

Research Data Management

Data Skills: Planning for Research Success



Instructors



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Slides: <https://datamanagement.hms.harvard.edu/class-materials>



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Data Management
Working Group



Countway Library of Medicine

An Alliance of the Harvard Medical School and Boston Medical Library



Center *for the History of Medicine*

**Harvard Chan Bioinformatics
Core**



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Department of
Systems Biology



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Research Information Technology Solutions - RITS

HMS Information Technology

ICCB-Longwood Screening Facility

DRSC/TRiP Functional Genomics

The Neurobiology Imaging Facility

in the Neurobiology Department of Harvard Medical School

Hi+S

Harvard Program in Therapeutic Science

Harvard Biomedical Data Management

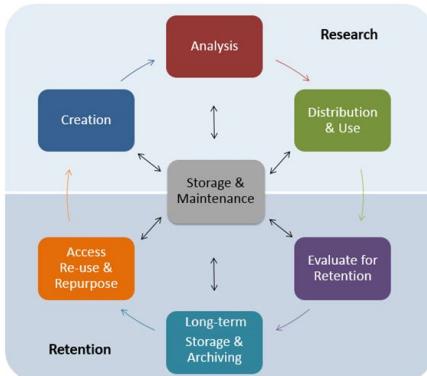
Best practices & support services for research data lifecycles

About ▾ Best Practices ▾ Plan ▾ Store ▾ Share ▾ Resources & Support

Data Management

Data Management is the process of providing the appropriate labeling, storage, and access for data at all stages of a research project. We recognize that best practices for each of these aspects of data management can and often do change over time, and are different for different stages in the data lifecycle.

Early and attentive management at each step of the data lifecycle will ensure the discoverability and longevity of your research.



← December 2018 →

S	M	T	W	T	F	S
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2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					



FEATURED NEWS



DMWG Featured in
Nature Article: How
to pick an electronic
laboratory notebook

Thursday, August 9, 2018

Submit Questions and Feedback

Upcoming Trainings & News

Receive Data Management Updates



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COUNTWAY
LIBRARY

FEATURED ONLINE TRAINING:



Best Practices for Biomedical
Research Data Management

An open online course aimed at a broad audience on recommended practices for managing research data. Take at your own pace, earn badges and interact with students from around the world!

FEATURED ONLINE TRAINING:



Research Signer & Reproducibility:
Understanding the Data
Lifecycle for Research Success

An online supplement to an in-person workshop, specifically tailored for Post-Docs. If you are affiliated with Harvard, you may receive a course certificate to promote your time taken on this topic.

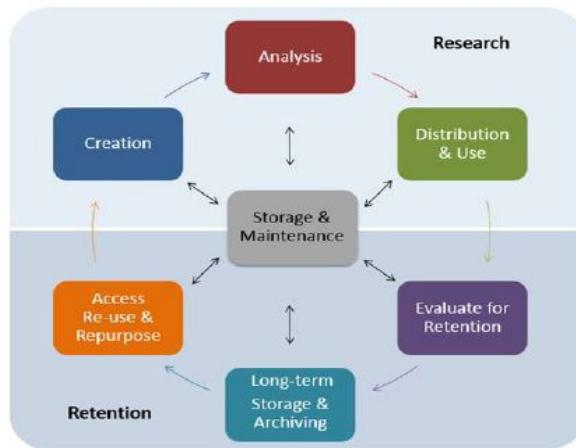
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Last Updated: 2018-08-09

Harvard Biomedical Data Management Website

<https://datamanagement.hms.harvard.edu>

Research Data Management Checklist



This document serves as a reference checklist to keep track of the elements that make up good research data management in the RDM lifecycle.

The RDM lifecycle is not linear and you may find yourself jumping around this lifecycle throughout your project.

Begin building or locate a detailed README.txt overview of your project immediately. Examples of data documentation include lab notebooks and experimental protocols, questionnaires, codebooks, data dictionaries, software syntax and output files, information about your equipment settings and calibration, database schema, methodology reports, and provenance information.

<http://datamanagement.hms.harvard.edu/metadata-overview>

Your DMP document should describe final dataset formats, documentation, analytic tools necessary to use the data, data sharing agreements, and how and when the data will be made accessible to others.

We are open to identifying new kinds of data management practices that could benefit the biomedical sciences. If you would like to contribute to the RDM website for your field, please contact the HMS Data Management Working Group through the website link to "Submit your questions and feedback!"

<http://datamanagement.hms.harvard.edu/>

DATA CREATION: RDM PLANNING

What does your research project look like from start to (anticipated) finish?



- | | |
|---|--|
| <input type="checkbox"/> ID | ✓ Determined by the funder and/or institution |
| <input type="checkbox"/> Funder(s) | ✓ Data security policy
✓ Data sharing policy
✓ Data retention policy |
| <input type="checkbox"/> Grant # | ✓ Post award DMPs only |
| <input type="checkbox"/> Project name | ✓ As it appears exactly as on the grant. Append to grant proposal. |
| <input type="checkbox"/> Project description (background/rationale) | ✓ What research question(s) are you addressing?
✓ Summarize the study methods and design including data collection method(s) and purpose of collection.
✓ If creating or collecting data in the field, how will you ensure its safe transfer into your main secured systems? |
| <input type="checkbox"/> Data description | ✓ Content description (brief) - include any value definitions, questionnaires or instruments, or analysis procedures.
✓ Type (imagine data, genomic, Qx, etc.)
✓ Format <ul style="list-style-type: none"> • Databases: XML, CSV • Geospatial: SHP, DBF, GeoTIFF, NetCDF • Moving Images: MOV, MPEG, AVI, MXF • Audio: WAVE, AIFF, MP3, MXF • Numbers/statistics: ASCII, DTA, POR, SAS, SAV • Images: TIFF, JPEG 2000, PDF, PNG, GIF, BMP • Text: PDF/A, HTML, ASCII, XML, UTF-8 • Graphs: JSON, YAML, XML |

If you need to convert or migrate your data files from one format to another, be aware of the potential risk of the loss or corruption of your data and take appropriate steps to avoid/minimize.

- | | |
|--|---|
| <input type="checkbox"/> PI | ✓ Briefly justify the use of format – is your chosen format open, non-proprietary and in widespread use?
✓ Estimated volume?
✓ Describe any existing data being used (citations, link and DOI). |
| <input type="checkbox"/> PI ORCID ID | ✓ Name of Principal Investigator(s) or main researcher(s) on the project. |
| <input type="checkbox"/> Administrative data | ✓ ORCID http://orcid.org/
✓ Contacts/addresses/email details
✓ Date of first DMP
✓ Date and details for subsequent revision(s) of DMP |
| <input type="checkbox"/> Additional Institution(s) | |

Research Data Management Checklist

datamanagement.hms.harvard.edu/hms-data-lifecycle

Introduce Yourself!



