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Ready for BioData Management?

DAY 2 DAY DATA MANAGEMENT COURSE

FOR LIFE SCIENCES

Funding:

- ELIXIR Implementation Study "Impact evaluation at Node-level - getting it done"
- ELIXIR-CONVERGE Project “Connect and align ELIXIR Nodes to deliver sustainable FAIR life-science data management services”

Agenda

9h30-10h30: Introduction to Research Data Management

10h30-11h00: Resources for Research Data Management (RDMkit, DMPortal, DSW, ELN)

11h00-11h15: Coffee break

11h15-12h00: The IGC use case

12h00-13h00: Hands-On Exercise with eLab Notebook, in pairs

13h00-14h00: Lunch break

14h00-15h00: Hands-On Exercise with eLab Notebook (cont.)

15h00-15h10: Ice breaker

15h10-16h30: Hands-On Exercise with DMPortal, in pairs

16h30-17h00: Wrap-up and closing

Trainers

Daniel Faria
Assistant Professor at Instituto Superior Técnico & Researcher at INESC-ID
Scientific Coordinator of the Ready for BioData Management program

Jorge Oliveira
CTO of BioData.pt
Invited Assistant Professor at Instituto Superior Técnico

Carolina Ventura
Data Steward at Instituto Gulbenkian de Ciência

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Introduction to Research Data Management

Daniel Faria

Part I – The Core Concepts

Learning Outcomes:

- Distinguish Data, Information and Knowledge
- Understand Data Management and DMPs
- Define Reproducibility and Reusability

What is Science?

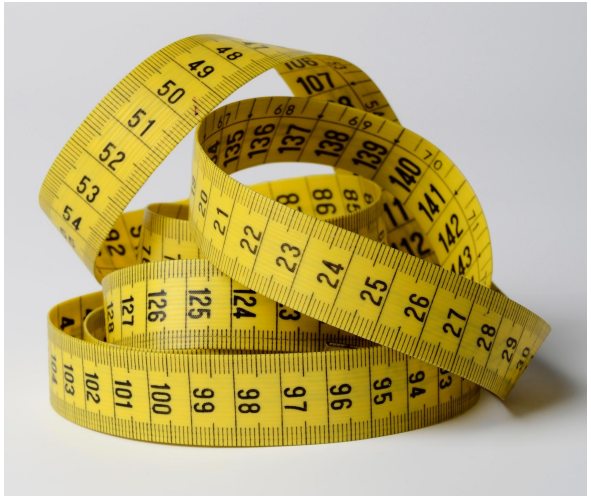
What is Science?

- A **knowledge** discovery paradigm
- Predicated on hypothesis testing through experimentation
- Implies **data** acquisition and analysis
- Requires testability and **reproducibility**

What are Data, Information and Knowledge?

What is Data?

- Datum: an atomic fact or piece of “information”
  - Melting Point: 0℃
  - Boiling Point: 100℃
- Dataset: a collection of data that share an object or scope



By Marta Longas from Pexels

What is Information?

- Information: data + context (metadata)
  - Object: Water w/ < 500 mg/L dissolved solids
  - Experimental conditions: 1 atm
  - …

What is Metadata?

