85 cancer microarray clinical trial publications

69% increase in citations for articles w/publicly available data

Funder mandates



“...directed Federal agencies with more than \$100M in R&D expenditures to develop plans to make the published results of federally funded research freely available to the public within one year of publication and requiring researchers to better account for and manage the digital data resulting from federally funded scientific research.”

Posted by Michael Stebbins on February 22, 2013 at 12:04 PM EST



The Obama Administration is committed to the proposition that citizens deserve easy access to the results of scientific research their tax dollars have paid for. That's why, in a policy memorandum released today, OSTP Director John Holdren has directed Federal agencies with more than \$100M in R&D expenditures to develop plans to make the published results of federally funded research freely available to the public within one year of publication and requiring researchers to better account for and manage the digital data resulting from federally funded scientific research. OSTP has been looking into this issue for some time, soliciting broad public input on multiple occasions and convening an interagency working group to develop a policy. The final policy reflects substantial inputs from scientists and scientific organizations, publishers, members of Congress, and other members of the public—over 65 thousand of whom recently signed a *We the People* petition asking for expanded public access to the results of taxpayer-funded research.

Which agencies are affected?



\$54M



\$35M



\$23M



Aspects of data management

DMPs/Planning

Storage & backup

File organization & naming

Documentation & metadata

Legal/ethical
considerations

Sharing & reuse

Archiving &
preservation

Data types & formats

Data types

Observational | Can't be recaptured, recreated or replaced; Examples: sensor readings, sensory (human) observations, survey results

Experimental | Should be reproducible, but can be expensive; Examples: gene sequences, chromatograms, spectroscopy, microscopy, cell counts

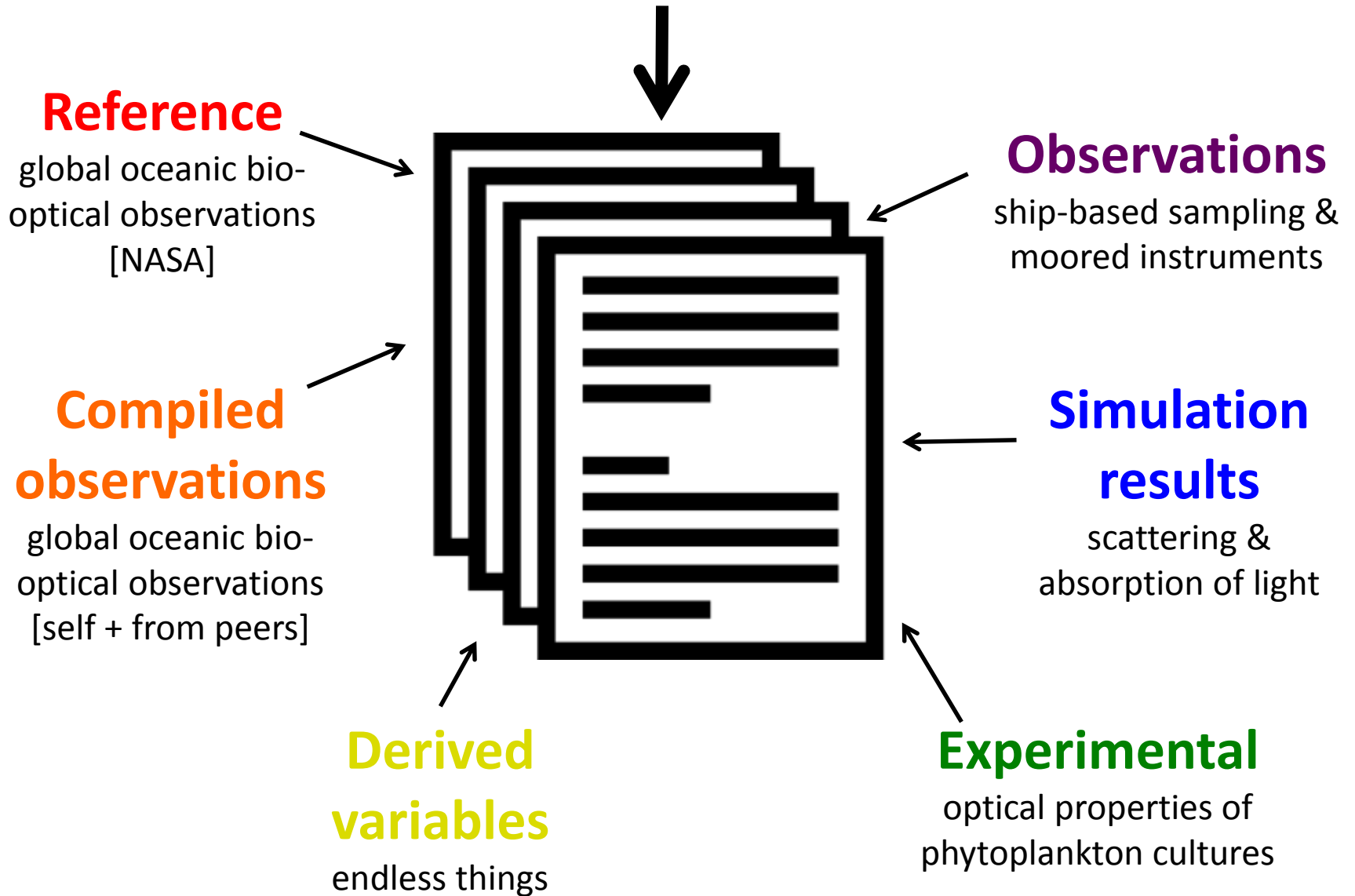
Derived or compiled | Reproducible, but can be very expensive; Examples: text and data mining, compiled database, 3D models

Simulation | Models and metadata, where the input can be more important than output data; Examples: climate models, economic models, biogeochemical models

Reference/canonical | Static or organic collection [peer-reviewed] datasets, most probably published and/or curated; Examples: gene sequence databanks, chemical structures, census data, spatial data portals

Amanda's dissertation

The spectral backscattering properties of marine particles



Data types: another classification

Qualitative data “is a categorical measurement expressed not in terms of numbers, but rather by means of a natural language description. In statistics, it is often used interchangeably with "categorical" data.” See also: **nominal**, **ordinal**

Quantitative data “is a numerical measurement expressed not by means of a natural language description, but rather in terms of numbers. However, not all numbers are continuous and measurable.”

“My favorite color is **blue-green**.” vs. “My favorite color is 510 nm.”

More common data types

Geospatial data has a geographical or geospatial aspect. Spatial location is critically tied to other variables.

Digital image, audio & video data

Documentation & scripts Sometimes, software code IS data; likewise with documentation (laboratory notebooks, written observations, etc.)


File Formats

“A **file format** is a standard way that information is encoded for storage in a computer file. It specifies how bits are used to encode information in a digital storage medium.” - Wikipedia

Data type

Qualitative, tabular
experimental data

Possible formats



- Excel spreadsheet (.xlsx)
- Comma-delimited text (.csv)
- Access database (.mdb/,accdb)
- Google Spreadsheet
- SPSS portable file (.por)
- XML file

Reflective Writing: 60 seconds

What types & formats of data will you be generating and/or using?

Observational | Experimental | Derived | Compiled |
Simulation | Reference/Canonical
Qualitative | Quantitative | Geospatial
Image/audio/video | Scripts/codes

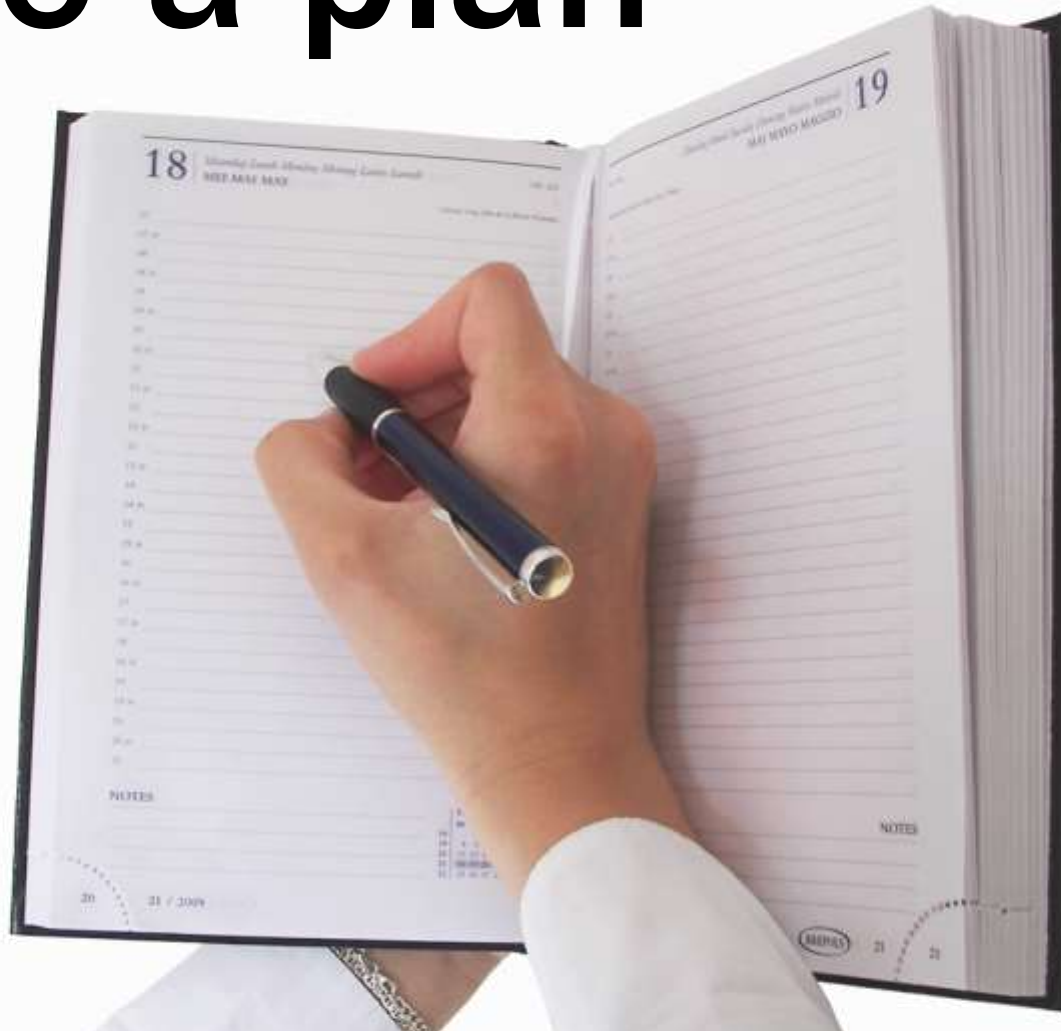


The “big picture”



Where do you start?