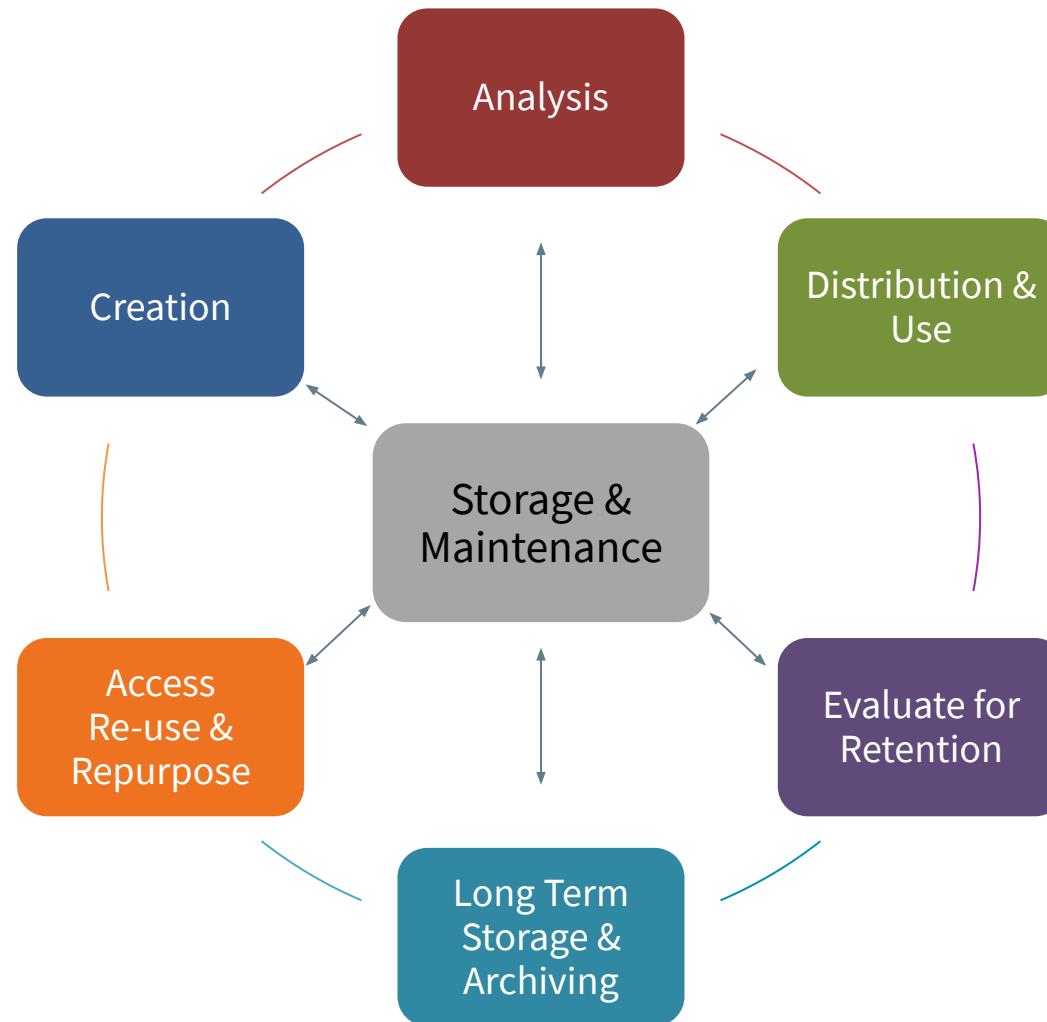
Name

School / Department

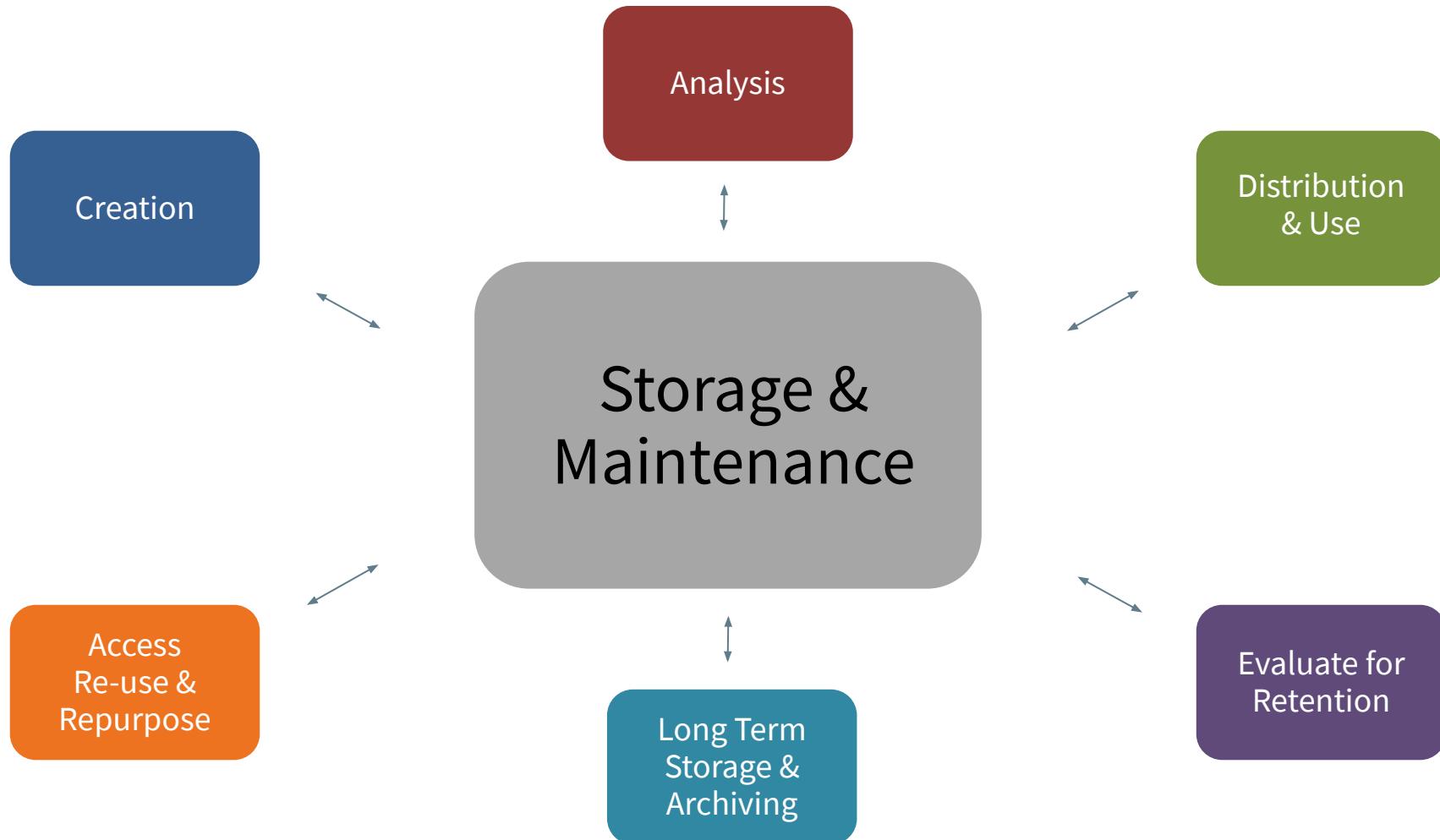
Most common data format

(Text, Excel, SPSS, Google Docs, etc.)

Data Lifecycle for Biomedical Data



Storage affects the whole cycle



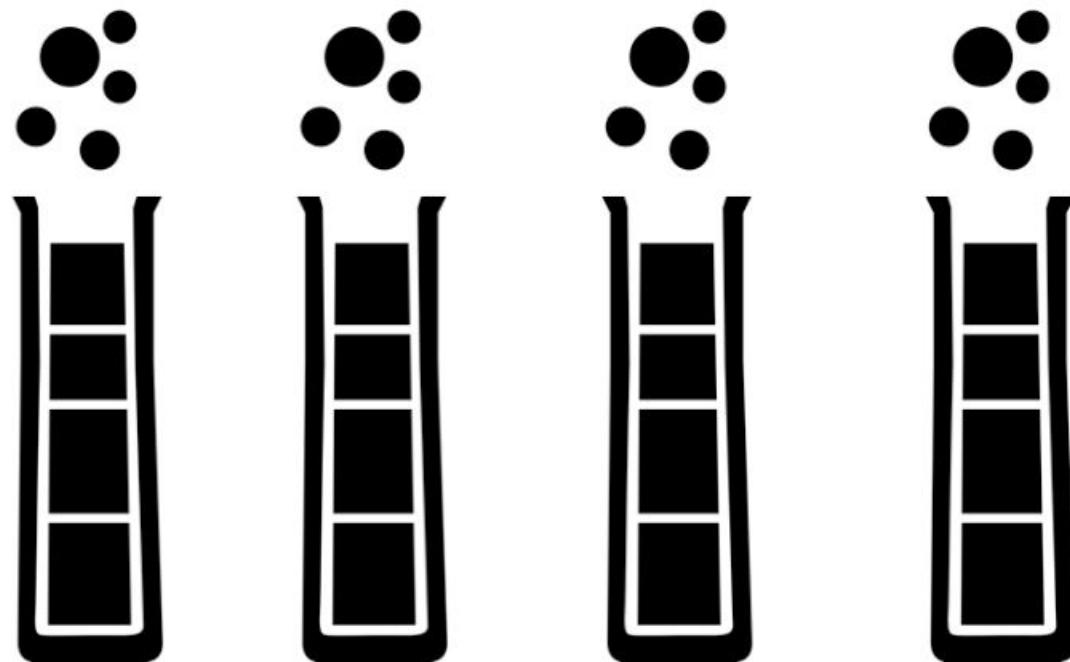
Why Manage Data?