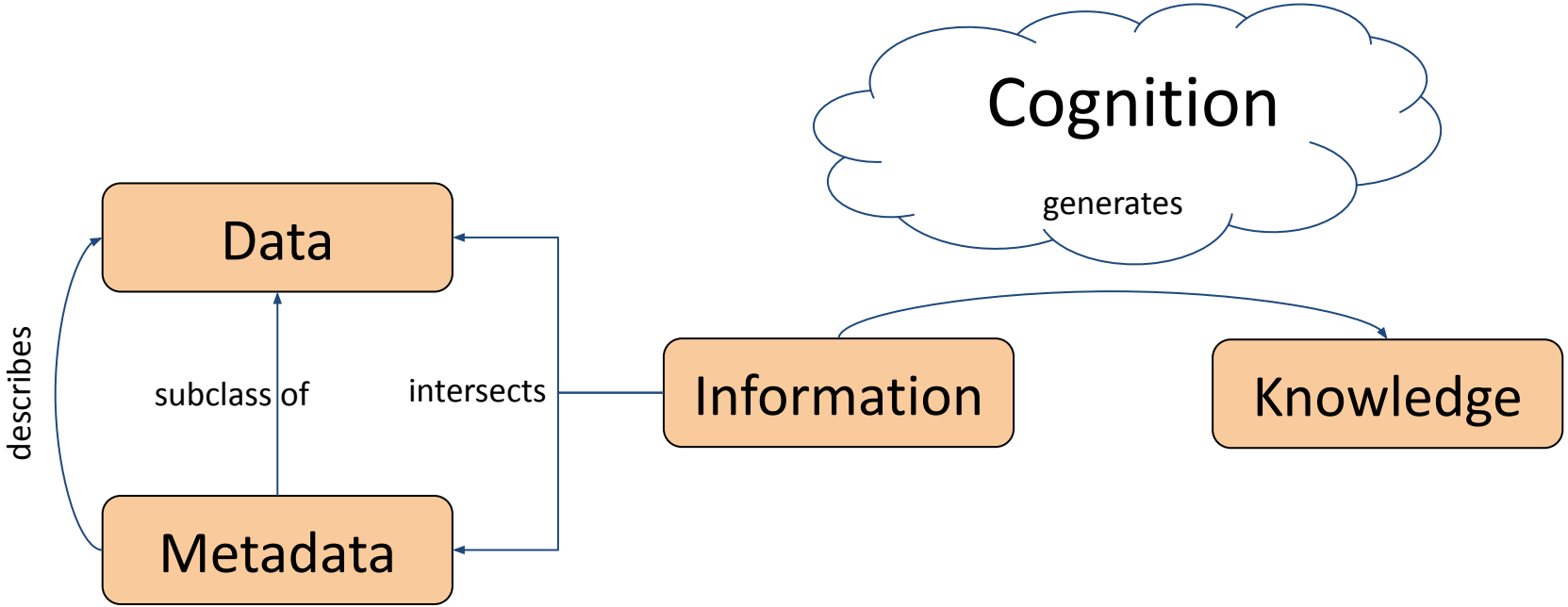
- Metadata is data about data, providing context:
  - **Who** produced the data?
  - **When** was the data produced?
  - **What** is the data about?
  - **Why** was the data produced?
  - **How** can the data be used? (license)

By Dr. Marcus Gossler - Own work, CC BY-SA 3.0

What is Knowledge?

- Knowledge: information + (actionable) understanding
  - If I heat tap water until it starts boiling, I can cook food at 100℃
  - If I see water boiling, I shouldn't put my hand in it

What are Data, Information and Knowledge?



What is Research Data Management?

What is Research Data Management?

- Research data management (RDM) encompasses all the processes involving research data across all the stages of the data lifecycle: collecting, organizing, documenting, processing, analysing, storing, and sharing

https://rdmkit.elixir-europe.org/

What is Research Data Management?

- Good RDM aims at:
  - Improving research effectiveness and efficiency
  - Improving data security (avoiding (meta)data loss)
  - Preventing errors
  - Increasing research impact
  - Ensuring **reproducibility** and promoting **data reusability**

What is a Data Management Plan?

- A DMP is a formal document used to plan and support data management activities by anticipating needs and requirements in a (research) project, facility or institution
- It is to data management what a blueprint is to construction

What are Reproducibility and Reusability?

What is Reproducibility?

- Research is reproducible if the same analysis performed on the same dataset consistently produces the same result
- Reproducibility is necessary but not sufficient for science
- Lack of reproducibility means poor scientific practices or fake science

		Data	
		Same	Different
Analysis	Same	Reproducible	Replicable
	Different	Robust	Generalisable

What is Reusability?

