Leibniz-Institut für Polymerforschung Dresden

Research Data Management – A practical guide

How to manage scientific data in your daily work

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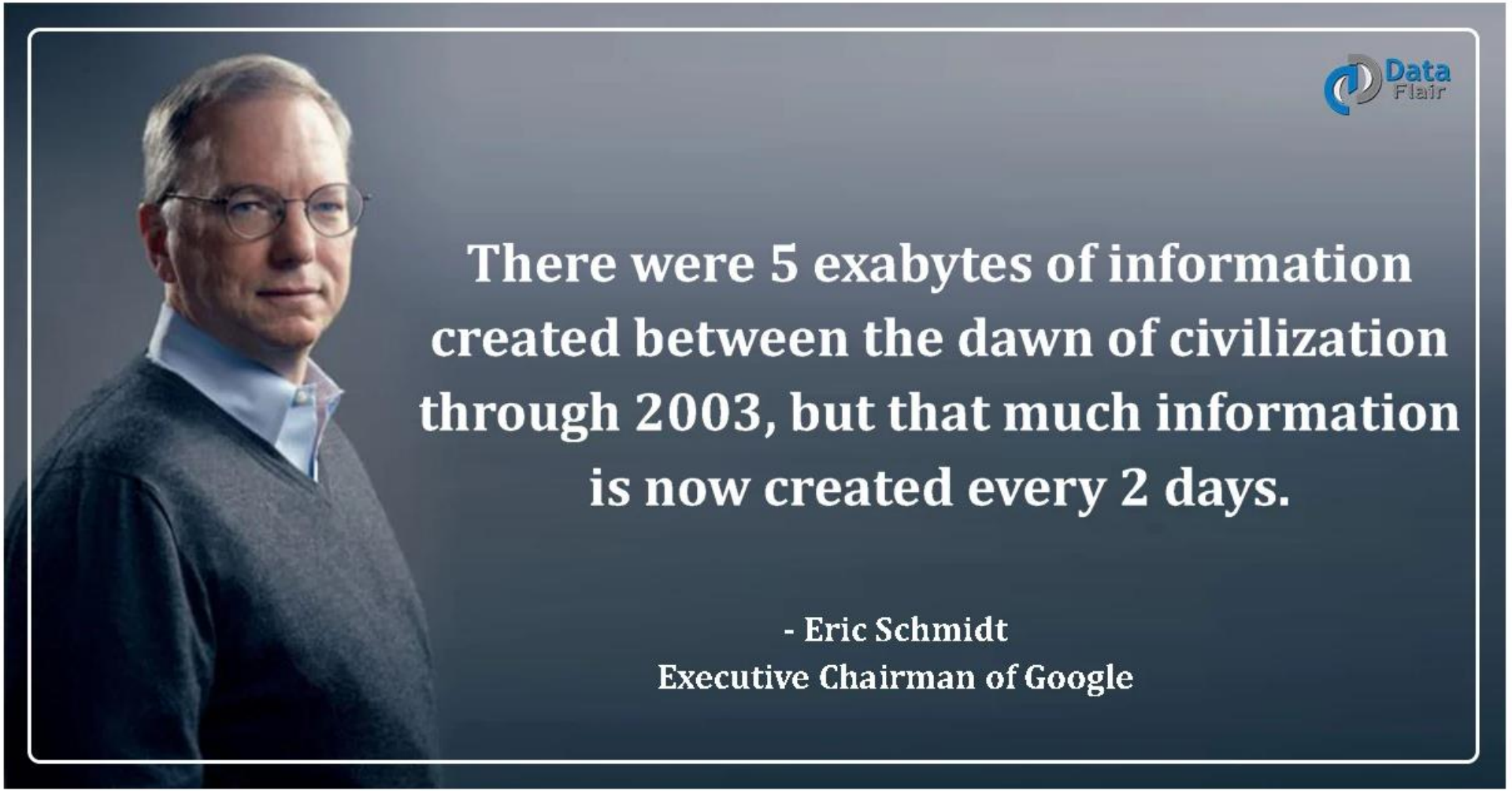
POLYMER SEPARATION GROUP

Stellenbosch UNIVERSITY IYUNIVESITHI UNIVERSITEIT

Short Course: Outline

1. **Introduction – why we need to care about our data?**
2. **Basic principles/tools for research data management**
   - ✓ Name your data – Conventions and nomenclature
   - ✓ Describing your data set – Meta data and ReadMe
   - ✓ Structure your data - Folder management
   - ✓ Document your scientific /practical work - Electronical lab notes
3. **Practical „real-life“ example**

https://xkcd.com/1459/



https://data-flair.training/blogs/data-science-big-data-quotes/

Data Flair

You can have data without information, but you cannot have information without data.