- Easier to analyze organized, documented data
- Find data more easily
- Don't drown in irrelevant data
- Don't lose data
- Get credit for your data
- Avoid accusations of misconduct



Data Sharing and Management Snafu in 3 Short Acts

Goal = Reproducibility



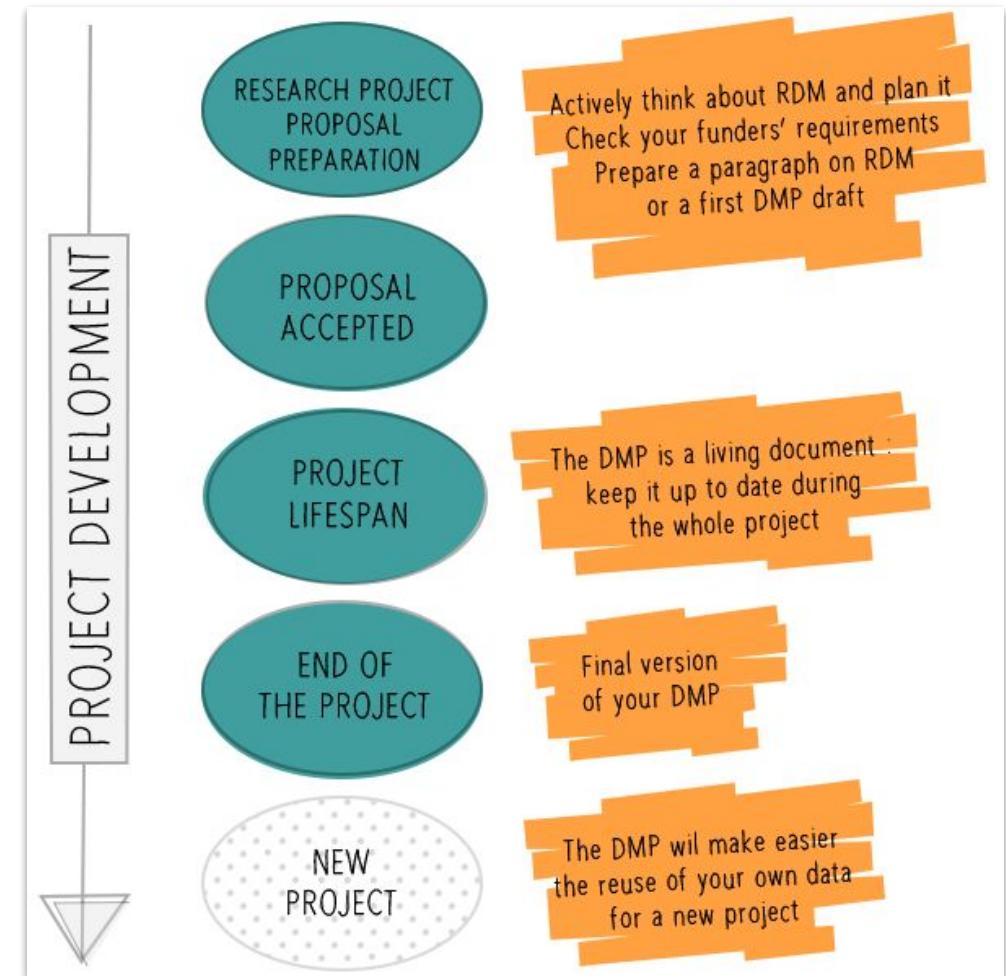
Science!



Not Science.

Data Management Plan

A data management plan (DMP) is a written document that describes the data you expect to acquire or generate during the course of a research project, how you will manage, describe, analyze, and store those data, and what mechanisms you will use at the end of your project to share and preserve your data.

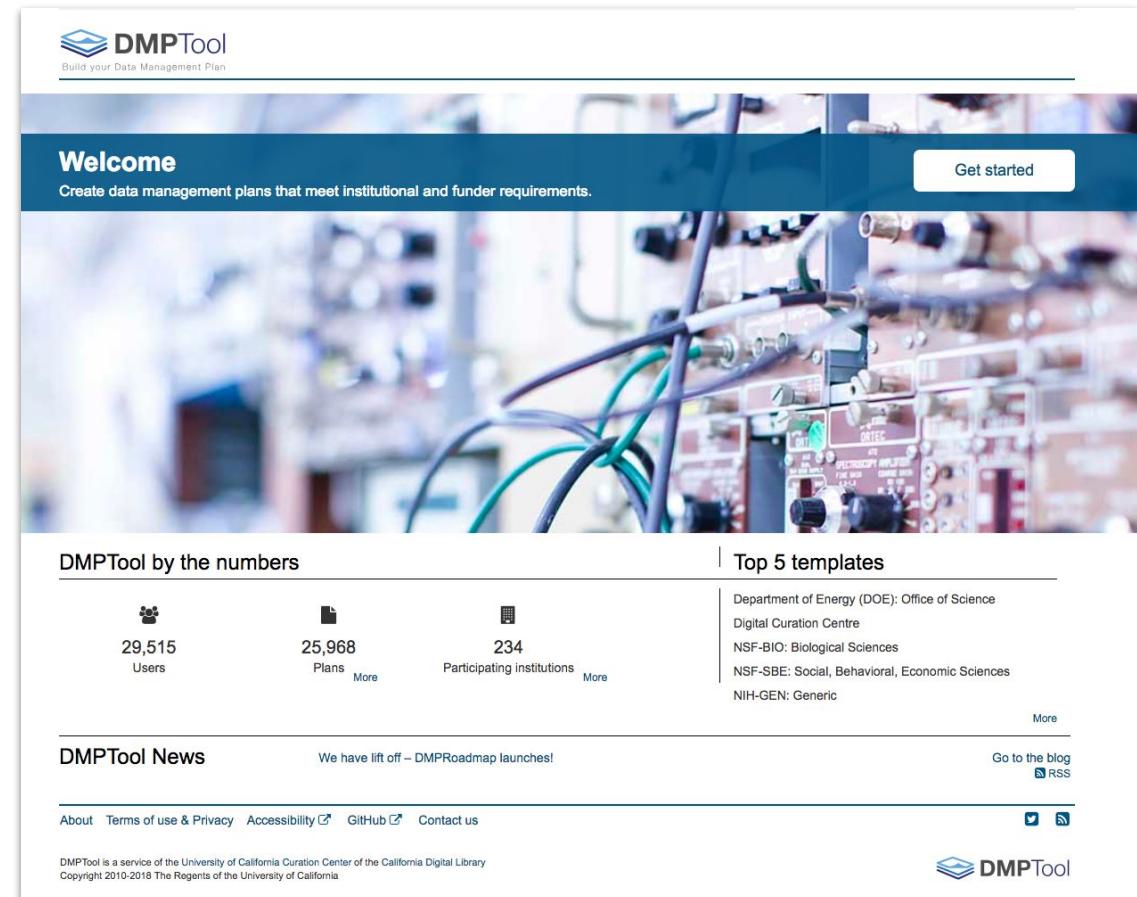


<https://researchdata.epfl.ch/plan-fund/dmp>

DMPTool

The DMPTool is an online tool that includes data management plan templates for many of the large funding agencies that require them.

Harvard is an affiliated partner institution. You can login as a user from your institution with your HarvardKey. By being affiliated Harvard, you will be presented with institution-specific guidance to help you complete your plan.



The screenshot shows the DMPTool homepage. At the top, there's a navigation bar with the DMPTool logo and a subtext "Build your Data Management Plan". Below the header is a banner featuring a blurred image of laboratory equipment, specifically a circuit board with various components and wires. The banner has a dark blue header with the word "Welcome" and a subtext "Create data management plans that meet institutional and funder requirements." On the right side of the banner is a white button labeled "Get started". Below the banner is a section titled "DMPTool by the numbers" containing three items: "29,515 Users", "25,968 Plans", and "234 Participating institutions". To the right of this is a "Top 5 templates" sidebar listing: Department of Energy (DOE): Office of Science, Digital Curation Centre, NSF-BIO: Biological Sciences, NSF-SBE: Social, Behavioral, Economic Sciences, and NIH-GEN: Generic. At the bottom of the page, there's a "DMPTool News" section with a link "We have lift off – DMPRoadmap launches!", social media links for Twitter and RSS, and footer links for About, Terms of use & Privacy, Accessibility, GitHub, and Contact us. The footer also notes that DMPTool is a service of the University of California Curation Center of the California Digital Library and is copyright 2010-2018 The Regents of the University of California. The DMPTool logo is located at the bottom right.