- Research data is reusable if it can be readily adapted and combined with other data to test research hypotheses other than the one for which it was collected
- Reusability is critical in data-intensive research fields, especially where data acquisition is expensive

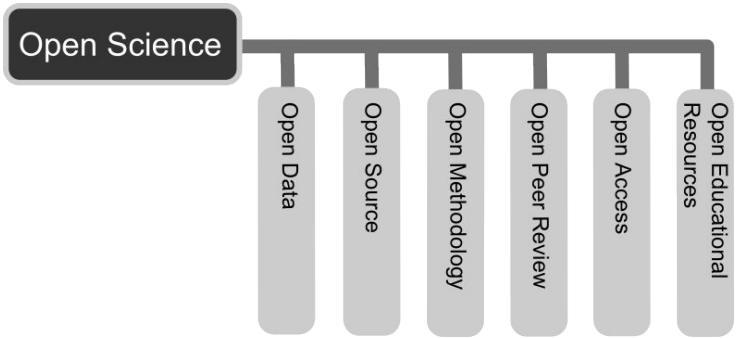
Part II – The Demands & Motivations

Learning Outcomes:

- Explain the Open Science movement and the FAIR data principles
- Understand the demands of funders

Open Science

- Scientific research and its dissemination accessible to all levels of society
  - publications
  - data
  - physical samples
  - software
  - ...



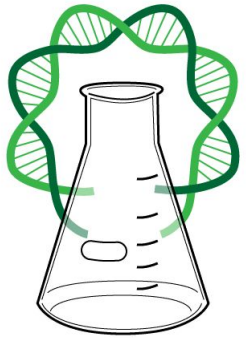
By Andreas E. Neuhold, CC BY 3.0

- Transparent and accessible knowledge shared and developed through collaborative networks

Open Science

Layers:

- **Open Access**: research outputs distributed online, free of cost or access barriers
- **Open Research**: data, result and methodology clearly documented and freely available online
- **Open-Notebook Science**: primary record of a research project publicly available online as it is recorded—no insider information



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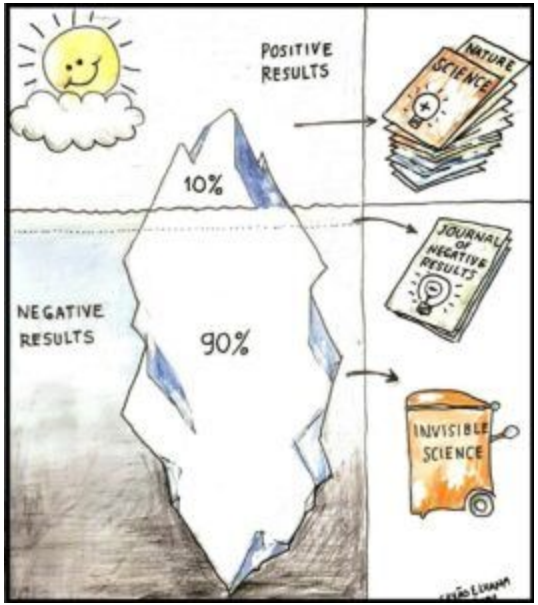
To Share or Not to Share Research Data?

To Share

- If the research was funded through public funds, the funder expects some return to society, and data is often the most valuable output of the project (**reusability**)
- Sharing the data and experimental protocol is essential for **reproducibility**, and should be demanded by journals and/or during peer review

To Share

- Negative results should also be published and even data that was not conducive to scientific publications can and should be shared
    - It may be useless to you but it can be useful for someone else

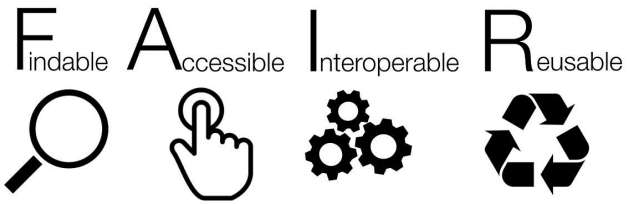


Not To Share

- Data supporting a pending patent or that can be leveraged into a start-up company
    - Both returns to society as far as funders are concerned
- Personal and/or sensitive data