Make a plan



Data storage & backup



“Your data are the life
blood of your research.
If you lose your data
recovery could be slow,
costly or even worse...

it could be impossible.”

Most common loss scenario: drive failure

Windows Error Recovery

Windows failed to start. A recent hardware or software change might be the cause.

If Windows files have been damaged or configured incorrectly, Startup Repair can help diagnose and fix the problem. If power was interrupted during startup, choose Start Windows Normally.

(Use the arrow keys to highlight your choice.)

Launch Startup Repair (recommended)

Start Windows Normally

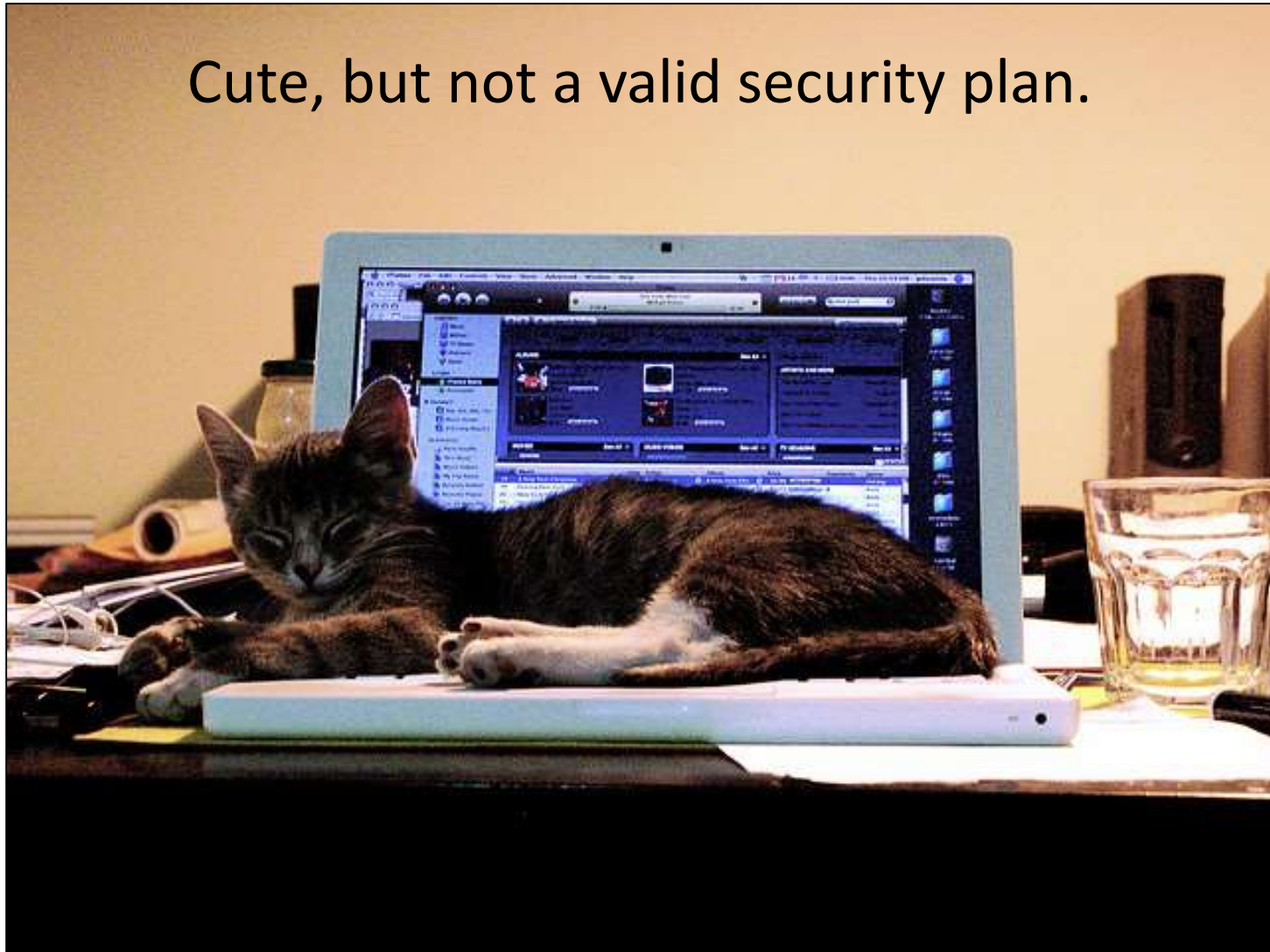
Seconds until the highlighted choice will be selected automatically: 20

Description: Fix problems that are preventing Windows from starting

ENTER=Choose

This happens a lot: physical theft & unintentional damage

Cute, but not a valid security plan.



Rare, unexpected events happen

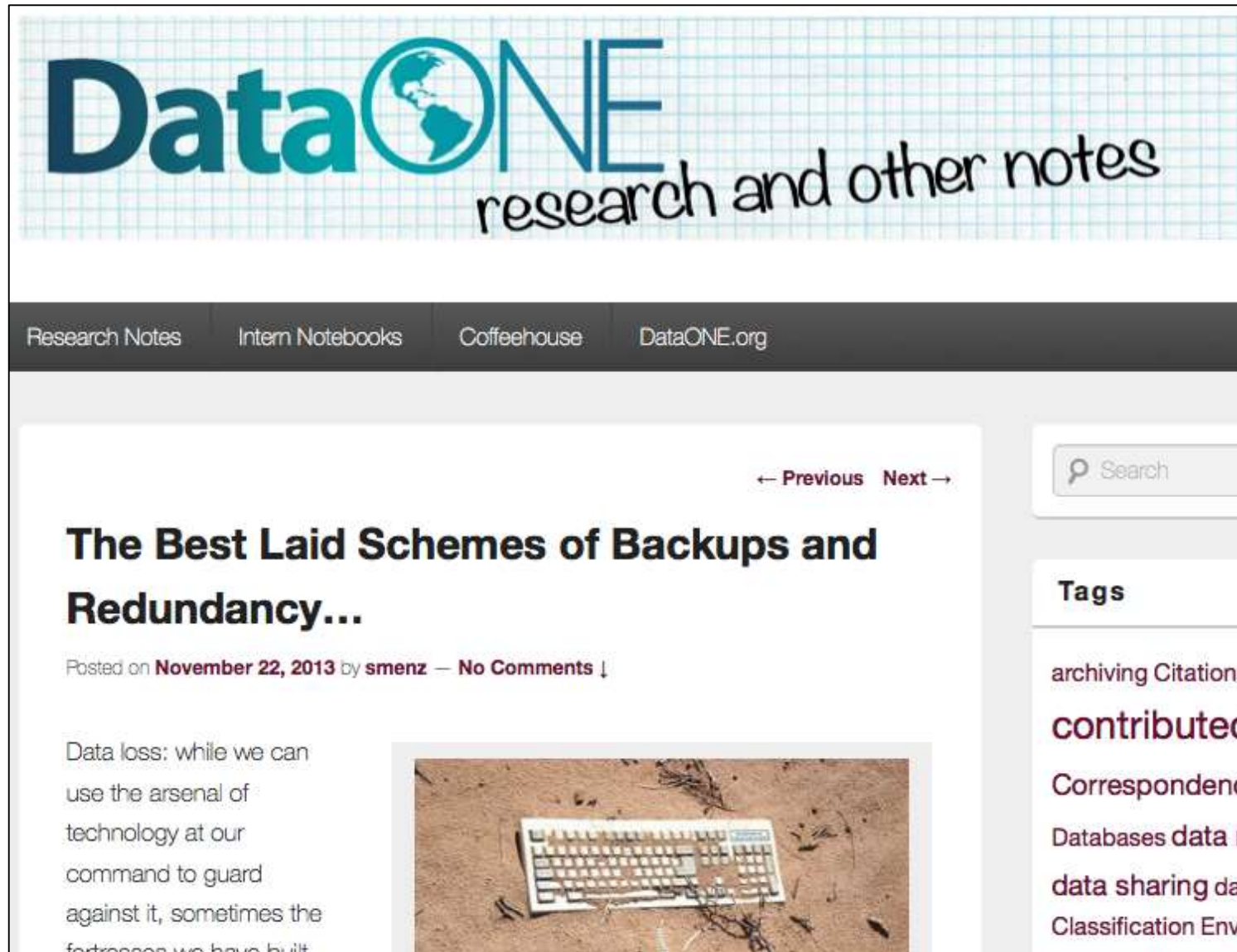
University of Southampton, School of Electronics and
Computer Science, Southampton, UK, 2005



It CAN happen to you



Real-world lesson: Audit your backups...



The screenshot shows the DataONE website header with the logo "DataONE" and the tagline "research and other notes". Below the header is a navigation bar with links for "Research Notes", "Intern Notebooks", "Coffeehouse", and "DataONE.org". The main content area features a blog post titled "The Best Laid Schemes of Backups and Redundancy..." by smenz, dated November 22, 2013. The post text begins with "Data loss: while we can use the arsenal of technology at our command to guard against it, sometimes the fortresses we have built". An image of a keyboard on the ground is partially visible. A search bar and a tags section are on the right side of the page.

DataONE
research and other notes


Research Notes Intern Notebooks Coffeehouse DataONE.org

← Previous Next →

The Best Laid Schemes of Backups and Redundancy...