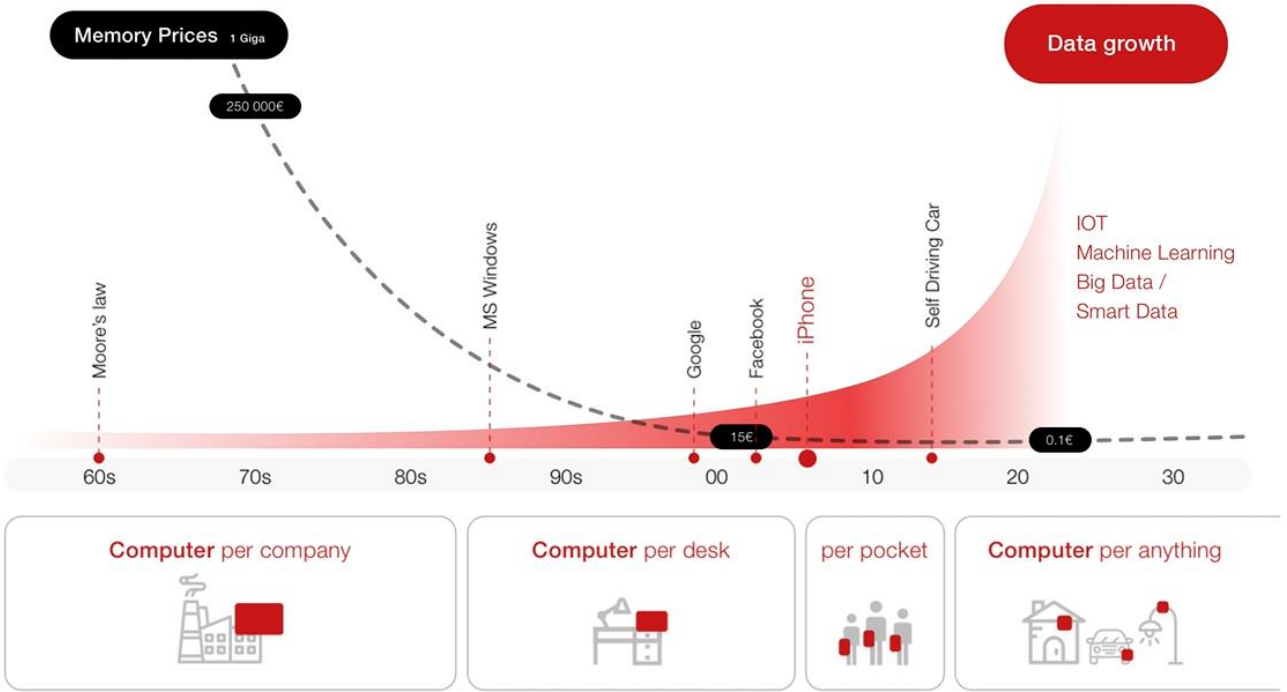
- Daniel Keys Moran

American Computer Programmer and Science Fiction Writer

https://data-flair.training/blogs/data-science-big-data-quotes/

1. Why we need to care about our data?

Motivation:

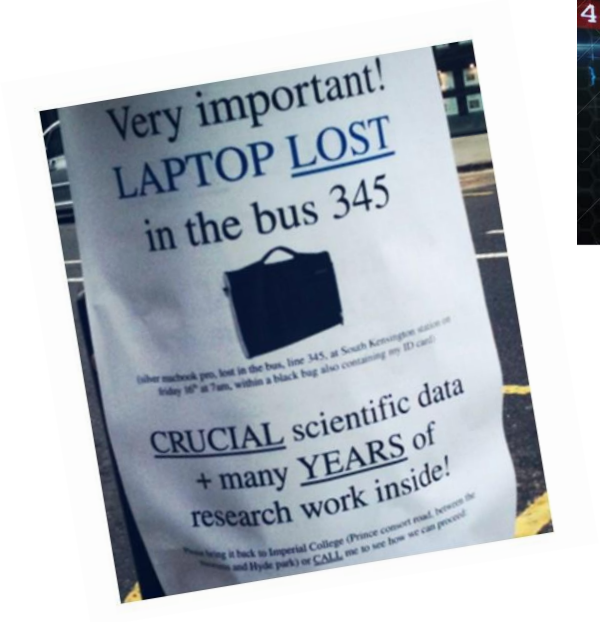


https://d-one.ai/#we-make-sense

1. Why we need to care about our data?

Motivation:

- **Data Security**



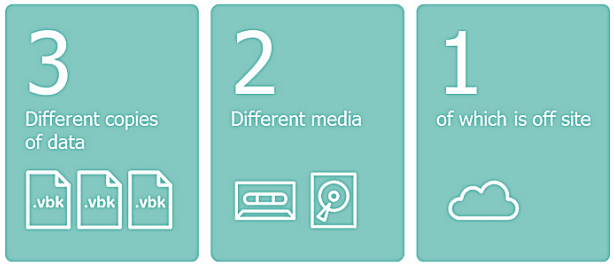
1. Why we need to care about our data?