The FAIR Data Principles

Findability: (Meta)data are easy to find for both humans and computers



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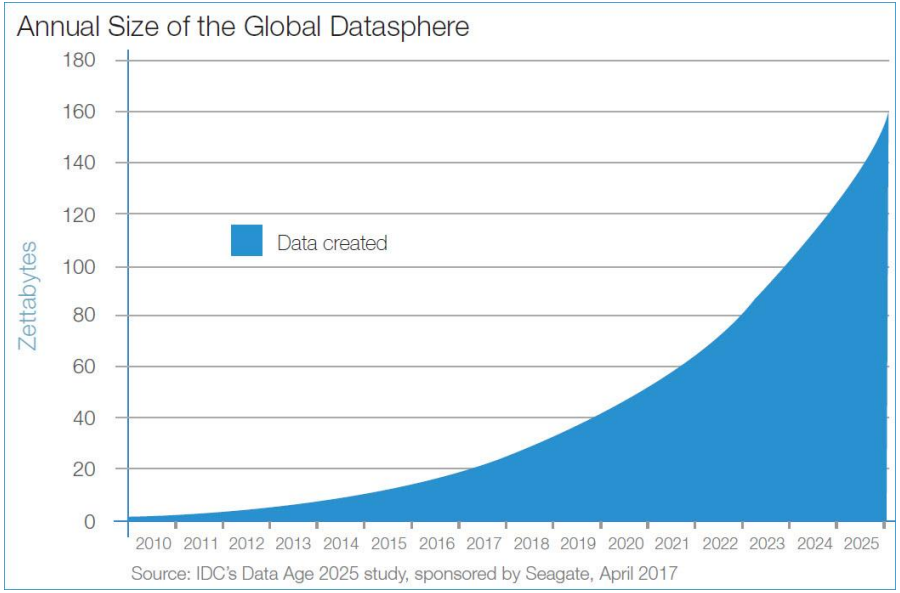
Accessibility: (Meta)data have a defined access protocol with authentication and authorization rules

Interoperability: (Meta)data are integratable with other similar datasets and interpretable by applications or workflows for analysis, storage and processing

Reusability – (Meta)data should be well described so that it can be interpreted and reused

Findability

Our data production is growing exponentially



Findability

- More data ⇒ harder search
- Things can get lost amid a sea of things
- If we can’t find it, we can’t reuse it

By Martin Handford, retrieved from: https://exploringyourmind.com/how-does-our-brain-find-waldo/

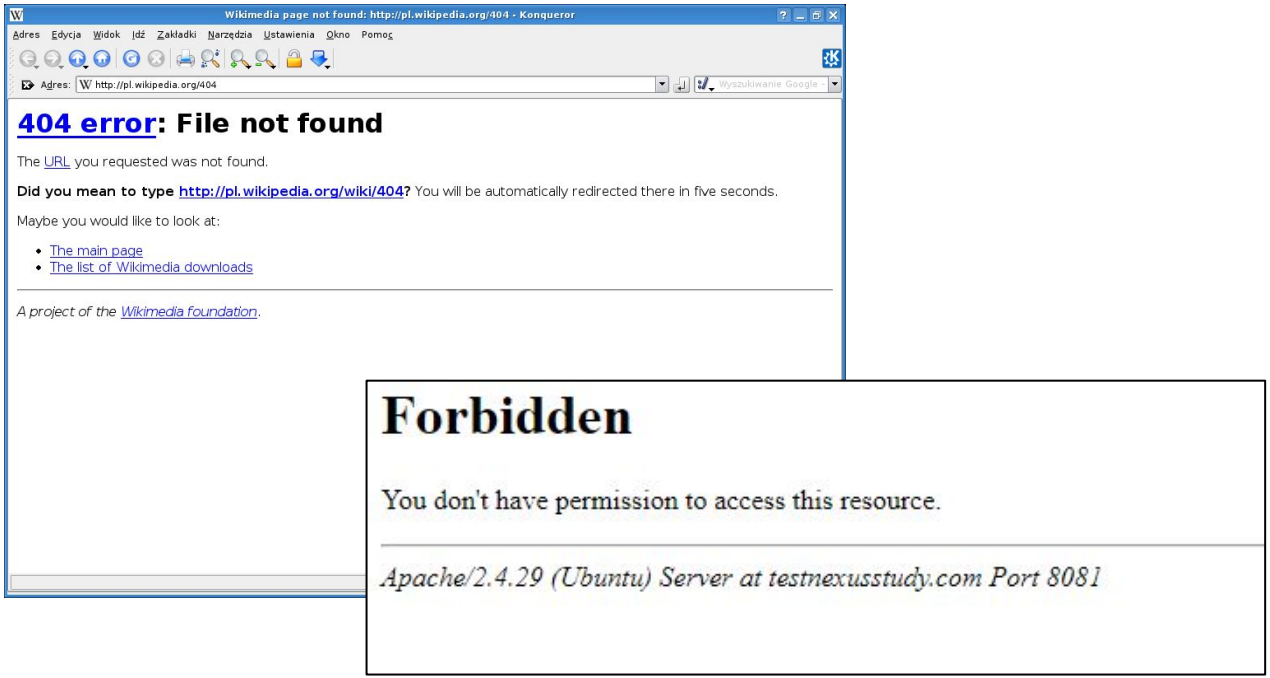
How to Make Research Data Findable?