Posted on **November 22, 2013** by **smenz** — **No Comments** ↓

Data loss: while we can use the arsenal of technology at our command to guard against it, sometimes the fortresses we have built



Search

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contributed
Correspondence
Databases data r
data sharing da
Classification Envi

Data backup

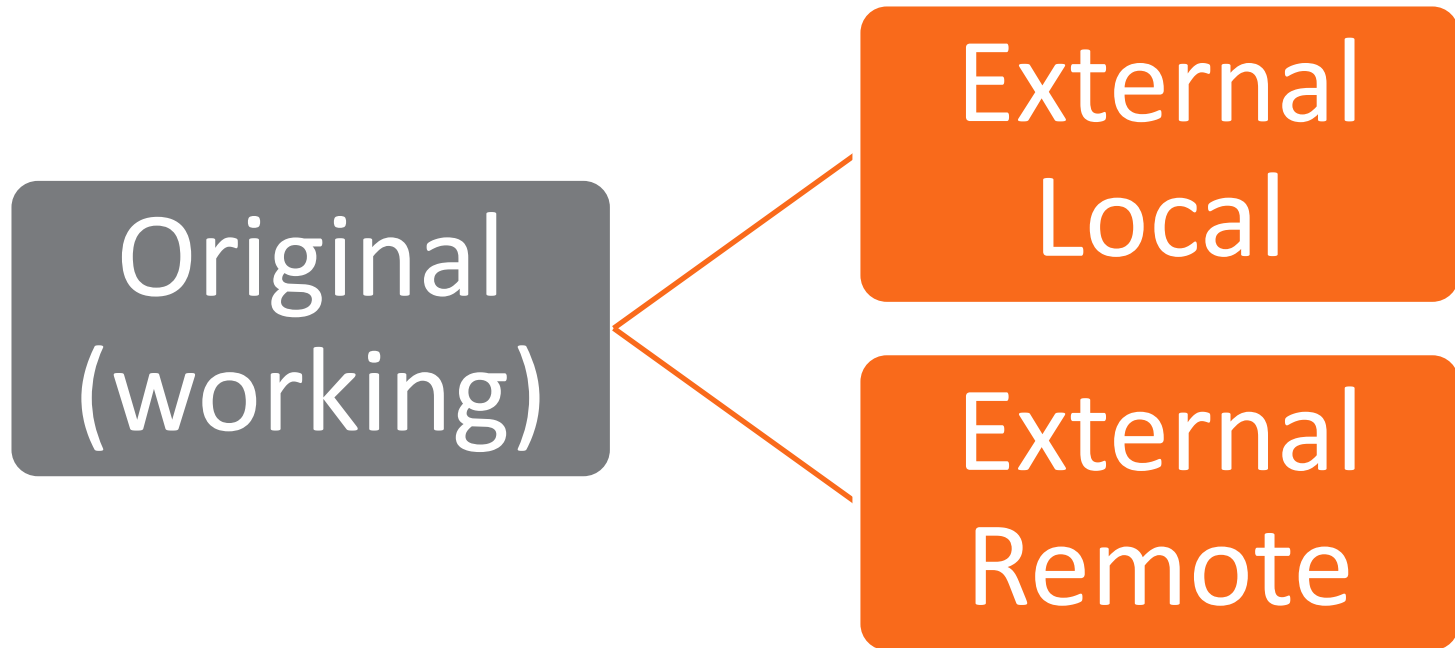
“Keeping backups is probably your most important data management task.”

-Everyone

1. Some data backup is better than none.
2. Automated backups are better than manual.
3. Your data are only as safe as your last backup.

Data backup

Best Practice: 3 Copies of datasets



Data storage options

1. Personal computers (PCs) & laptops
2. External storage devices
3. Networked Drives
4. Cloud servers

Storage: PC/laptop

Advantages

Convenient

Disadvantages

Drive failure common

Laptops: susceptible to theft & unintentional damage

Not replicated

Bottom Line

Do NOT use to store master copies of data

Not a long term storage solution

Back up important data & files regularly

Storage: external storage devices



Advantages

Convenient, cheap & portable

Disadvantages

Longevity not guaranteed (e.g. Zip disks)

Errors writing to CD/DVD are common

Easily damaged, misplaced or lost (=security risk)

May not be big enough to hold all data; multiple drives needed

Bottom Line

Do NOT use to store master copies of data

Not recommended for long-term storage

Storage: networked drives

Advantages

Data in single place, backed up regularly

Replicated storage not vulnerable to loss due to hardware failure

Secure storage minimizes risk of loss, theft, unauthorized use

Available as needed (assuming network avail.)

Disadvantages

Cost may be prohibitive; export control

Bottom Line

Highly recommended for master copies of data

Recommended for long-term storage (~5 years)

Storage: cloud storage

Advantages

Data in single place, backed up regularly

Replicated storage not vulnerable to loss due to hardware failure

Secure storage minimizes risk of loss, theft, unauthorized use

Disadvantages

Cost may be prohibitive

Upload/download bottleneck & fees

Longevity?