<https://datamanagement.hms.harvard.edu/data-management-plan>

<https://dmptool.org>

Data

Raw data: What is being measured or observed? This is the data that is being generated during the research project.

Processed data: How can the raw data be made useful- able to be manipulated?

Analyzed data: What does the data tell us? Is it significant? How so?

Finalized/Published data: How does the data support your research question?

Creation

- ✓ Raw data
- ✓ Working files

Analysis

- ✓ Analytical methods
- ✓ Analysis results

Metadata

Data documentation provides the information necessary to fully understand and interpret the data

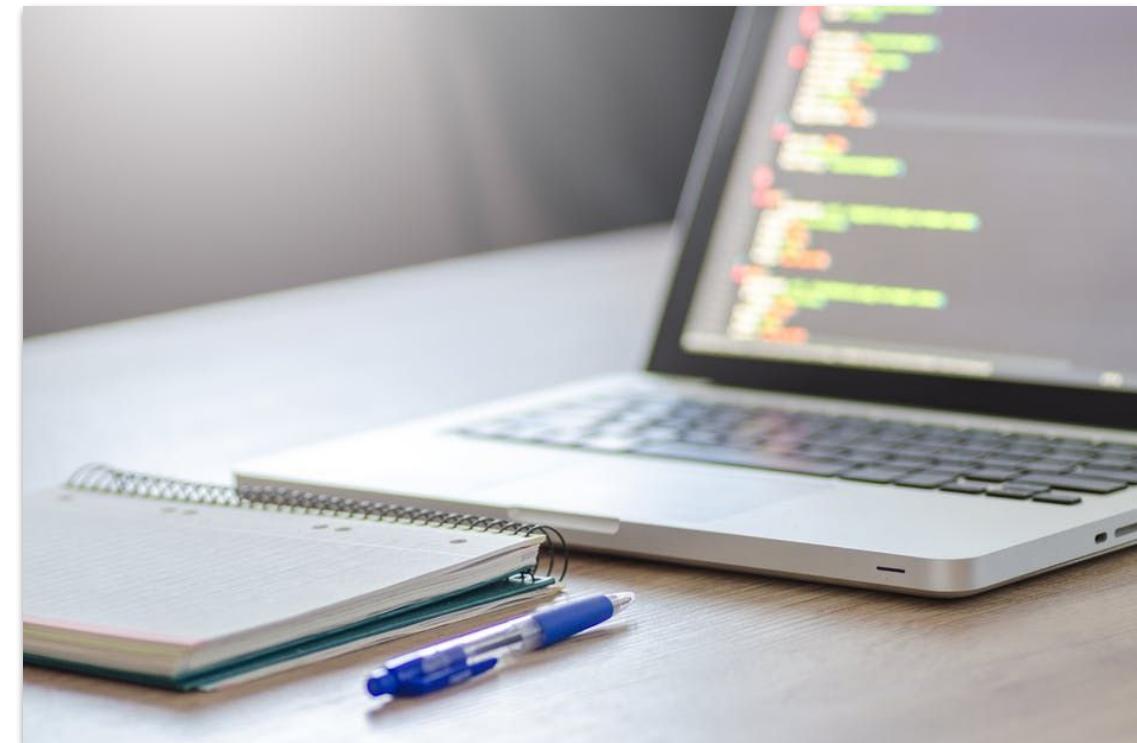
Metadata should be standardized, consistent and interoperable, and facilitates discovery, preservation and archiving of data



Andy Warhol, *Big Torn Campbell's Soup Can (Pepper Pot)*, 1962 The Andy Warhol Museum, Pittsburgh Founding Collection, Contribution The Andy Warhol Foundation for the Visual Arts, Inc.

On-Your-Own Exercise Documentation

For your most common data type, make a list of the most important information to record for each dataset.



File Conventions



Versioning

- For analyzed data use version numbers
- Save files often to a new version
- Label the final version FINAL
- Consider GIT or SVN



Organization

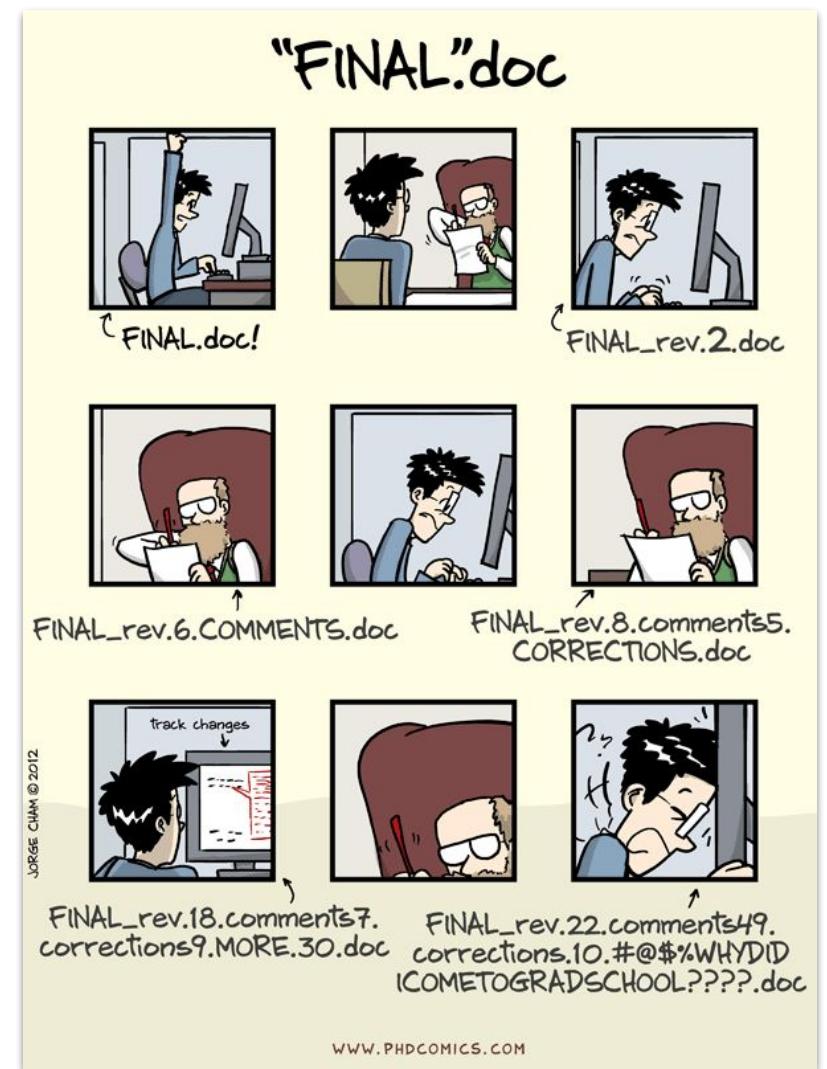
- Any system is better than none
- One project, one folder
- Separate folders for data or project stages
- Date-based folders (pairs well with lab notebook)

File Conventions

Files with naming conventions:

20161104_ProjectA_Ex1Test1_SmithE_v1.xlsx

20180204-ProjectA-Report-SmithE-v5-FINAL.docx



Document Your Conventions

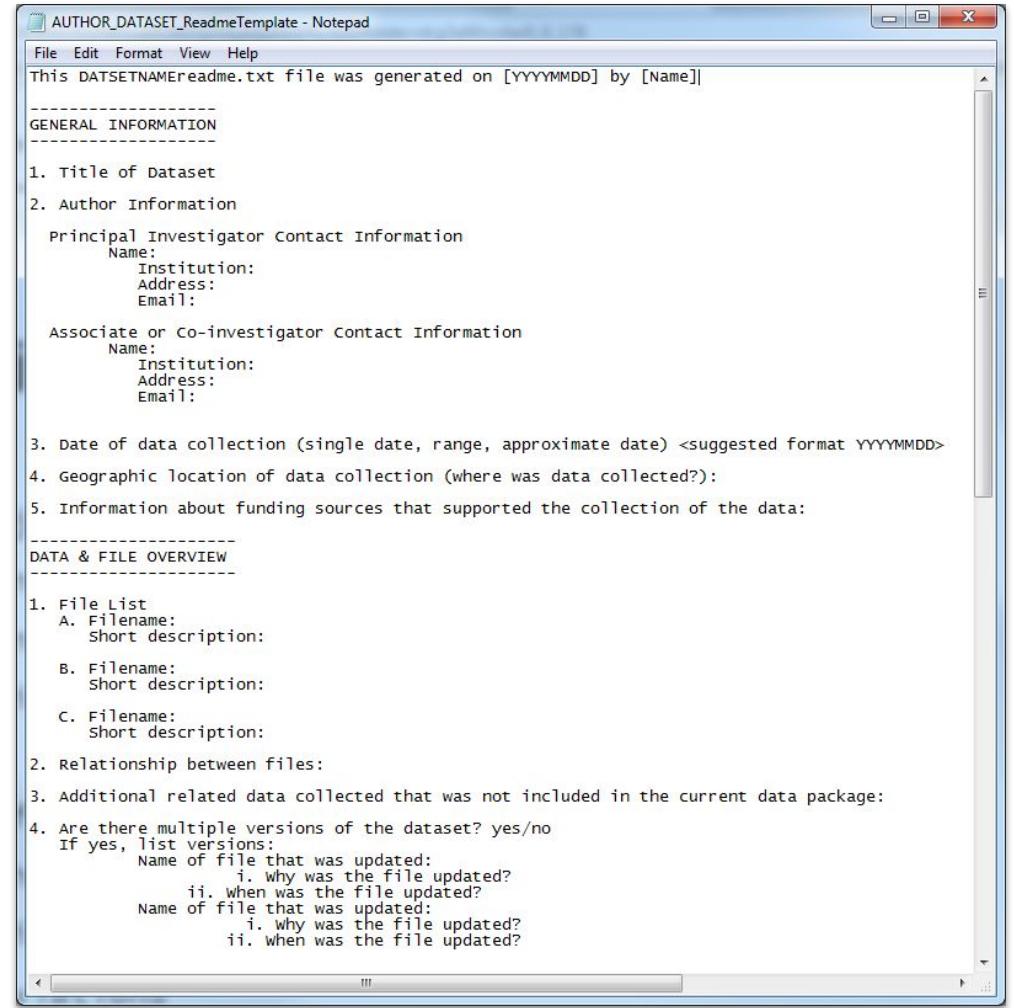
No point to have a system without documentation!

- README.txt (use .txt over .doc because it's more durable)
- Front cover of research notebook
- A printout by the computer



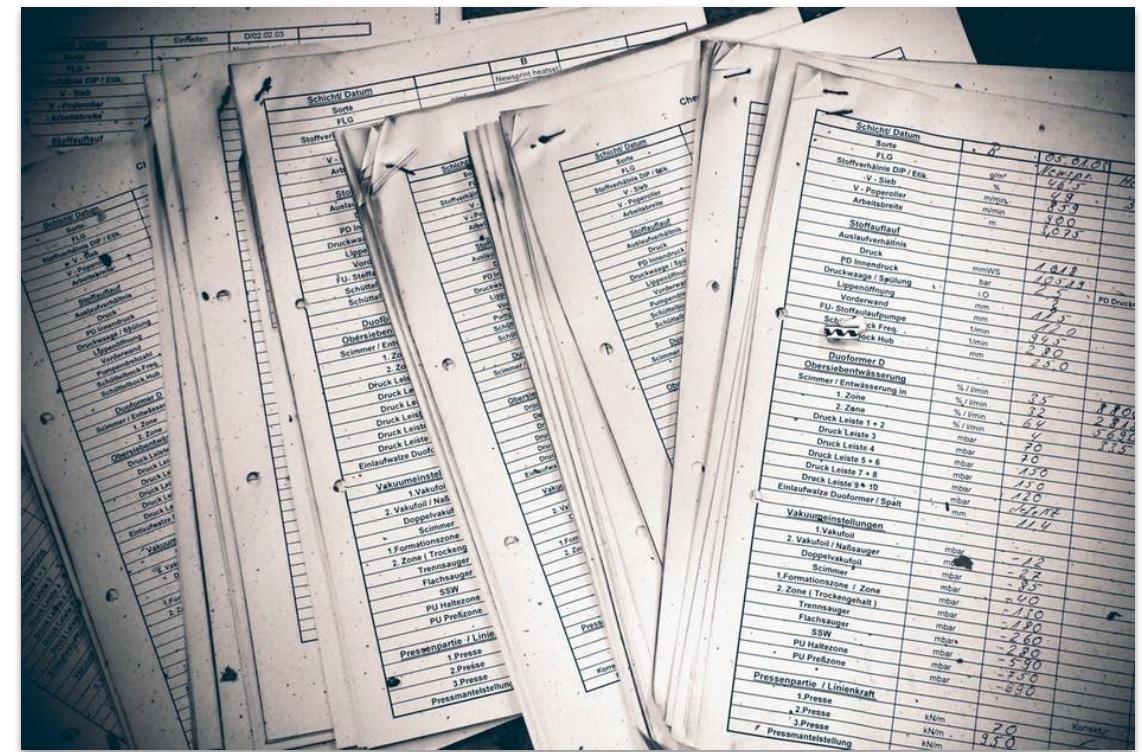
README File

- Basic project information
- Title, Contributions, Grant Info
- Contact information
- All locations of where data live, including backups
- Useful information about the files and how they are organized
- Explain file naming conventions and abbreviations



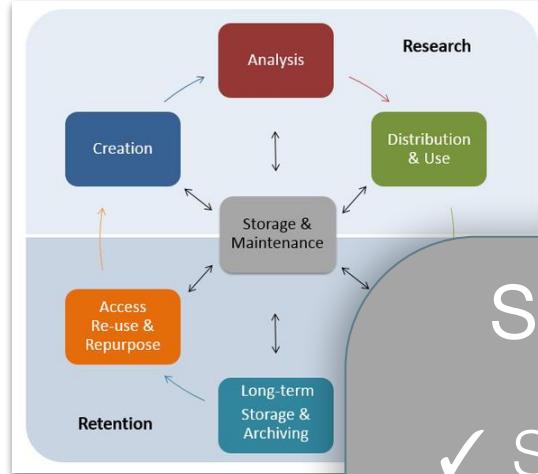
On-Your-Own Exercise Conventions

Develop a file naming convention for your most common data type.



Storage

**Storage,
backup, and
security are
interrelated**



Storage & Maintenance

- ✓ Store on appropriate tier, with proper security
- ✓ Store locally on servers or in the cloud
- ✓ Plan to maintain system