How to Make Research Data Findable?

- Describe data with precise metadata useful for searching
- Use a (structured) controlled vocabulary for metadata fields and values
- Put data in a repository that uses persistent unique identifiers, indexes metadata and allows searches

By Martin Handford, retrieved from: https://exploringyourmind.com/how-does-our-brain-find-waldo/

Accessibility

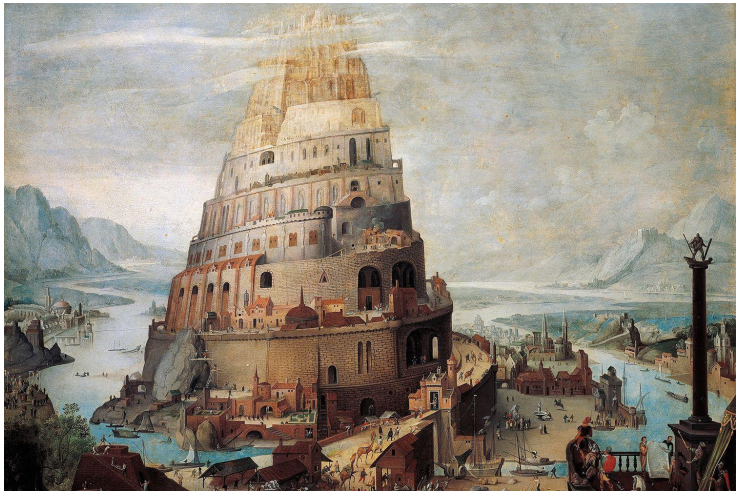


How to Make Research Data Accessible?

- Put data in a repository that:
  - Uses persistent unique identifiers
  - Has a standard access protocol
    - Preferably supports both human and computer access
  - Has authentication and authorization protocols, if the data requires it

Interoperability

- Specialization of science ⇒ divergence of vocabulary, file formats, data organization and viewpoints
- All lead to sundered data that cannot be combined with other data and/or used by particular applications or workflows

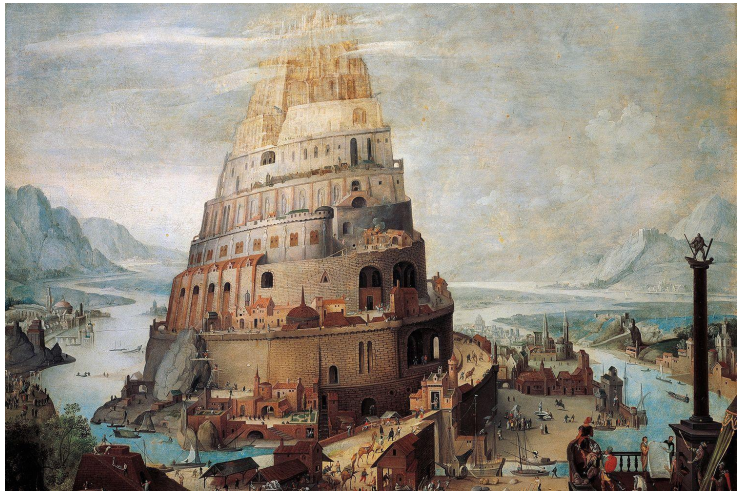


By Abel Grimmer, retrieved from: http://cbcpnews.net/cbcpnews/the-tower-of-babel/

How to Make Research Data Interoperable?