Export control

Bottom Line

Possibly recommended for master copies of data

Not recommended for in-process data, large files

Storage: Google Drive for OSU

Advantages

All same advantages of network & cloud storage

File sharing & collaboration w/variable access levels

Unlimited storage (GD), 30 GB non-GD

Automatic version control on GD

Disadvantages

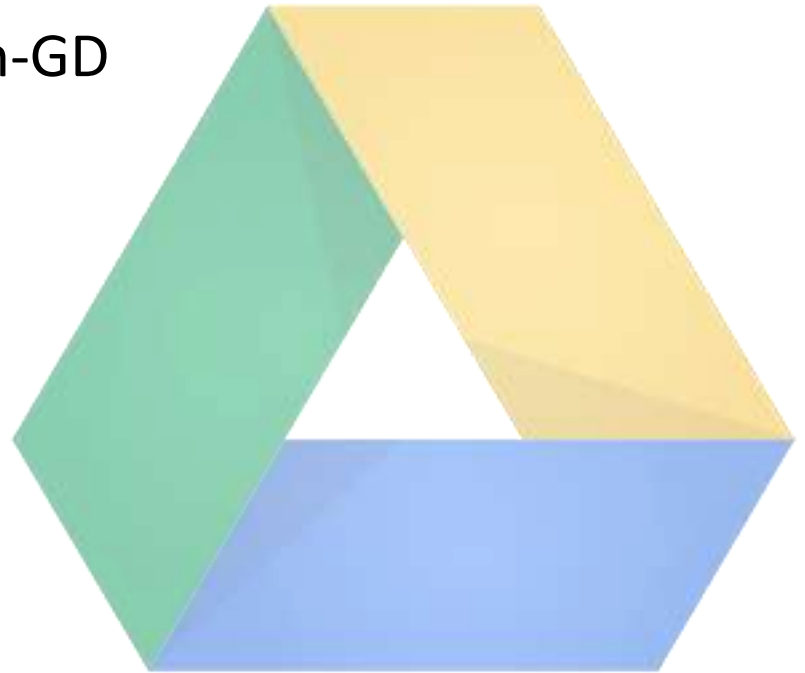
30 GB may not be enough

Upload/download bottleneck

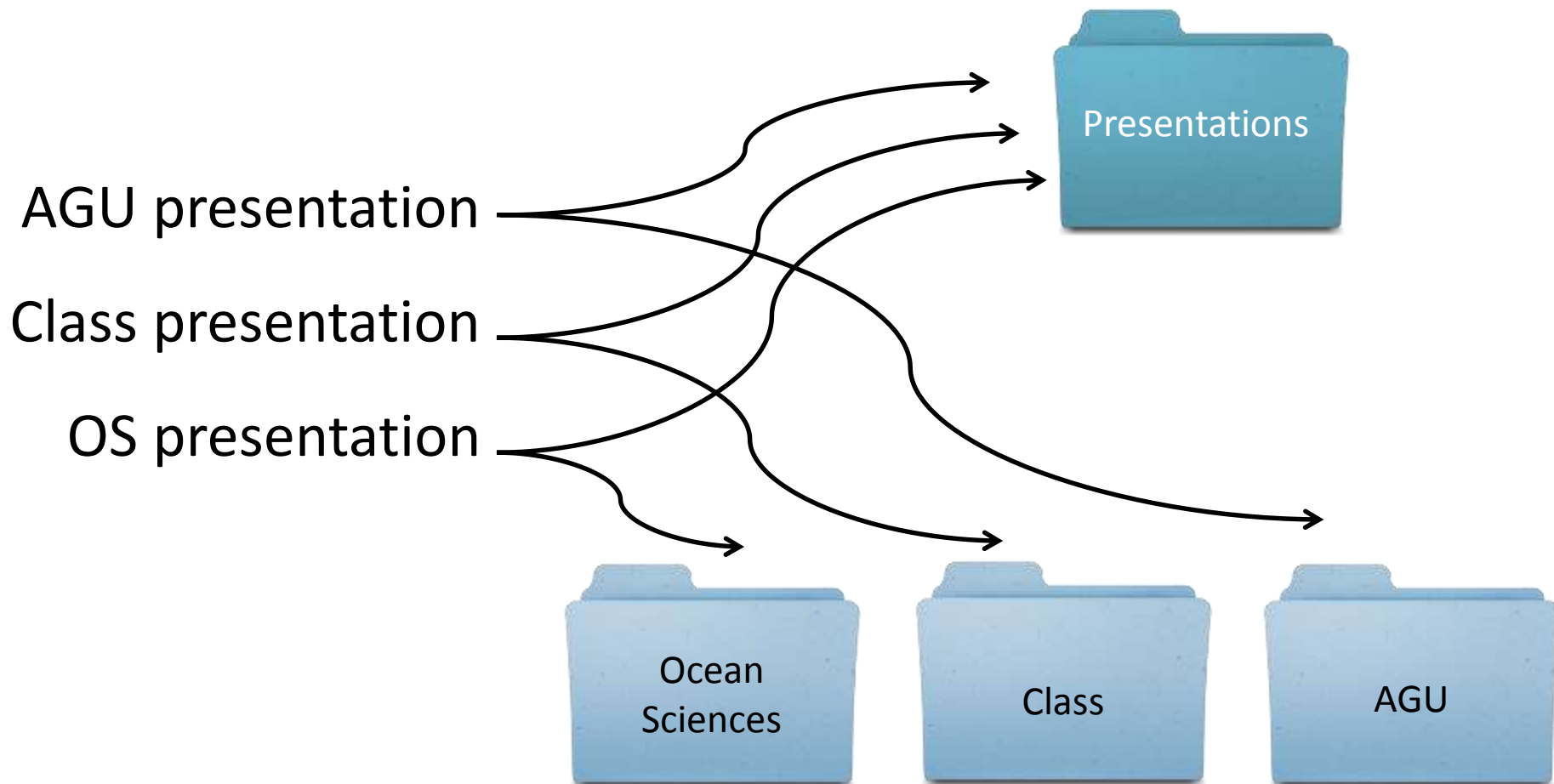
Bottom Line

Possibly recommended for master copies of data

Possibly not recommended for in-process data, large files



Data organization



Data storage options

Local

Computer

External storage

Network server

Remote

Network server

Cloud storage

Google Apps

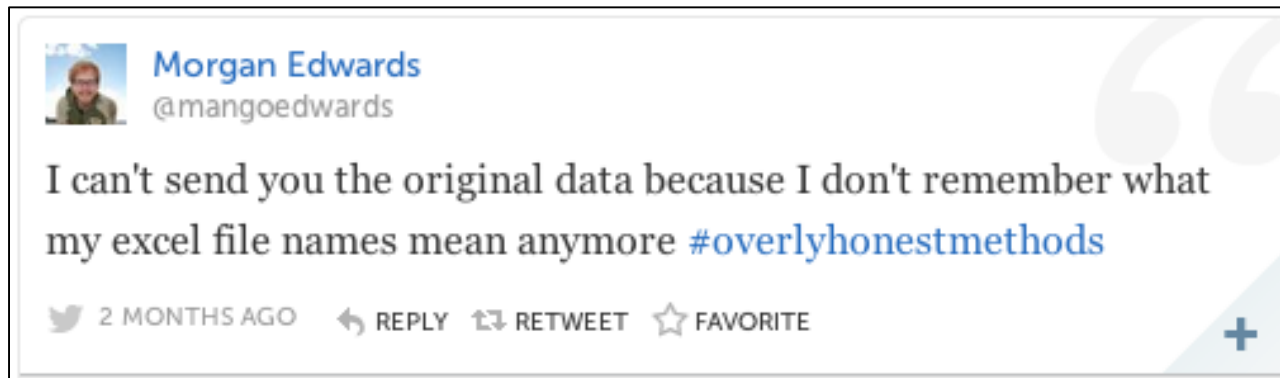
Box, Dropbox,
etc.

File-naming conventions

File naming strategy?

Filename	Date Modified	Size	Type
data_2010.05.28_test.dat	3:37 PM 5/28/2010	420 KB	DAT file
data_2010.05.28_re-test.dat	4:29 PM 5/28/2010	421 KB	DAT file
data_2010.05.28_re-re-test.dat	5:43 PM 5/28/2010	420 KB	DAT file
data_2010.05.28_calibrate.dat	7:17 PM 5/28/2010	1,256 KB	DAT file
data_2010.05.28_huh??.dat	7:20 PM 5/28/2010	30 KB	DAT file
data_2010.05.28_WTF.dat	9:58 PM 5/28/2010	30 KB	DAT file
data_2010.05.29_aaarrgh.dat	12:37 AM 5/29/2010	30 KB	DAT file
data_2010.05.29_#*\$@*&!!.dat	2:40 AM 5/29/2010	0 KB	DAT file
data_2010.05.29_crap.dat	3:22 AM 5/29/2010	437 KB	DAT file
data_2010.05.29_notbad.dat	4:16 AM 5/29/2010	670 KB	DAT file
data_2010.05.29_woohoo!!.dat	4:47 AM 5/29/2010	1,349 KB	DAT file
data_2010.05.29_USETHISONE.dat	5:08 AM 5/29/2010	2,894 KB	DAT file
analysis_graphs.xls	7:13 AM 5/29/2010	455 KB	XLS file
ThesisOutline!.doc	7:26 AM 5/29/2010	38 KB	DOC file
Notes_Meeting_with_ProfSmith.txt	11:38 AM 5/29/2010	1,673 KB	TXT file
JUNK...	2:45 PM 5/29/2010		Folder
data_2010.05.30_startingover.dat	8:37 AM 5/30/2010	420 KB	DAT file

#OverlyHonestMethods



File naming conventions

s/n, variable

Retain

order

Project_instrument_location_YYYYMMDDhhmmss_e

xtra.ext

Index/grant

conditions

Leading zero!

File naming strategies

Order by date:

1955-04-12_notes_MassObs.docx
1955-04-12_questionnaire_MassObs.pdf
1963-12-15_notes_Gorer.docx
1963-12-15_questionnaire_Gorer.pdf

Order by subject:

Gorer_notes_1963-12-15.docx
Gorer_questionnaire_1963-12-15.pdf
MassObs_notes_1955-04-12.docx
MassObs_questionnaire_1955-04-12.pdf

Order by type:

Notes_Gorer_1963-12-15.docx
Notes_MassObs_1955-04-12.docx
Questionnaire_Gorer_1963-12-15.pdf
Questionnaire_MassObs_1955-04-12.pdf

Forced order with numbering:

01_MassObs_questionnaire_1955-04-12.pdf
02_MassObs_notes_1955-04-12.docx
03_Gorer_questionnaire_1963-12-15.pdf
04_Gorer_notes_1963-12-15.docx

Version control



File Edit View Insert Format Data

Share...

New ▶

Open... ⌘O

Rename...

Make a copy...

Import...

See revision history ⌘⇧G

Spreadsheet settings...

Download as ▶

Publish to the web...

Email collaborators...

Email as attachment...

Print ⌘P

Revision history ✕

Jun 13, 3:30 PM PT
■ Nicole Vasilevsky

May 30, 12:45 PM PT
■ Nicole Vasilevsky

May 29, 7:53 PM PT
■ anonymous

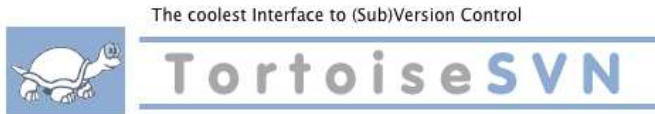
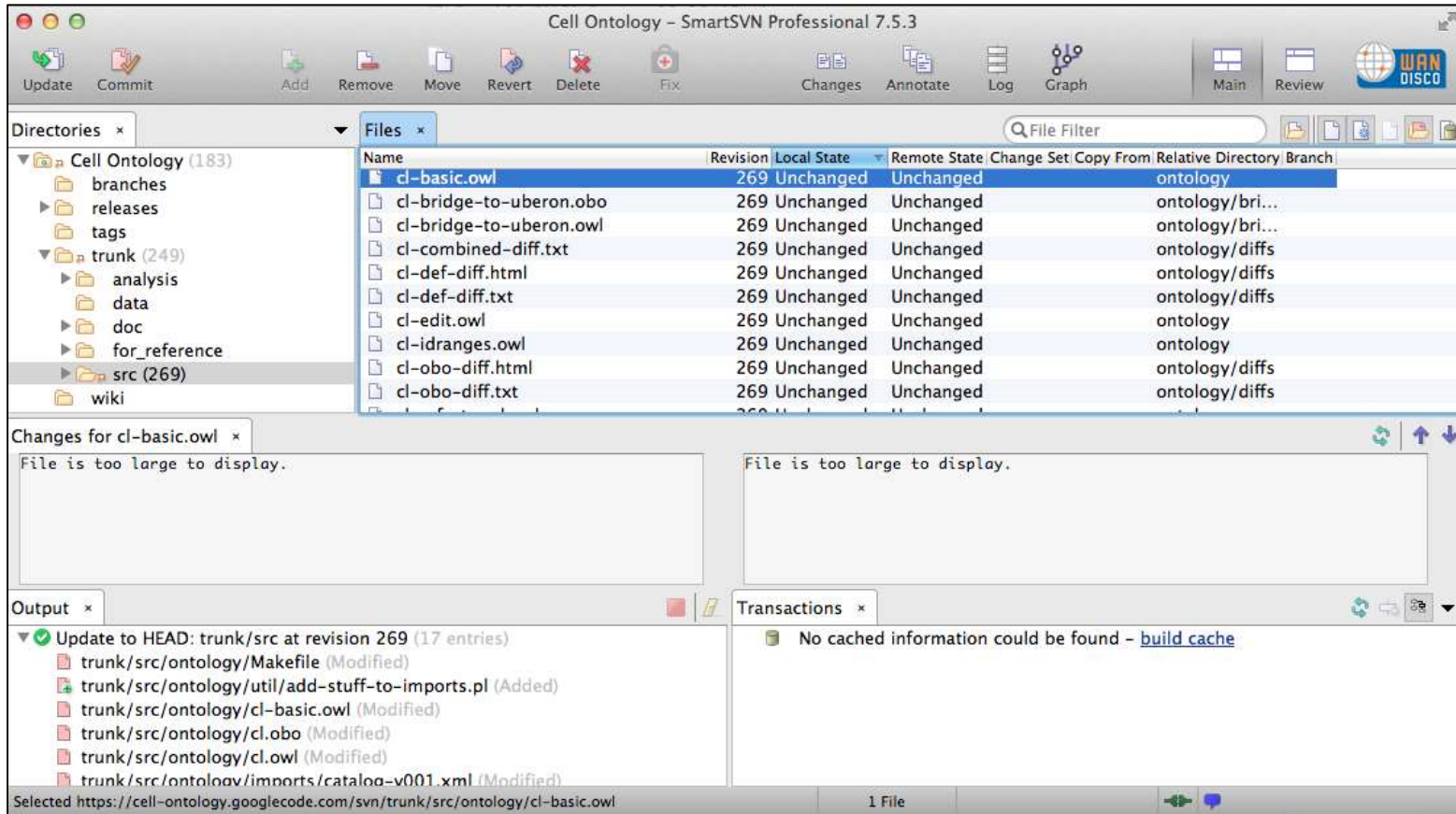
May 29, 9:51 AM PT
■ Nicole Vasilevsky

May 28, 10:14 AM PT
■ Nicole Vasilevsky

May 21, 7:48 AM PT
■ Nathan Urban

May 16, 6:38 PM PT
■ Nicole Vasilevsky

Version control





Random suggestion

Disambiguate yourself

ORCID

Connecting Research
and Researchers

Open Researcher & Contributor ID



John L. Campbell
Forest Research Ecologist
Oregon State University, Corvallis, OR

John L. Campbell
Forest Research Ecologist
Center for Research on Ecosystem Change
US Forest Service, Durham, NC





[Winter in northeastern North America: a critical period for ecological processes](#)

JL Campbell, MJ Mitchell, PM Groffman... - *Frontiers in Ecology* ..., 2005 - Eco Soc America

Ecological research during winter has historically been a low priority in northeastern North America, an oversight that stems from the commonly accepted notion that there is little biological activity when temperatures drop below freezing. However, recent research has ... Cited by 108 Related articles All 10 versions Cite

[Post-wildfire logging hinders regeneration and increases fire risk](#)