Security

Access

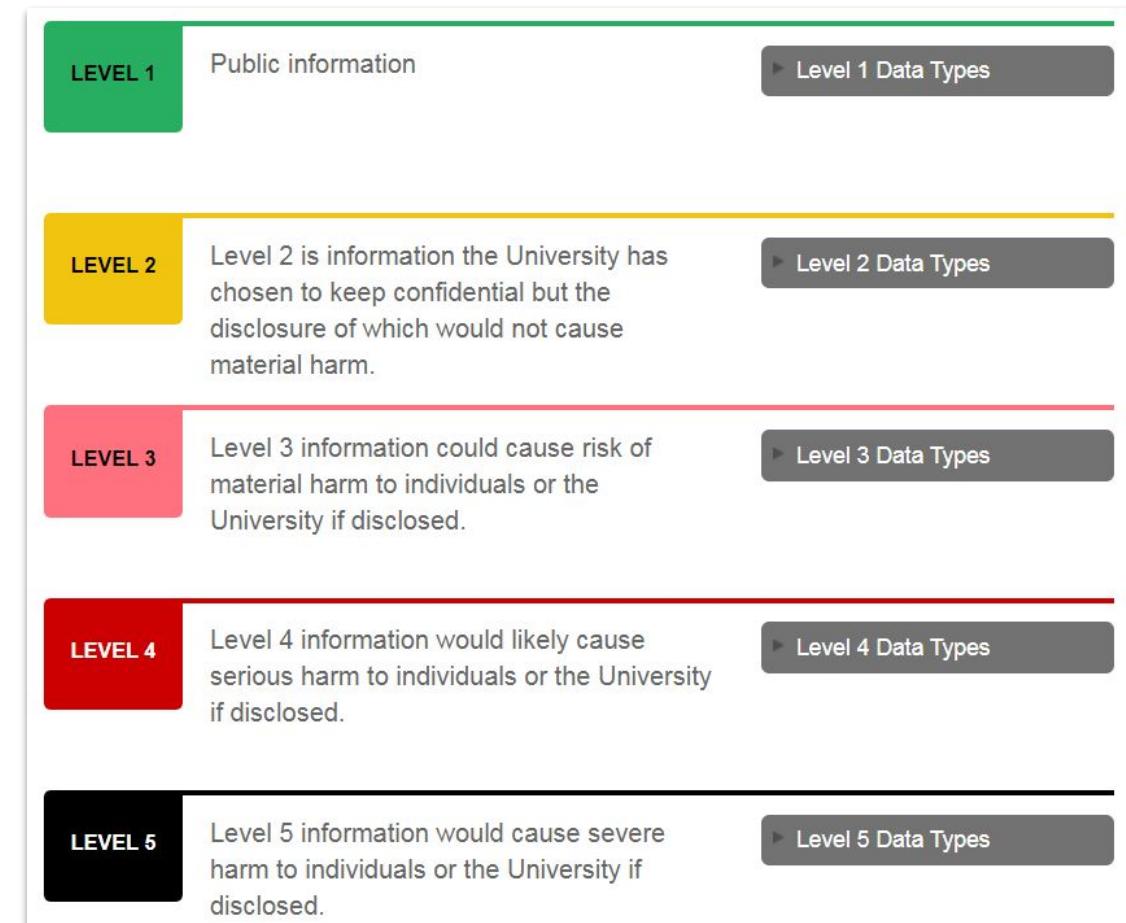
Limiting the availability of your data

Systems

Protecting your hardware and software

Data Integrity

Ensure that your data is not manipulated in an unauthorized way



Electronic Lab Notebooks

Electronic Lab Notebooks at HMS

Lab notebooks are good for writing down procedures, observations, conclusions and for drawing flow charts and diagrams by hand. However, in order to accommodate the increase of digital data collected, researchers have taped instrumentation and computer printouts onto the pages of their notebooks, or cross-referenced larger data sets by recording file names and locations in the notebook.

An ELN (electronic lab notebook) is a software tool that in its most basic form is a digital version of a page in a paper lab notebook. In this electronic notebook you can record your observations, draw graphs, store data and images, and search for data using your computer or mobile device. This offers several advantages over a paper notebook:

The number of available ELN tools is increasing and the functions they offer are becoming more advanced. However, this may be confusing to evaluate all of the advantages and limitations of each tool and how it can best serve your project.

The Electronic Lab Notebook Matrix has been created to aid HMS researchers in evaluating the various ELN tools currently available. It is designed to help researchers compare and contrast the numerous solutions available and make informed decisions about which tools best fit their needs. The matrix provides a detailed overview of the features and capabilities of each tool, along with specific details on how they can be used to support research workflows.

Questions about Electronic Lab Notebooks at HMS? Contact us at datamanagement@hms.harvard.edu

Features	Specifications															
	Benchling	Biovia	Confluence	Doccollab	ECL	ELOG	Evernote	Exemplar	Findings	Hivebench	IDBS	LabArchives	LabCollector	LabWare	LabVantage	LabW
Interactivity																
Intuitive Interface Design	✓	No response received	*	*	No response received	*	No response received	*	*	*	*	✓	No response received	*	*	
Auto Metadata Harvest	*	No response received	✗	✓	No response received	✗	No response received	*	No response received	✗	✓	✓	No response received	✗	✓	
Search functions can search across file formats and beyond types	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Ability to manipulate files and images	*	No response received	*	*	No response received	*	No response received	*	No response received	*	*	*	*	*	*	
Support for multiple open windows	✓	*	✓	✓	✓	No response received	✓	✓	*	✓	✓	✓	✓	✓	✓	
Ability to link out	✗	No response received	*	✓	✓	✓	✓	✓	✓	✓	✓	✓	No response received	✓	✓	
Support for Researcher Documentation																
Hyperlink support	✓	No response received	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	No response received	✓	✓	
Metadata Creation Prompts	✓	No response received	✗	✓	✓	No response received	✗	No response received	✗	✓	✓	✓	No response received	✗	✓	
Rights Management (licensing)	*	No response received	*	✓	✓	No response received	*	No response received	✓	✓	*	✓	✓	✓	✓	
Protocol Integration	✓	*	✓	✓	✓	No response received	✓	*	✓	✓	✓	✓	*	*	*	
Adaptability to Lab Workflows																
Accounts/Permissions Levels	✓	No response received	*	✓	✓	✓	✓	✓	*	*	✓	✓	✓	✓	*	
Internal Data Sharing	✓	*	*	✓	✓	No response received	✓	✓	✓	✓	✓	✓	✓	✓	*	
Adaptable to a Variety of Workflows	*	No response received	*	*	*	No response received	*	No response received	*	*	*	*	*	*	*	
Compatibility with authoring tools	✓	No response received	*	✓	✓	No response received	✗	No response received	✗	✓	✓	✓	No response received	✗	*	
Windows Compatible	✓	No response received	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*	
Macintosh Compatible	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	*	
Linux Compatible	✓	✓	✗	✓	✓	✓	✓	No response received	✓	✓	✓	✓	✓	No response received	✓	
Android Compatible	✓	✓	✓	✓	✓	✓	✓	No response received	✓	✓	✓	✓	✓	✓	*	
iOS Compatible	✓	✓	✓	✓	✓	✓	✓	No response received	✓	✓	✓	✓	✓	✓	*	
Storage																
Cloud Storage	✓	No response received	✗	✓	✓	No response received	✓	No response received	✓	✓	✓	✓	✓	✓	*	
Local Storage	*	No response received	✓	✓	✗	No response received	✓	No response received	✓	✓	✓	✓	No response received	✓	✓	
Hybrid (cloud/local) Storage	*	No response received	✗	✗	No response received	✗	No response received	✗	No response received	✓	✓	✓	No response received	✗	✗	
Versioning	*	*	*	*	*	No response received	*	No response received	*	No response received	*	*	*	*	*	
File Redundancy	*	No response received	*	*	No response received	*	No response received	*	No response received	*	*	*	No response received	*	*	
Creates stable URLs or persistent identifiers for entries	✓	No response received	✓	✓	No response received	✓	No response received	✓	No response received	✓	✓	✓	No response received	✓	✓	
Can unregistered users access the data found at persistent links?	✓	No response received	✓	✗	No response received	✗	No response received	✓	No response received	*	*	*	No response received	✗	*	
Storage Capacity - Users	*	No response received	*	*	No response received	*	No response received	*	No response received	*	*	*	No response received	*	*	
Storage Capacity - Max File Size	*	No response received	*	*	No response received	*	No response received	*	No response received	*	*	*	No response received	*	*	

Electronic Lab Notebook Matrix

<https://datamanagement.hms.harvard.edu/electronic-lab-notebooks>

On-Your-Own Exercise

Storage

1. Conduct a quick inventory of your data:
 - *What datasets do you have?*
 - *How big are they?*
2. Inventory where your files are currently stored, including backups:
 - *How safe are your data?*
3. Do you have any PHI or HRCI data?
 - *What do you need to ensure their security?*

Ownership

Do you know who owns your data or the dataset you are using?



There are a lot of parties with an interest in your research data, not limited to: funder, institution, boss/advisor, collaborators, and you.

Each of these may have a policy (explicit or not) on who has ownership of & who gets access to the data.

Data Sharing

When establishing data sharing and access policies and provisions, consider *whom* you will share your data with, *how* it will be shared, and *when* in the research process you will share it.

Distribution & Use

- ✓ Share data with collaborators
- ✓ Annotate datasets & upload to public repositories
- ✓ Include in relevant publications & reports



give credit
get credit
cite data

Data Publication: Citation & Attribution

Acknowledgement of the use of someone else's information or work is a long-accepted practice in scholarly communication.