Motivation:

- **Data Security**

  - ✓ Backup **(notice: USB drives are not a backup!)**
  - ✓ **3-2-1 Backup rule:**

- **3** copies of data (1 x primary copy of raw data, 2 x copies of backup)
- **2** media (copies of data on at least 2 different storage media)
- **1** external backup (original and backups not at the same location)



https://www.easeus.de/backup-wiederherstellen/321-backup-strategie.html

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1. Why we need to care about our data?

Leibniz-Institut für Polymerforschung Dresden

Motivation:

- **Data Security**
- **Part of "Good Scientific (Research) Practices"**

Bundesministerium für Bildung und Forschung

European Commission

- Demand of national / international funders
- Institutional rules and policies for handling research data
- Prevention of scientific misconduct: data fabrication, falsification and plagiarism

Alexander von HUMBOLDT STIFTUNG

VolkswagenStiftung

FULBRIGHT Scholar Program

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

DFG Deutsche Forschungsgemeinschaft

NIH National Institutes of Health Turning Discovery Into Health

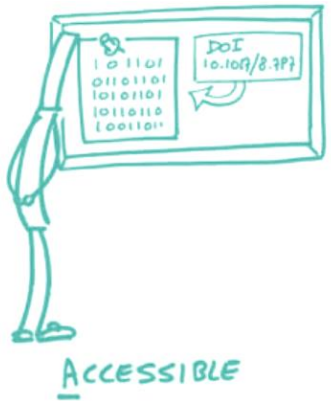
POLYMER SEPARATION GROUP

1. Why we need to care about our data?

Motivation:

- **Data Security**
- **Good Scientific (Research) Practice**
- **FAIR principle**

F … Do I find the data?



I … Do I understand the data?

A … Can I access the data?

R … What I'm allowed to do with the data?

1. Why we need to care about our data?

Motivation:

- **Data Security**
- **Good Scientific (Research) Practice**
- **FAIR principle**

More information about FAIR data: https://www.go-fair.org/fair-principles/

1 Why we need to care about our data?

Motivation:

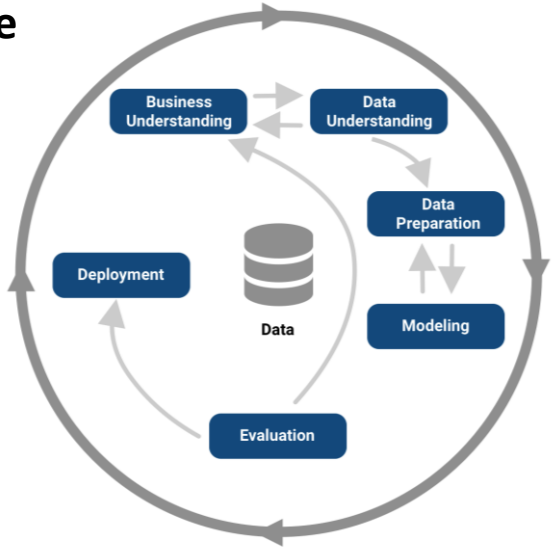
- **Data Security**
- **Good Scientific (Research) Practice**
- **FAIR principle**
- **Data Sharing: Movie clip, open science**

https://thepublicationplan.com/2019/05/14/five-essential-factors-for-data-sharing/, https://youtu.be/N2zK3sAtr-4, CC-BY licence

1. Why we need to care about our data?

Motivation:

- **Data Security**
- **Good Scientific (Research) Practice**
- **FAIR principle**
- **Data Sharing**
- **Data Science**