DC Donato, JB Fontaine, JL Campbell, WD Robinson... - *Science*, 2006 - sciencemag.org

... However, our data indicate that delay was responsible for ~10% of the woody fuel present after logging. ← JK Agee, *Fire Ecology of Pacific Northwest Forests* (Island Press, Washington, DC, 1993). ... More in Collections. **Ecology**. Related Jobs from ScienceCareers. ... Cited by 156 Related articles All 63 versions Cite

[Site-level evaluation of satellite-based global terrestrial gross primary production and net primary production monitoring](#)

DP Turner, WD Ritts, WB Cohen... - *Global Change* ..., 2005 - Wiley Online Library

... AA, Running, SW, Zhao, M., Wofsy, SC, Dunn, AL, Law, BE, **Campbell, JL**, Oechel, WC ... 3 Department of Forest **Ecology** and Management, University of Wisconsin, Madison, WI 53706, USA., 4 ... HARV is within the Harvard Forest Long Term **Ecological** Research (LTER) site in ... Cited by 175 Related articles All 25 versions Cite

[Supply-side controls on soil respiration among Oregon forests](#)

JL Campbell, OJ Sun, BE Law - *Global Change Biology*, 2004 - Wiley Online Library

... Additional Information. How to Cite. **Campbell, JL**, Sun, OJ and Law, BE (2004), Supply-side controls on soil respiration among Oregon forests. *Global Change Biology*, 10: 1857-1869. doi: 10.1111/j.1365-2486.2004.00850.x. Author Information. ... Cited by 48 Related articles All 2 versions Cite

[Ecosystem processes and human influences regulate streamflow response to climate change at long-term ecological research sites](#)

JA Jones, JF Creed, KL Hatcher, RJ Warren, MB Adams... - *BioScience*, 2012 - JSTOR

Analyses of long-term records at 35 headwater basins in the United States and Canada indicate that climate change effects on streamflow are not as clear as might be expected, perhaps because of ecosystem processes and human influences. Evapotranspiration was ... Cited by 18 Related articles All 28 versions Cite

[Can fuel-reduction treatments really increase forest carbon storage in the western US by reducing future fire emissions?](#)

JL Campbell, ME Harmon... - *Frontiers in Ecology and* ..., 2011 - Eco Soc America

It has been suggested that thinning trees and other fuel-reduction practices aimed at reducing the probability of high-severity forest fire are consistent with efforts to keep carbon (C) sequestered in terrestrial pools, and that such practices should therefore be rewarded ...

- include patents
- include citations
- Create alert

Another Doppelgänger

Chris Langdon
Studies ocean acidification
OSU HMSC



OSU
Oregon State
UNIVERSITY

Oregon Sea Grant

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Resistance of Pacific Oyster Larvae and Juveniles to Ocean Acidification

Resistance of Pacific Oyster Larvae and Juveniles to the Effects of Ocean Acidification (2014-17)

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MIAMI

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- Department of Marine Biology and Ecology
- Department of Marine Ecosystems and Society
- Department of Marine Geosciences
- Department of Ocean Sciences

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Lab Website
Google Scholar Profile

Research Publications Students Courses

Albright R, Mason B, Langdon C (2008) Effect of aragonite saturation state on the settlement and post-settlement growth of *Pavites astrooides* larvae. *Coral Reefs* doi:10.1007/s00338-008-0392-5

Manzello D, Kleypas J, Budd DA, Eakin CM, Glynn PW, Langdon C (2008) Poorly cemented coral reefs of the eastern tropical Pacific: possible insights into reef development in a high-CO₂ world. *Proceedings of the National Academy of Science*, 105(30), doi:10.1073/pnas.0712167105



Chris Langdon
Studies ocean acidification
University of Miami



Metadata

What is metadata?

- Data about data
- Structured information that describes, explains, locates, or otherwise makes it easier to retrieve, use, or manage an information resource.



NISO, *Understanding Metadata*

Metadata

“The metadata accompanying your data should be written for a user **20 years into the future** -- what does that person need to know to use your data properly? Prepare the metadata for a user who is unfamiliar with your project, methods, or observations.”

Oak Ridge National Laboratory Distributed Active
Archive Center for Biogeochemical Dynamics
(ORNL DAAC)



OAK RIDGE NATIONAL LABORATORY

Managed by UT-Battelle for the Department of Energy

Metadata in real life

You use it all the time...

TITLE	Moby-Dick / Herman Melville ; edited by Hershel Parker, Harrison Hayford ; pictorial materials prepared by John B. Putnam.	
AUTHOR	Melville, Herman, 1819-1891.	
PUBLISHER	New York : Norton, c2002.	
NOTE:	"An authoritative text before Moby-Dick: international controversy, reviews and letters by Melville, analogues and sources, reviews of Moby-Dick, criticism." Includes bibliographical references (p. 725-726).	
SUBJECTS	Ahab, Captain (Fictitious character) -- Fiction. Melville, Herman, 1819-1891. Moby Dick. Whaling -- Fiction. Whales -- Fiction.	
LOCATION	CALL NUMBER	STATUS
Valley	PS2384 .M6 2002	AVAILABLE
OSU Cascades/COCC Floor 2	PS2384 .M6 2002	AVAILABLE

Weather Conditions for:
CW5709 Corvallis, OR (C5709)
 Elev: 239 ft; Latitude: 44.55133; Longitude: -123.29117

Current time: Tue, 20 Nov 3:33 pm (PST)
 Most Recent Observation: Tue, 20 Nov 3:12 pm (PST)

Time (PST)	Temp (f)	Dew Point (f)	Relative Humidity (%)	Wind Direction	Wind Speed (mph)	Altimeter Setting (inches)	Station Pressure (inches)	Quality Control
20 Nov 3:12 pm	54	46	75	SW	4G13	29.71	29.463	OK
20 Nov 3:02 pm	54	47	77	W	7G11	29.70	29.453	OK
20 Nov 2:52 pm	53	47	81	WSW	3G08	29.70	29.453	OK
20 Nov 2:42 pm	53	47	80	W	4G16	29.70	29.453	OK
20 Nov 2:32 pm	55	48	76	SSW	3G11	29.69	29.443	OK
20 Nov 2:22 pm	56	47	73	WSW	5G12	29.68	29.433	OK
20 Nov 2:12 pm	56	48	75	SW	5G12	29.68	29.433	OK
20 Nov 2:02 pm	56	48	74	SW	7G12	29.67	29.423	OK

Nutrition Facts	
Serving Size 4 OZ. SERVING (112g) Servings Per Container VARIED	
Amount Per Serving	
Calories 170	Calories from Fat 70
% Daily Value*	
Total Fat 8g	12%
Saturated Fat 3g	15%
Cholesterol 65mg	22%
Sodium 70mg	3%
Total Carbohydrate 0g	0%
Dietary Fiber 0g	0%
Sugars 0g	
Protein 23g	
<ul style="list-style-type: none"> Vitamin C 0% Iron 15% 	
*Percent Daily Values are based on a diet of other people's misdeeds.	

Major metadata standards

Darwin Core | **biological diversity, taxonomy**

Dublin Core | **general**

DDI (Data Documentation Initiative) | **social & behavioral sciences**

DIF (Directory Interchange Format) | **environmental sciences**

EML (Ecological Metadata Language) | **ecology, biology**

ISO 19115 | **geographic data**

01101101 01100101 01110100 01100001
01100100 01100001 01110100 01100001

Metadata examples

Santa Barbara Coastal Long Term Ecological Research (LTER)

[web link](#)

Bureau of Labor Statistics, Consumer Price Index, 1913-1992

[web link](#)



Legal & ethical considerations



Data sharing & reuse

“...digitally formatted scientific data resulting from unclassified research supported wholly or in part by Federal funding should be stored and **publicly accessible** to search, retrieve, and analyze.”

Office of Science and Technology Policy
The White House



How to preserve & share data



How to preserve & share data

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- [Forest Products Laboratory \(U.S.\) \(1912\)](#)
- [Oregon State University. Agricultural](#)

Data journals



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The Data Publishing Journal

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Earth Syst. Sci. Data, 4, 47-73, 2012
www.earth-syst-sci-data.net/4/47/2012/
doi:10.5194/essd-4-47-2012
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Data management plans



What is a data management plan?

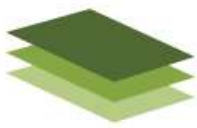
...Physical specimens consist of carbonate biothems and filtered water samples are stored in Spilde or Northup's labs until completion of analyses. At this time they are returned to the federal agency for museum curation or destroyed during analysis. Field notes will be scanned into pdf files, with a copy sent to Carlsbad Caverns National Park or other federal cave manager. SEM images will be saved in the tif format. ...



Sections of a data management plan

1. Types of data
2. Data & metadata standards
3. Archiving & preservation
4. Sharing (access provisions)
5. Transition from collection to reuse