The following elements are generally considered the core elements of a data citation:

- *Author/Creator(s): creators of the data; can be one or more people or organizations*
- *Title: title of the data set*
- *Version: exact version or edition of the data set used*
- *Publication Date: date when the data set was published or released*
- *Publisher/Archive: data center or repository that is archiving and distributing*
- *Identifier/Locator: URL or other linkable locator for the data; a persistent, permanent URL such as a DOI (Digital Object Identifier) or a handle is preferred*

Unique Identifiers



Digital Object Identifier

Permanently assigned to an object to provide a resolvable persistent network link to current information about that object, including where the object, or information about it, can be found on the Internet

www.doi.org



Open Researcher and Contributor ID

Provides a persistent digital identifier that distinguishes you from every other researcher and supports automated linkages between you and your professional activities ensuring that your work is recognized

orcid.org

On-Your-Own Exercise

ORCID

Don't have an ORCID?

Create one now!

It's free, easy and will last throughout your professional career!

orcid.org



REPOSITORIES

Dryad
figshare
GigaScience
Harvard Dataverse
NIH and NCBI Repositories
Scientific Data
Zenodo
Additional Resources

HOME / BEST PRACTICES /

Repositories

The number of available resources for data sharing and data publication has increased substantially over the past few years, making it difficult for individual researchers to evaluate the advantages and limitations of the various options they search for the right solution to address their needs.

Here, we compare and contrast several of the general data repositories and data publication platforms available for biomedical science researchers. Click on the matrix below to see detailed descriptions of each resource.

Requirement		Dataverse	Dryad	figshare	Zenodo	GigaScience	Scientific Data
Data Size and Format							
Hosting of common file formats (e.g. csv, tsv, xls, xlsx, doc, pdf)		✓	✓	✓	✓	✓	✗
Hosting of proprietary file formats (e.g. raw image files)		✓	✓	✓	✓	✗	✗
Unlimited size per file		✗	✓	✗	✗	✓	✗
Unlimited total dataset size		✓	✓	✓	✓	✓	✗
Data Licensing							
CC0 waiver1	recommended		required		recommended	available	required
Data Attribution and Citation Tools							
Assignment of dataset DOIs		✓	✓	✓	✓	✓	✗
User Access Controls							
Tiered access (e.g. administrator-level, collaborator-level, curator-level)		✓	✗	✓	✗	✓	✗
Journal-integrated, anonymous access (for peer review pre-publication)		✗	✓	✓	✗	✓	✗
Optional embargo to data release following publication		✗	✓	✓	✓	✓	✗
Data Access Tools							
Comprehensive data and metadata search tools		✓	✗	✗	✗	✗	✗
Data access via direct download		✓	✓	✓	✓	✓	✗
Data downloading via API		✓	✓	✓	✓	✓	✗
Built-in tools for reading proprietary file formats		✗	✗	✓	✗	✗	✗
Integrated data analysis tools		✓	✗	✗	✗	✓	✗
Cost							
Data deposition fees	none	tiered	none	none	none	none	✗
Data maintenance fees	none	none	none	none	none	none	✗

Requirement	Dataverse	Dryad	figshare	Zenodo	GigaScience	Scientific Data
Data Size and Format						
Hosting of common file formats (e.g. csv, tsv, xls, xlsx, doc, pdf)	✓	✓	✓	✓	✓	✗
Hosting of proprietary file formats (e.g. raw image files)	✓	✓	✓	✓	✗	✗
Unlimited size per file	✗	✓	✗	✗	✓	✗
Unlimited total dataset size	✓	✓	✓	✓	✓	✗
Data Licensing						
CC0 waiver1	recommended	required	recommended	available	required	✗
Data Attribution and Citation Tools						
Assignment of dataset DOIs	✓	✓	✓	✓	✓	✗
User Access Controls						
Tiered access (e.g. administrator-level, collaborator-level, curator-level)	✓	✗	✓	✗	✗	✗
Journal-integrated, anonymous access (for peer review pre-publication)	✗	✓	✓	✗	✓	✗
Optional embargo to data release following publication	✗	✓	✓	✓	✓	✗
Data Access Tools						
Comprehensive data and metadata search tools	✓	✗	✗	✗	✗	✓
Data access via direct download	✓	✓	✓	✓	✓	✗
Data downloading via API	✓	✓	✓	✓	✓	✗
Built-in tools for reading proprietary file formats	✗	✗	✓	✗	✗	✗
Integrated data analysis tools	✓	✗	✗	✗	✓	✗
Cost						
Data deposition fees	none	tiered	none	none	none	✗
Data maintenance fees	none	none	none	none	none	✗

Data Repository Comparison Matrix

<https://datamanagement.hms.harvard.edu/repositories>

On-Your-Own Exercise

Repositories

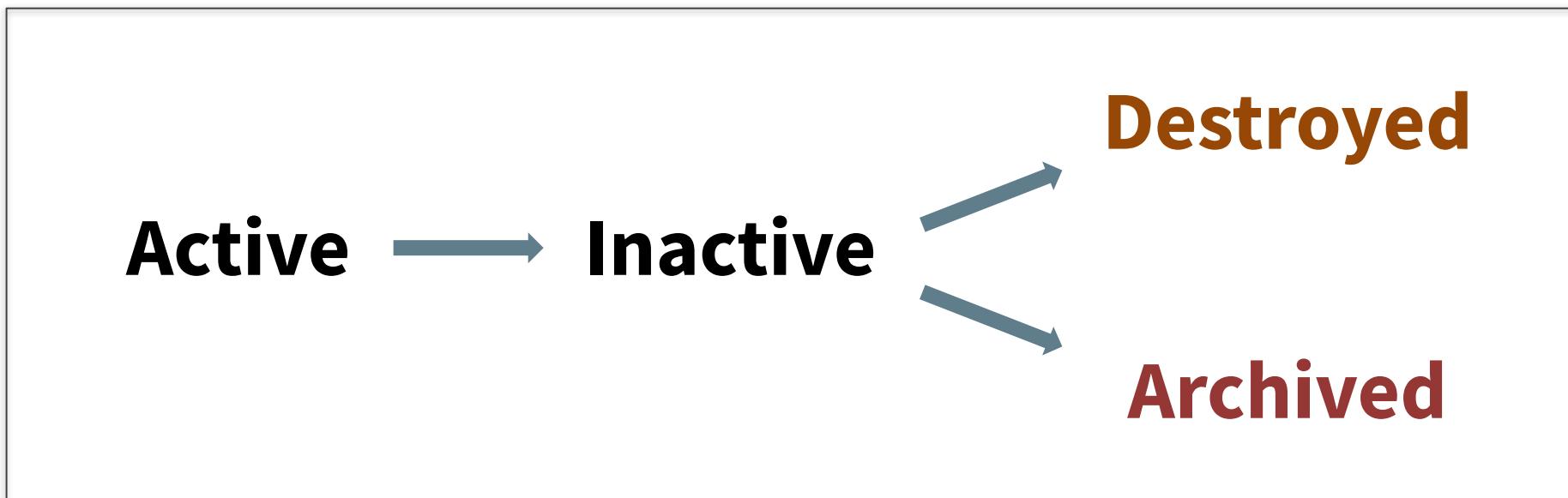
Consider your grant funding or project goals:

- Are you required to deposit your data in a repository?
- What repository(ies) will work for your dataset?



Research Records

Four Types of Records



Retention

Data retention requirements are put in place by funding agencies and sponsoring institutions for a number of reasons:

- *promote the reuse of data within and across disciplines*
- *protect intellectual property rights*
- *make research findings available*
- *support open data initiatives*

Evaluate for Retention

- ✓ Identify and retain essential research records
- ✓ Organize and annotate appropriately

Appraisal & Archiving

Appraisal process for evaluating research records and data:

- ***Inventory of the records:*** volume, data types, formats, metadata, other relevant information
- ***Interview about the project:*** impact of the project, significance of the research or researcher, basic information about the grant

Long-term Storage & Archiving

- ✓ In compliance with HMS & federal policy
- ✓ As requested by investigators

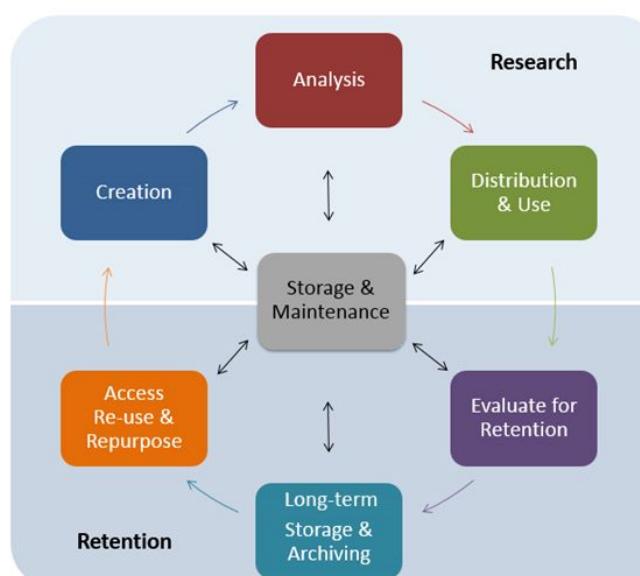
Questions?