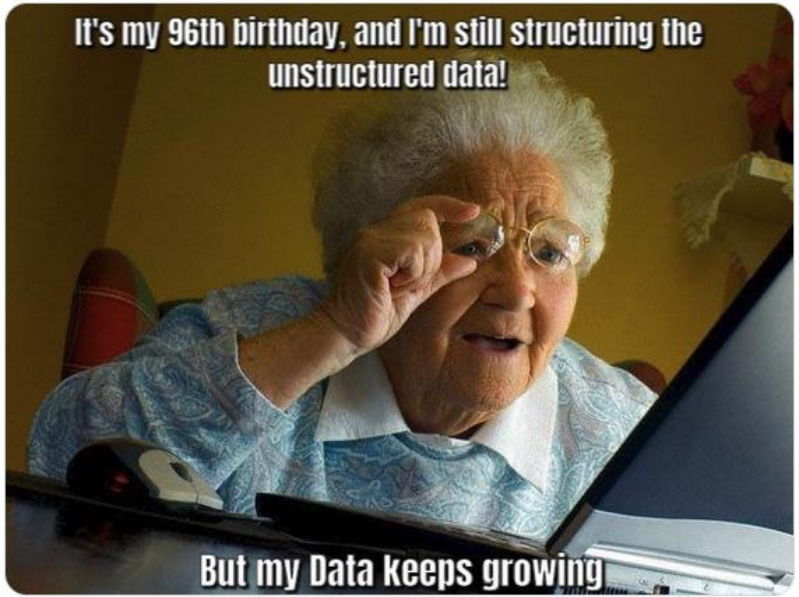


AdobeStock, https://www.usedatatolead.com/post/6-schritte-zu-einem-erfolgreichen-data-science-projekt

1. Why we need to care about our data?

Key Points for Data Management:

- 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

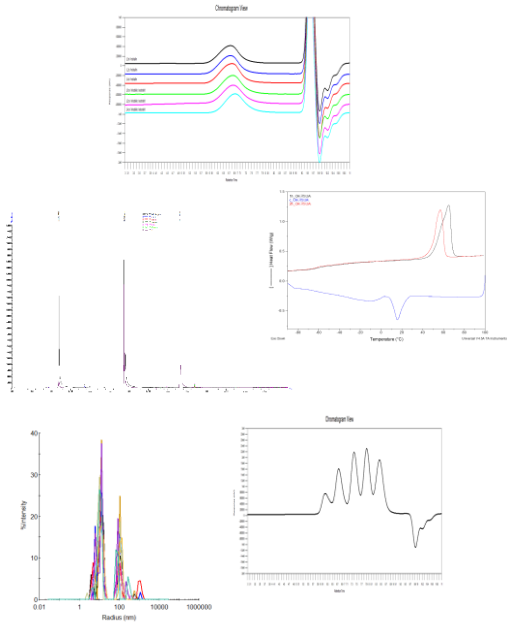


https://twitter.com/datadynamicsinc/status/1522877966090661888?lang=da

2. Basic principles/tools for research data management

Lots of information in your head gets lost over time

You, today



You, in six months (or anyone else)

2. Basic principles/tools for research data management

Describe your data!

You, today

And in 6 months!!!

https://www.wunderweib.de/schoene-schokoideen-pralinen-selber-machen-3375.html, https://www.lauensteiner.de/de/nougat-pralinen-p7844/, https://www.lieferello.de/Pralinen/Lindt-Mini-Pralin-s-9St-44g.html, https://www.krusteundkruemel.de/so-liest-der-low-carber-die-label-auf-nahrungsmitteln/

2. Basic principles/tools for research data management

Enable integration with other data

DATASET

Data collection

https://www.merkur.de/wirtschaft/aldi-lidl-edeka-kaufland-mars-bounty-ferrero-suessigkeiten-lieferschwierigkeiten-supermaerkte-discounter-zr-91117331.html

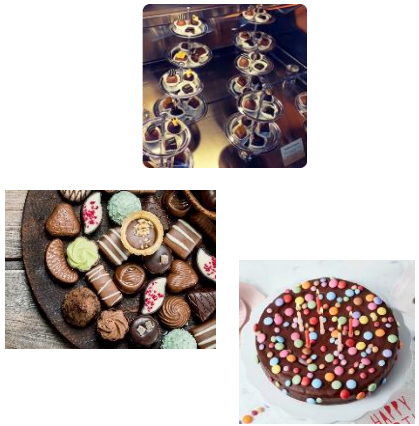
2. Basic principles/tools for research data management

Enable long-standing usage of collected data

Data collection

Select

Use



Data selection for research

https://relaxdays.de/wohnen/kuche/serviergeschirr/servierstander/etagere-porzellan-10035404.html, https://www.pinterest.de/pin/wir-wnschen-allen-finalisten-des-food-blog-award-2015-im-rahmen-der-berlin-food-week-heute-viel-erfolg-zu-den-finalisten-gehren--419819996492652425/