See resources on your handout + use DMPTool



Your go-to
resource for data
management plans

Contact information

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Specialist

amanda.whitmire@oregonstate.edu

Steve Van Tuyl | Data and Digital Repository
Librarian

steve.vantuyl@oregonstate.edu

<http://bit.ly/OSUData>

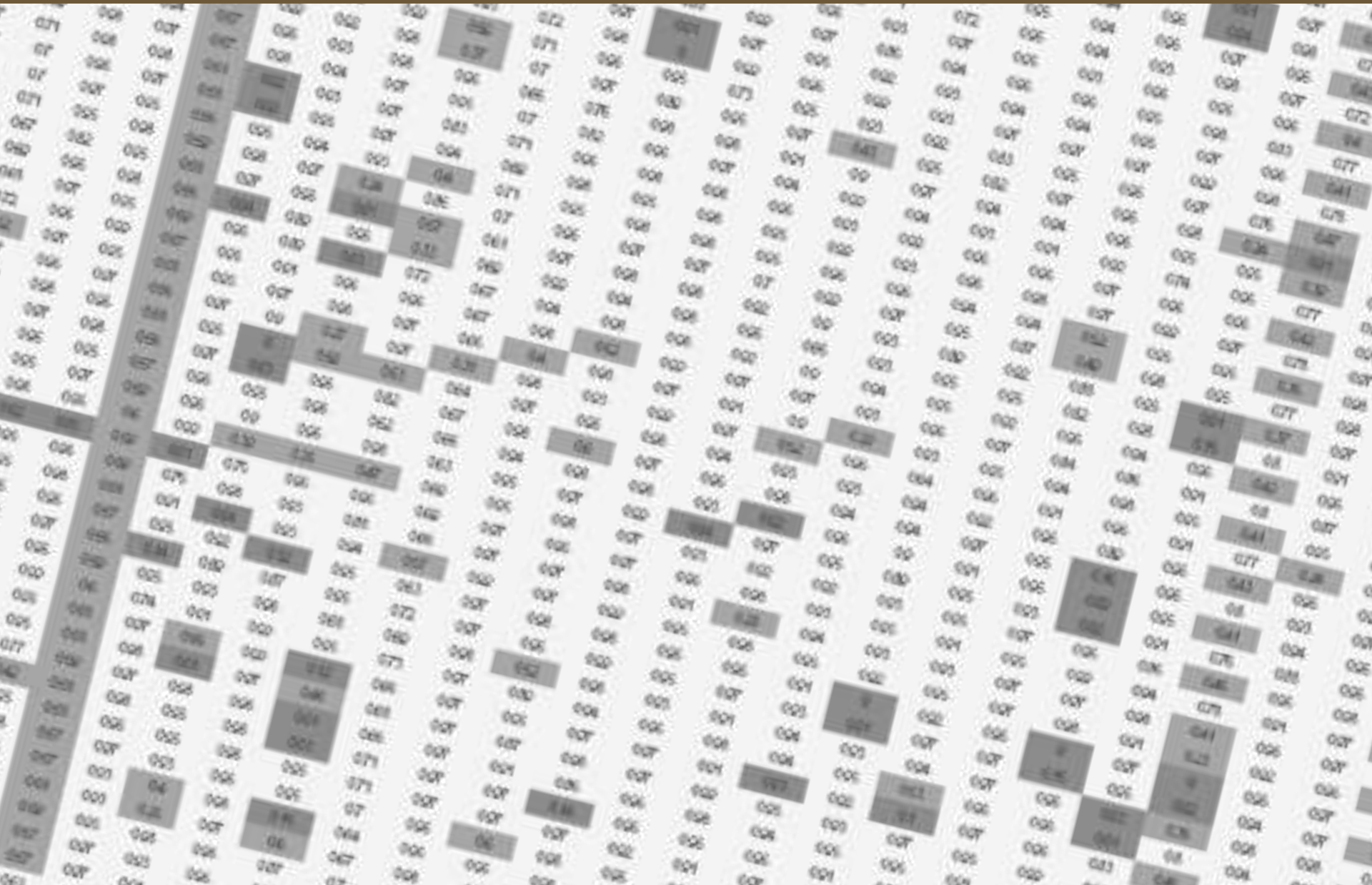


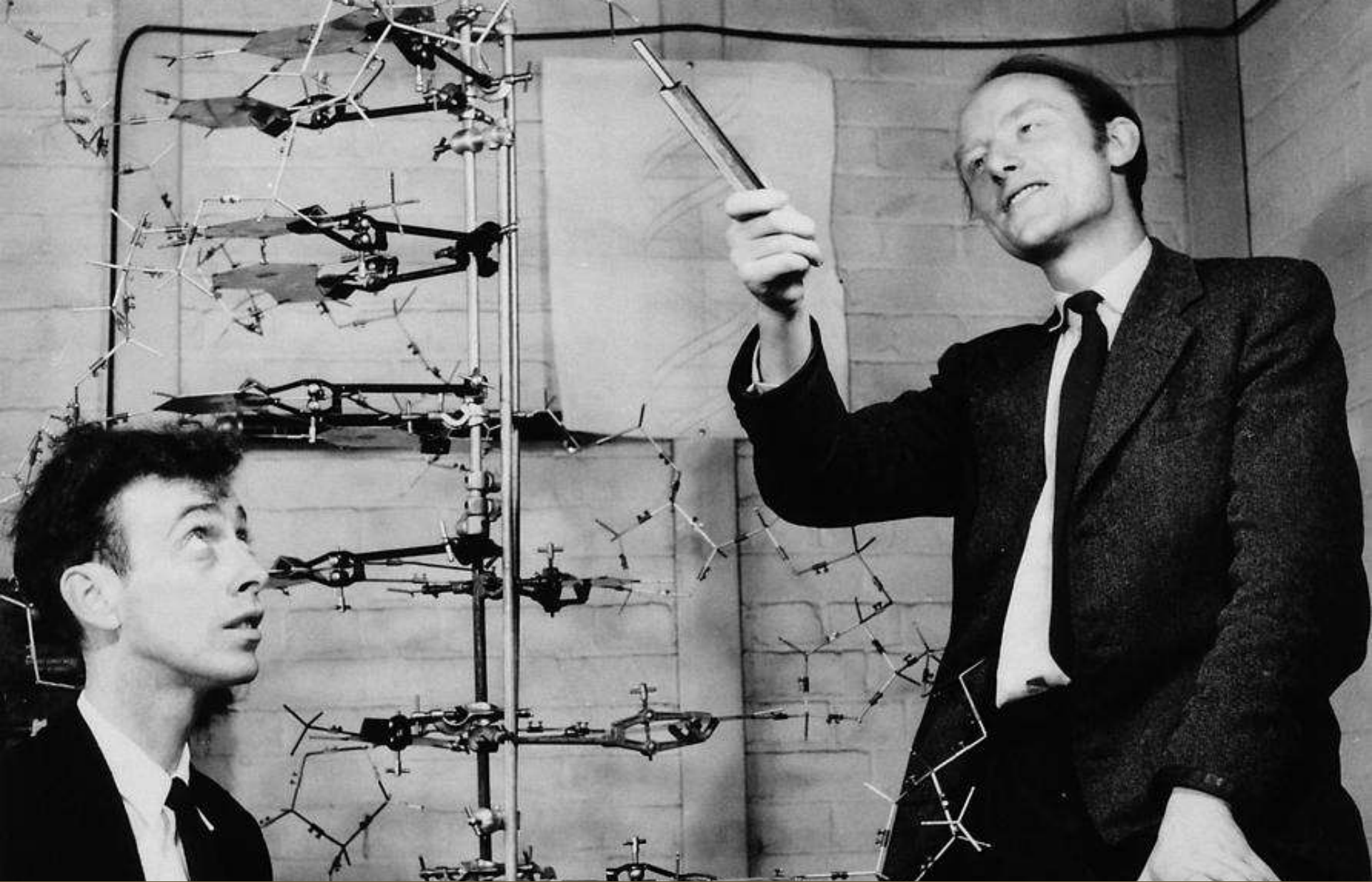
end



Extra / Outdated Slides

Data does not speak for itself...