How to Make Research Data Interoperable?

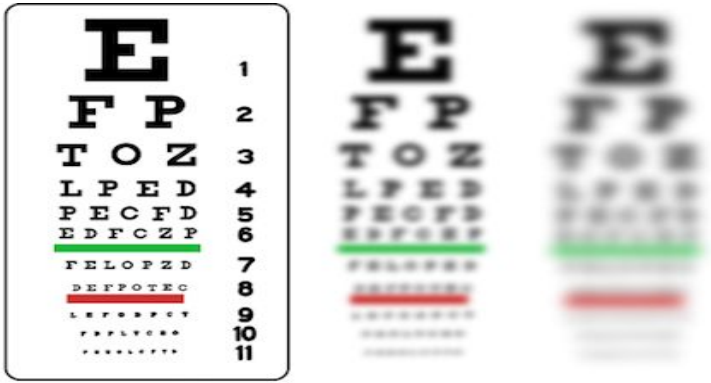
- Use standard (open) file formats
- Use a (structured) controlled vocabulary for metadata fields and values
- Include cross-references to external data objects whenever suitable



By Abel Grimmer, retrieved from: http://cbcpnews.net/cbcpnews/the-tower-of-babel/

Reusability

- Reusability hinges on findability and interoperability, but also on **interpretability**
- We need to be able to readily interpret the data to figure out if and how we can reuse it
- We can’t afford to read a whole research paper to interpret every dataset



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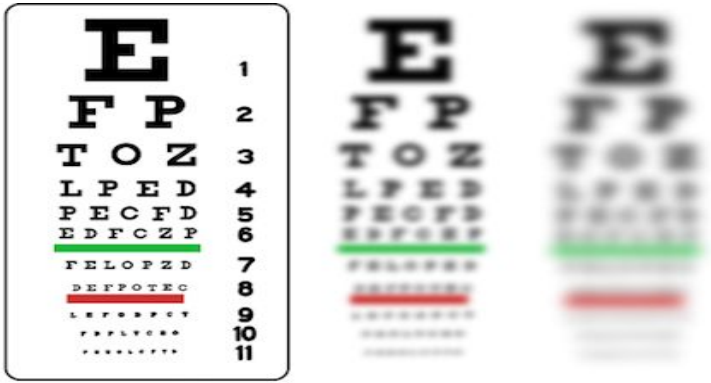
How to Make Research Data Interpretable?

How to Make Research Data Interpretable?

- Describe data with sufficient metadata for interpreting it and understanding the experimental context—each dataset should be fully self-contained
- Use a (structured) controlled vocabulary for metadata fields and values



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The Funders' Demands

- Research funders are increasingly demanding that you comply with the FAIR data principles and that you include DMPs in your research projects that demonstrate how you will comply
- Very soon it will be impossible to get European or national funding without a DMP
- And validation of FAIRness is coming in the near future

Wrap Up

- Publishing data only in scientific papers is not enough
  - Papers are not efficient vehicles for knowledge transfer!!!
- Data must be published in a FAIR manner
- Data need not be published before the scientific publication
- Data need not be fully public
  - “As open as possible, as closed as necessary”

Part III – Day-to-Day Data Management

Learning Outcomes:

- Describe the challenges of producing FAIR data
- Explain the benefits of good RDM

Producing FAIR Data

- Consider national policies, institutional policies, funder's policies
- Learn specific recipes in the FAIR Cookbook
- Consult information hubs about existing standards, such as FAIRsharing.org
- Search for key concepts through ontology lookup services, such as BioPortal

Producing FAIR Data

- Is there a default public database or repository for your research domain?
  - Does it have a metadata schema?
- Are there community metadata standards?
  - Do they cover your use case?
- Are there adequate ontologies?
- Are there default data (open) file formats?