Harvard Biomedical Data Management
Best practices & support services for research data lifecycles

About ▾ Best Practices ▾ Plan ▾ Store ▾ Share ▾ Resources & Support

Data Management
Data Management is the process of providing the appropriate labeling, storage, and access for data at all stages of a research project. We recognize that best practices for each of these aspects of data management can and often do change over time, and are different for different stages in the data lifecycle.

Early and attentive management at each step of the data lifecycle will ensure the discoverability and longevity of your research.



← December 2018 →

S	M	T	W	T	F	S
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2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

🔍

FEATURED NEWS



DMWG Featured in Nature Article: How to pick an electronic laboratory notebook
Thursday, August 9, 2018

Submit Questions and Feedback
Upcoming Trainings & News
Receive Data Management Updates



BEST PRACTICES FOR BIOMEDICAL RESEARCH DATA MANAGEMENT

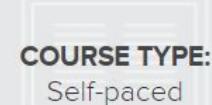
Started Jan 8, 2018

 COURSE DATE:
Starts Jan 8, 2018

 DURATION:
On-going

 COMMITMENT:
7+ hrs/week

 REQUIREMENT:
None

 COURSE TYPE:
Self-paced

 CREDENTIAL:
Badge, Certificate
(free)

Open Online Course via Canvas
bit.ly/HMS-RDM-MOOC

Upcoming Workshops / Seminars

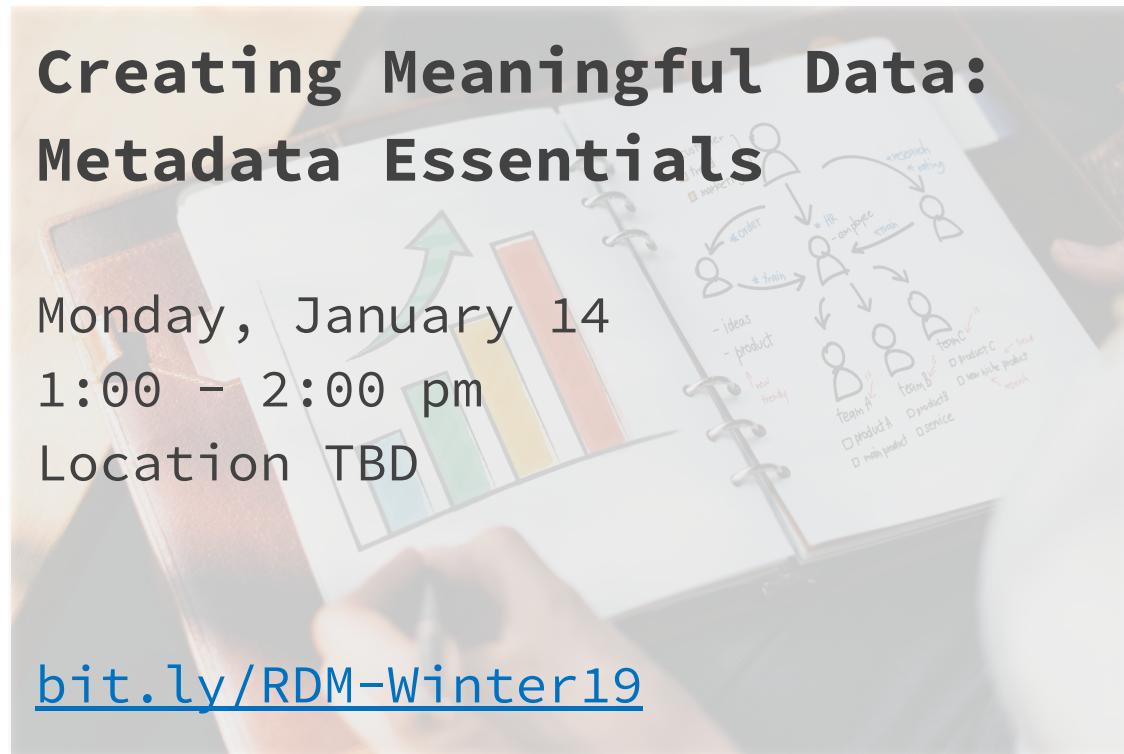
Creating Meaningful Data: Metadata Essentials

Monday, January 14

1:00 - 2:00 pm

Location TBD

bit.ly/RDM-Winter19



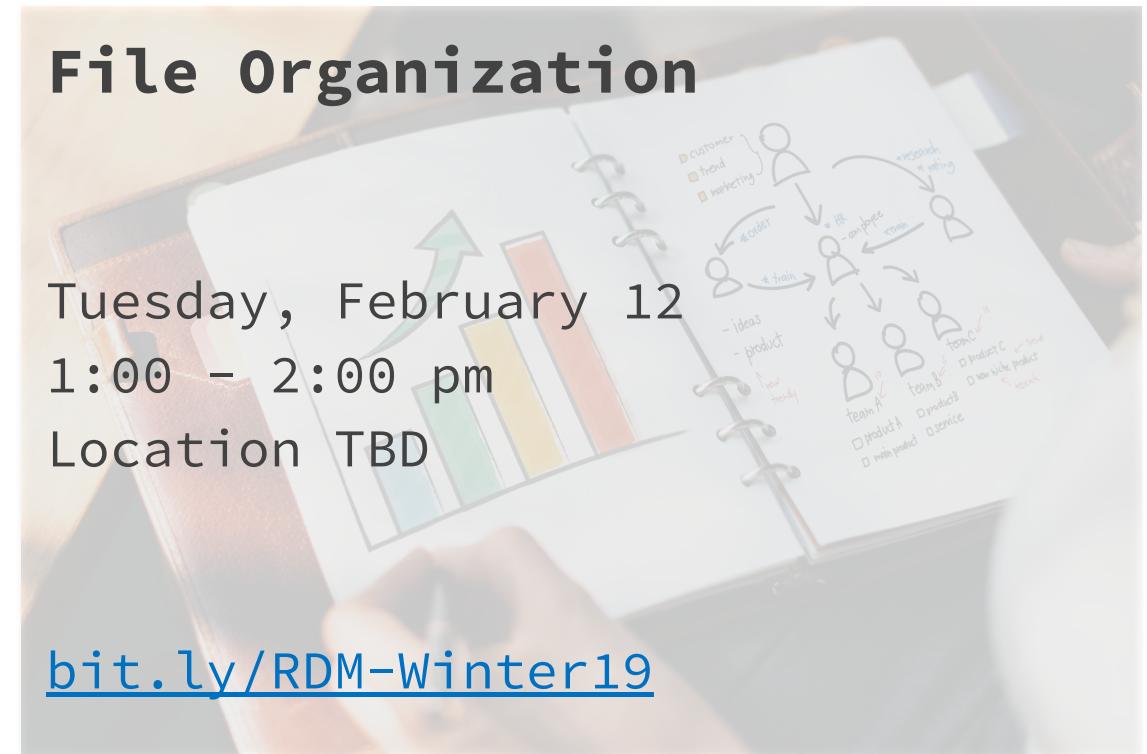
File Organization

Tuesday, February 12

1:00 - 2:00 pm

Location TBD

bit.ly/RDM-Winter19



bit.ly/rdm-survey

Key Resources

Harvard Biomedical Data Management
datamanagement.hms.harvard.edu

Center for the History of Medicine | Archives and Records Management
www.countway.harvard.edu/chom/archives-and-records-management

Research Information Technology Solutions
rits.hms.harvard.edu

Office of the Vice Provost for Research | Research Data Security & Management
vpr.harvard.edu/pages/research-data-security-and-management

Harvard Catalyst | The Harvard Clinical and Translational Science Center
catalyst.harvard.edu

Office for Scholarly Communications
osc.hul.harvard.edu/policies