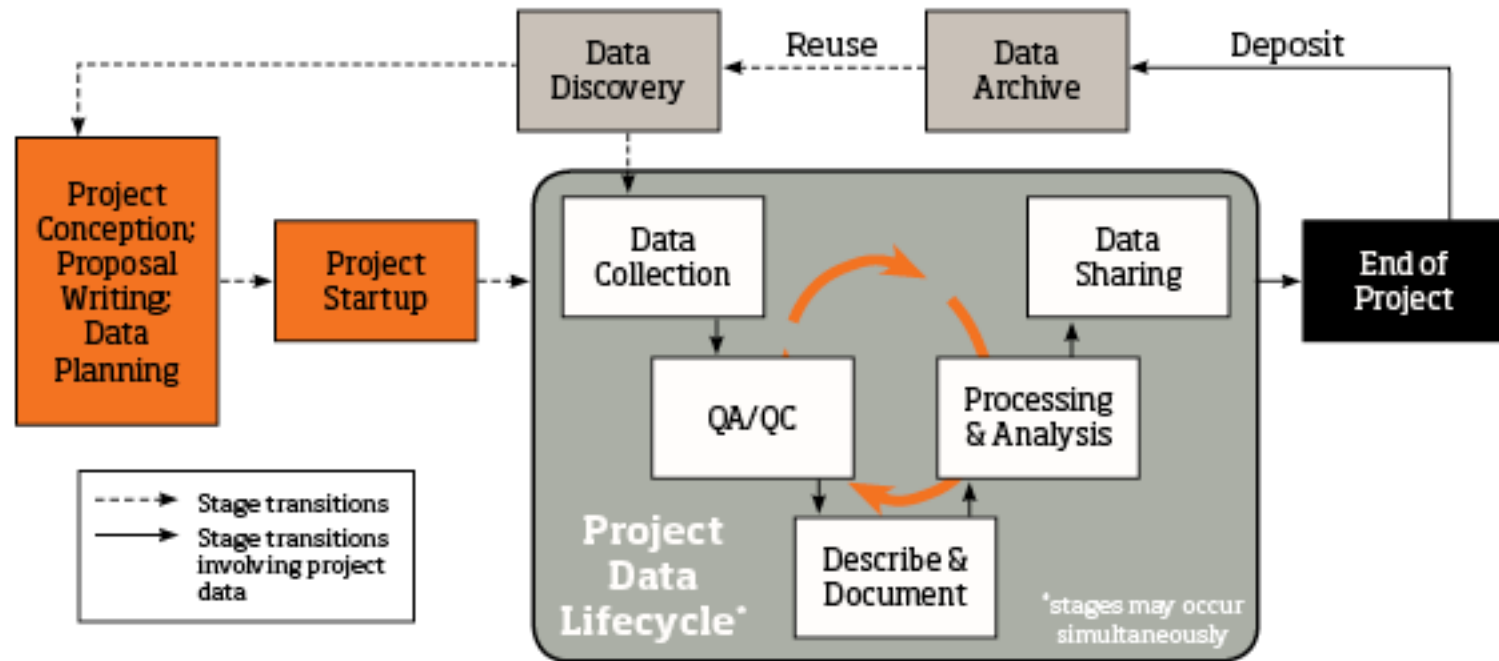
YOU speak for YOUR data

But first, you need to manage it



Data management in the lifecycle

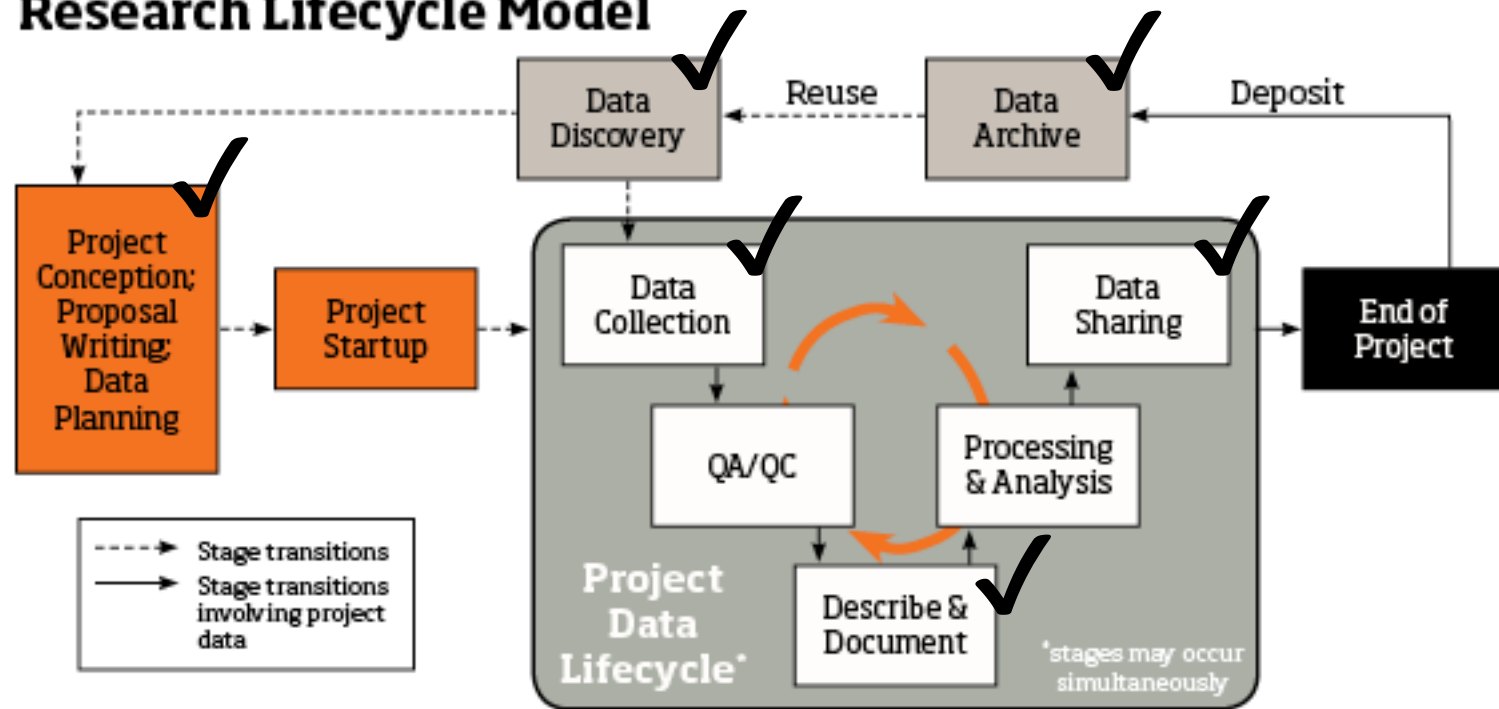
Research Lifecycle Model



Adapted from: <http://dmconsult.library.virginia.edu/lifecycle>
<http://www.icpsr.umich.edu/icpsrweb/content/deposit/guide/#cycle>

How can OSU Libraries help?

Research Lifecycle Model



Adapted from: <http://dmconsult.library.virginia.edu/lifecycle>
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Types, formats & stages of data

Raw data



Types, formats & stages of data



Intermediate data

Types, formats & stages of data



Final data

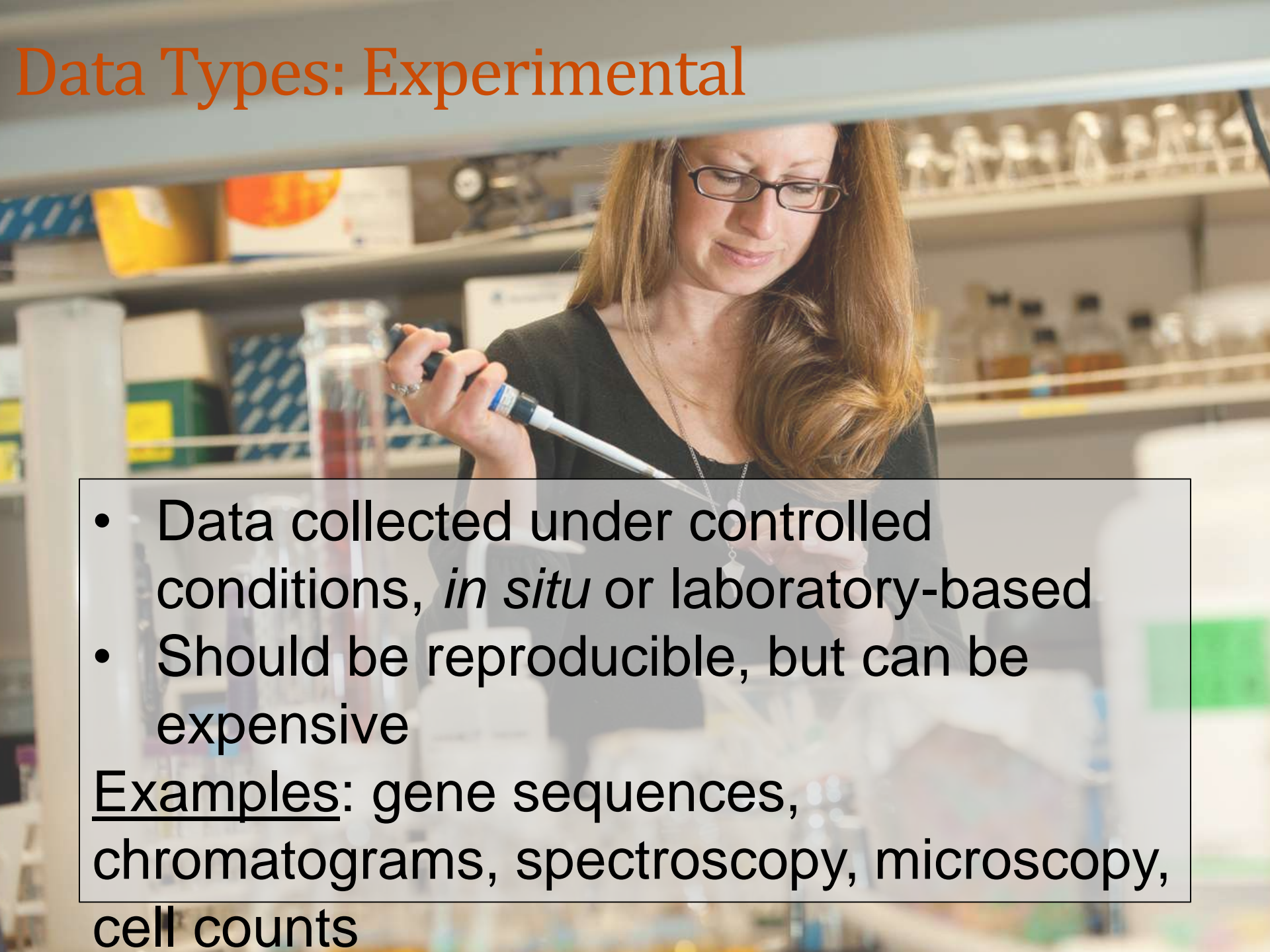
Data Types: Observational

A close-up photograph of a woman with brown hair looking through black binoculars. She is wearing a silver ring on her finger and a watch on her wrist. The background is a blurred field of tall green grass under a blue sky.

- Captured *in situ*
- Can't be recaptured, recreated or replaced

Examples: Sensor readings, sensory (human) observations, survey results

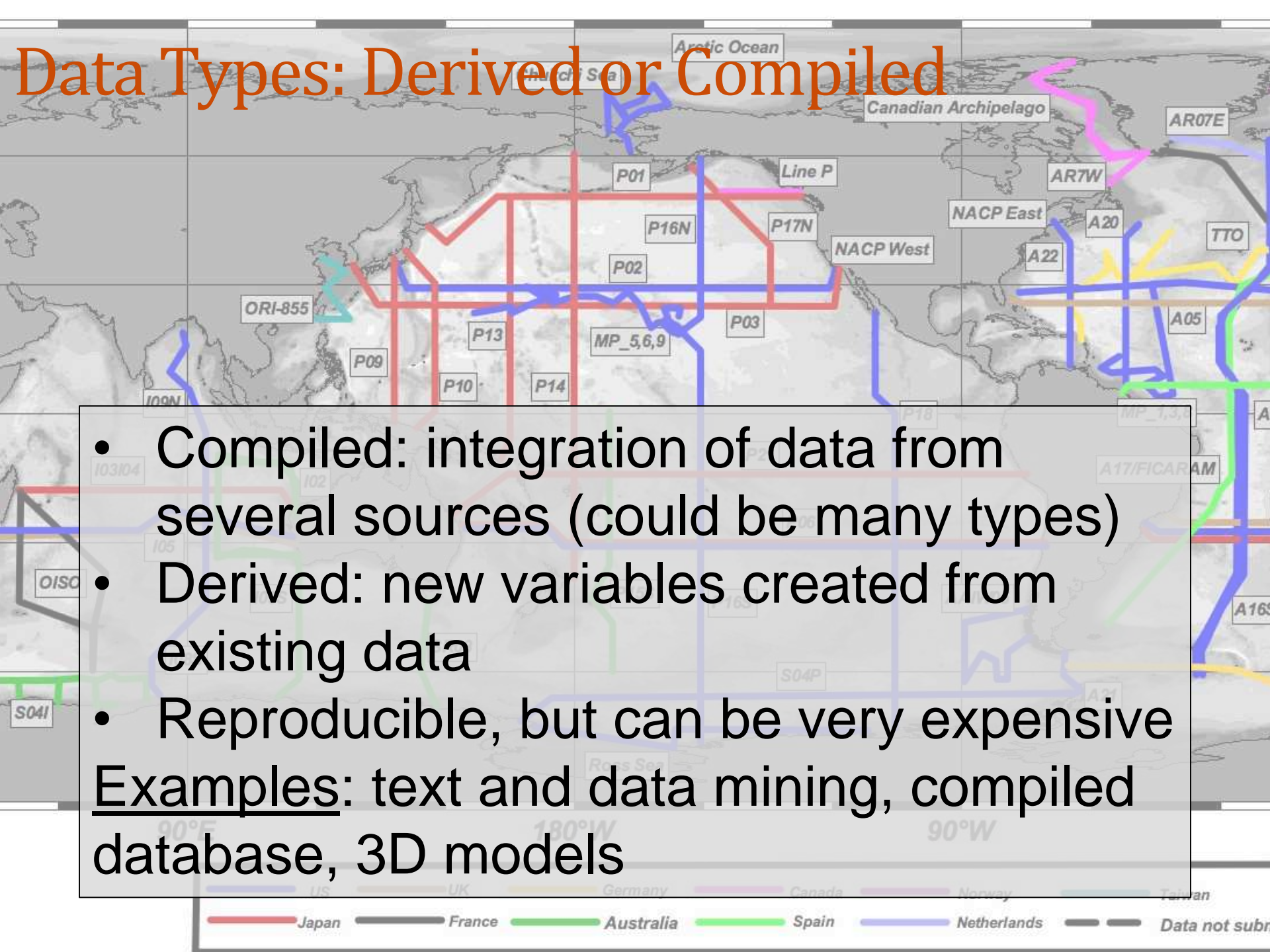
Data Types: Experimental

- 
- A woman with long brown hair and glasses is working in a laboratory. She is wearing a black top and is using a pipette to transfer liquid into a test tube. The background shows shelves with various laboratory equipment and supplies.
- Data collected under controlled conditions, *in situ* or laboratory-based
 - Should be reproducible, but can be expensive