Producing FAIR Data

- Organize, Document & Annotate:
  - Your code / scripts / workflows,
  - Your protocols
  - Your data & metadata
- According to the applicable guidelines / standards or the repository where you're depositing your data / materials
- Using domain ontologies, recommended file formats

Producing FAIR Data

- **Is a lot of work**
  - Especially if you only think about it when publishing your data
    - You have to trace all the data and experimental details—risk of (meta)data loss
    - Inertia and rush lead to poor job

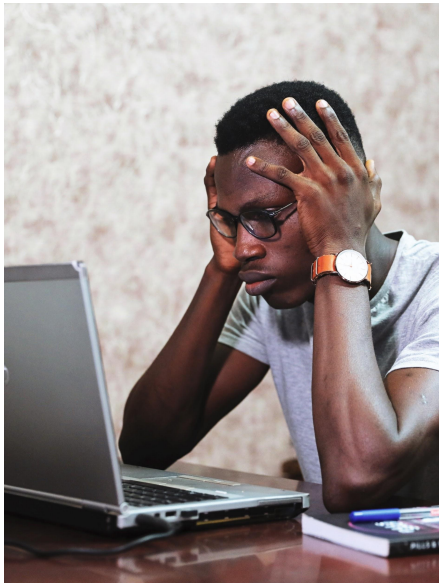


Photo by Oladimeji Ajegbile from Pexels

Producing FAIR Data

- **Is much easier with good data management across the data lifecycle**

Plan

- Do your homework
  - Legal and ethical issues
  - National / funder's / institutional policies
  - Best practices in your domain
  - Standards and ontologies
- Allocate resources to subsequent stages
  - People, equipment, time
- **Make a DMP!**

Collect

- Capture **provenance** and **methodological metadata** according to established standards
- Use standard (open) file formats
- Ensure data quality
- Ensure (temporary) data storage: persistent, secure, redundant
- Use an **electronic lab notebook** (ELN) to keep a digital record of your research!

Process & Analyse

- Document all processing and analysis steps, according to established **metadata** standards
- Use/create workflows to ensure **reproducibility**
  - Document your code!
- Ensure link between storage and computing
- Name and organize your files sensibly and document file structure if not self-evident
- Use version control software (e.g. git)

Preserve

- Ensure long term data storage (for the duration determined during planning): persistent, secure, redundant
- Determine accessibility to the data: authentication and authorization protocols
- Ensure data is documented with sufficient metadata to enable its verification and **reuse**

Share

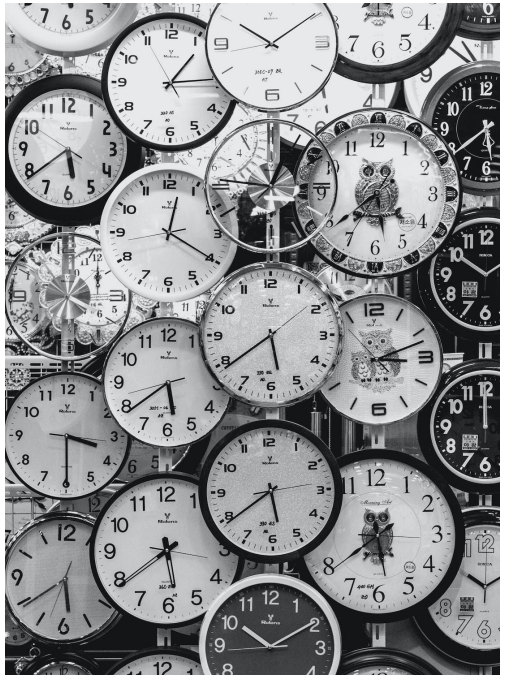
- Determine if the data can be publicly shared (in its entirety or partially) or how access to it can be gained
- Deposit data in a suitable repository, with sufficient metadata to enable **reuse**
  - Indexes metadata and enables searches
  - Has machine accessibility
  - Has authentication and authorization protocols if necessary

Reuse

- Not really a stage
- Data that you reuse should be contemplated at the plan and collect stages
- Making your data reusable is a concern that should permeate the whole data lifecycle

Day-to-Day Data Management

- Take some time each day:
  - To document what you did
    - In an ELN
    - Following metadata standards
    - Using controlled vocabularies
  - To organize your data
  - To document your code
  - To check and if necessary update your DMP



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Questions?

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