Examples: gene sequences, chromatograms, spectroscopy, microscopy, cell counts

Data Types: Derived or Compiled

- Compiled: integration of data from several sources (could be many types)
 - Derived: new variables created from existing data
 - Reproducible, but can be very expensive
- Examples: text and data mining, compiled database, 3D models



Data Types: Simulation

Hawaii

Hawaii

March 2013

March 2014

March 2015

March 2016

- Results from using a model to study the behavior and performance of an actual or theoretical system
- Models and metadata, where the input can be more important than output data

Examples: climate models, economic models, biogeochemical models

Data Types: Reference/Canonical

PLACE OF ABODE				NAME			RELATION		HOME DATA				PERSONAL DESCRIPTION				EDUCATION			PLACE OF BIRTH			MOTHER TONGUE OR NATIVE LANGUAGE OF FOREIGN BORN				CITIZENSHIP, ETC.			OCCUPATION AND INDUSTRY					EMPLOYMENT		VETERANS																																																														
of each person whose place of abode on April 1, 1930, was in this family				Relationship of this person to the head of the family			Date census taken and date of last census (month, year)		Includes every person living on April 1, 1930. Omit children born since April 1, 1930		Male or female		Age at last birthday		Color of race		Married (circle one)		Age at last marriage		Place of birth of each person enumerated end of his or her parents. If born in the United States, give State or Territory. If of foreign birth, give country in which birthplace is now situated. (See Instructions.) DISTRICTS CANADA-FRENCH from Canada-English, and Irish Free State from Northern Ireland			Language spoken in house before coming to the United States				Year of immigration, Naturalization, Date of citizenship			Trade, profession, or particular kind of work, as specified, or occupation, occupation, trade, etc., etc.					Whether actually at work on April 1, 1930, or in the last regular working year		Whether a veteran of U. S. Army or Navy																																																													
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51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100																																																		
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Static or organic collection [peer-reviewed] datasets, most probably published and/or curated.

Examples: gene sequence databanks, chemical structures, census data, spatial data portals

ABBREVIATIONS TO BE USED IN COLUMNS INDICATED:
Ca. 4-11-42-44-46-48-50-52-54-56-58-60-62-64-66-68-70-72-74-76-78-80-82-84-86-88-90-92-94-96-98-100-102-104-106-108-110-112-114-116-118-120-122-124-126-128-130-132-134-136-138-140-142-144-146-148-150-152-154-156-158-160-162-164-166-168-170-172-174-176-178-180-182-184-186-188-190-192-194-196-198-200-202-204-206-208-210-212-214-216-218-220-222-224-226-228-230-232-234-236-238-240-242-244-246-248-250-252-254-256-258-260-262-264-266-268-270-272-274-276-278-280-282-284-286-288-290-292-294-296-298-300-302-304-306-308-310-312-314-316-318-320-322-324-326-328-330-332-334-336-338-340-342-344-346-348-350-352-354-356-358-360-362-364-366-368-370-372-374-376-378-380-382-384-386-388-390-392-394-396-398-400-402-404-406-408-410-412-414-416-418-420-422-424-426-428-430-432-434-436-438-440-442-444-446-448-450-452-454-456-458-460-462-464-466-468-470-472-474-476-478-480-482-484-486-488-490-492-494-496-498-500-502-504-506-508-510-512-514-516-518-520-522-524-526-528-530-532-534-536-538-540-542-544-546-548-550-552-554-556-558-560-562-564-566-568-570-572-574-576-578-580-582-584-586-588-590-592-594-596-598-600-602-604-606-608-610-612-614-616-618-620-622-624-626-628-630-632-634-636-638-640-642-644-646-648-650-652-654-656-658-660-662-664-666-668-670-672-674-676-678-680-682-684-686-688-690-692-694-696-698-700-702-704-706-708-710-712-714-716-718-720-722-724-726-728-730-732-734-736-738-740-742-744-746-748-750-752-754-756-758-760-762-764-766-768-770-772-774-776-778-780-782-784-786-788-790-792-794-796-798-800-802-804-806-808-810-812-814-816-818-820-822-824-826-828-830-832-834-836-838-840-842-844-846-848-850-852-854-856-858-860-862-864-866-868-870-872-874-876-878-880-882-884-886-888-890-892-894-896-898-900-902-904-906-908-910-912-914-916-918-920-922-924-926-928-930-932-934-936-938-940-942-944-946-948-950-952-954-956-958-960-962-964-966-968-970-972-974-976-978-980-982-984-986-988-990-992-994-996-998-1000-1002-1004-1006-1008-1010-1012-1014-1016-1018-1020-1022-1024-1026-1028-1030-1032-1034-1036-1038-1040-1042-1044-1046-1048-1050-1052-1054-1056-1058-1060-1062-1064-1066-1068-1070-1072-1074-1076-1078-1080-1082-1084-1086-1088-1090-1092-1094-1096-1098-1100-1102-1104-1106-1108-1110-1112-1114-1116-1118-1120-1122-1124-1126-1128-1130-1132-1134-1136-1138-1140-1142-1144-1146-1148-1150-1152-1154-1156-1158-1160-1162-1164-1166-1168-1170-1172-1174-1176-1178-1180-1182-1184-1186-1188-1190-1192-1194-1196-1198-1200-1202-1204-1206-1208-1210-1212-1214-1216-1218-1220-1222-1224-1226-1228-1230-1232-1234-1236-1238-1240-1242-1244-1246-1248-1250-1252-1254-1256-1258-1260-1262-1264-1266-1268-1270-1272-1274-1276-1278-1280-1282-1284-1286-1288-1290-1292-1294-1296-1298-1300-1302-1304-1306-1308-1310-1312-1314-1316-1318-1320-1322-1324-1326-1328-1330-1332-1334-1336-1338-1340-1342-1344-1346-1348-1350-1352-1354-1356-1358-1360-1362-1364-1366-1368-1370-1372-1374-1376-1378-1380-1382-1384-1386-1388-1390-1392-1394-1396-1398-1400-1402-1404-1406-1408-1410-1412-1414-1416-1418-1420-1422-1424-1426-1428-1430-1432-1434-1436-1438-1440-1442-1444-1446-1448-1450-1452-1454-1456-1458-1460-1462-1464-1466-1468-1470-1472-1474-1476-1478-1480-1482-1484-1486-1488-1490-1492-1494-1496-1498-1500-1502-1504-1506-1508-1510-1512-1514-1516-1518-1520-1522-1524-1526-1528-1530-1532-1534-1536-1538-1540-1542-1544-1546-1548-1550-1552-1554-1556-1558-1560-1562-1564-1566-1568-1570-1572-1574-1576-1578-1580-1582-1584-1586-1588-1590-1592-1594-1596-1598-1600-1602-1604-1606-1608-1610-1612-1614-1616-1618-1620-1622-1624-1626-1628-1630-1632-1634-1636-1638-1640-1642-1644-1646-1648-1650-1652-1654-1656-1658-1660-1662-1664-1666-1668-1670-1672-1674-1676-1678-1680-1682-1684-1686-1688-1690-1692-1694-1696-1698-1700-1702-1704-1706-1708-1710-1712-1714-1716-1718-1720-1722-1724-1726-1728-1730-1732-1734-1736-1738-1740-1742-1744-1746-1748-1750-1752-1754-1756-1758-1760-1762-1764-1766-1768-1770-1772-1774-1776-1778-1780-1782-1784-1786-1788-1790-1792-1794-1796-1798-1800-1802-1804-1806-1808-1810-1812-1814-1816-1818-1820-1822-1824-1826-1828-1830-1832-1834-1836-1838-1840-1842-1844-1846-1848-1850-1852-1854-1856-1858-1860-1862-1864-1866-1868-1870-1872-1874-1876-1878-1880-1882-1884-1886-1888-1890-1892-1894-1896-1898-1900-1902-1904-1906-1908-1910-1912-1914-1916-1918-1920-1922-1924-1926-1928-1930-1932-1934-1936-1938-1940-1942-1944-1946-1948-1950-1952-1954-1956-1958-1960-1962-1964-1966-1968-1970-1972-1974-1976-1978-1980-1982-1984-1986-1988-1990-1992-1994-1996-1998-2000-2002-2004-2006-2008-2010-2012-2014-2016-2018-2020-2022-2024-2026-2028-2030-2032-2034-2036-2038-2040-2042-2044-2046-2048-2050-2052-2054-2056-2058-2060-2062-2064-2066-2068-2070-2072-2074-2076-2078-2080-2082-2084-2086-2088-2090-2092-2094-2096-2098-2100-2102-2104-2106-2108-2110-2112-2114-2116-2118-2120-2122-2124-2126-2128-2130-2132-2134-2136-2138-2140-2142-2144-2146-2148-2150-2152-2154-2156-2158-2160-2162-2164-2166-2168-2170-2172-2174-2176-2178-2180-2182-2184-2186-2188-2190-2192-2194-2196-2198-2200-2202-2204-2206-2208-2210-2212-2214-2216-2218-2220-2222-2224-2226-2228-2230-2232-2234-2236-2238-2240-224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Metadata demonstration