2. Basic principles/tools for research data management

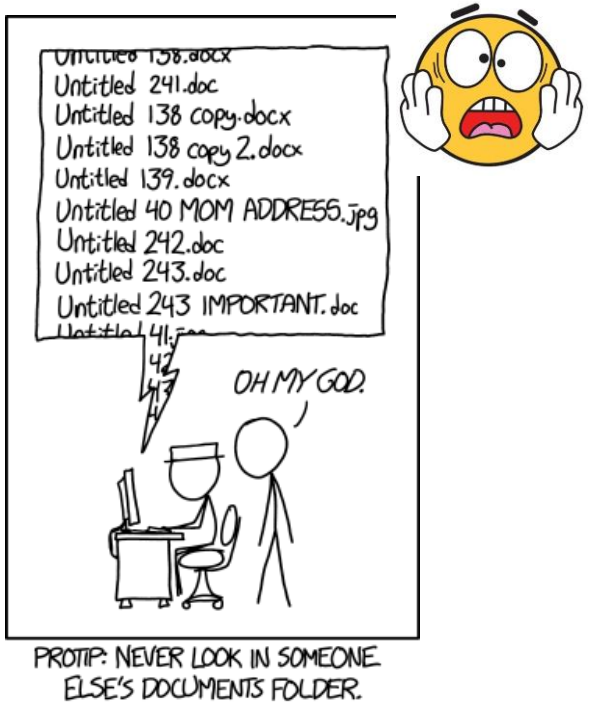
- ✓ Name your data – Conventions and nomenclature
- ✓ Describing your data set – Meta data and ReadMe
- ✓ Structure your data - Folder management
- ✓ Document your scientific /practical work - Electronical lab notes

File Naming

Do‘s and Don‘ts - Examples

Best practices

- 20240523_ProjectA_SEC_BoyeS_v1.xlsx
- 20240523_ProjectA_MeetingNotes_BoyeS_v2.docx
- 20240523_ManuscriptScience_BoyeS_v525.docx
- …



https://xkcd.com/1459/

File Naming

Requirements

- Human and machine-readable
- Be consistent
- Use date format ISO 8601: YYYYMMDD
- Include a version number (Creamer et al. 2014)
- Write down naming convention in data management plan

AVOID:

- Special characters: {}[]<>()*%#`;“,:?!§@ …
- Space
- Cryptic
- Too long

File Naming

Take-Home Tips

✓ 1. Think about your files - What related files are you working with?

- You can use different conventions for different file sets
- Do you have established file naming conventions in your displine or group?

Example: This convention will apply to all of my AF4 files, from raw data trough processed file

gibbons.de, datamanagement.hms.harvard.edu

File Naming

Take-Home Tips

- ✓ 1. Think about your files
- ✓ 2. Identify metadata (e.g. date, sample, experiment) – What information is needed to easily locate a specific file?

- Descriptive with contextual information
- Pick three pieces of metadata
- Names should be human readable: understand what‘s in each one

Example: For my AF4 measurements, I want to know date, sample ID, and injection number for that sample on that date

gibbons.de, datamanagement.hms.harvard.edu

File Naming

- ✓ Take-Home Tips
- ✓ 1. Think about your files
- ✓ 2. Identify metadata (e.g. date, sample, experiment)
- ✓ 3. Abbreviate or encode metadata - Don't forget to document any codes!

  - Standardize the categories and/or replace them with 2- or 3-letter codes

  Example: e.g. 2-letter project abbreviation: project 1 -> P1, project 2 ->P2 or 3-letter code for technique, SEC, AF4, NMR,…

gibbons.de, datamanagement.hms.harvard.edu

File Naming

Take-Home Tips

- ✓ 1. Think about your files
- ✓ 2. Identify metadata (e.g. date, sample, experiment)
- ✓ 3. Abbreviate or encode metadata
- ✓ 4. Use versioning - Are you maintaining different versions of the same file?

- Track versions by adding information on the end of file name
  - Use version numbers („v01“ or „v02“)
  - Use version date (YYYYMMDD)

Example: analysis workflow: _raw and _processed

gibbons.de, datamanagement.hms.harvard.edu

File Naming

Take-Home Tips

- How you want to sort and search
- Decide which metadata should appear at the beginning
- Use default order: alphatically, numerically, or chronologically

Example: AF4 measurement: 5075_2024-02-16 11-48 - wash 400uL

✓ 5. Think about how you will search for files – what comes first?

gibbons.de, datamanagement.hms.harvard.edu

File Naming

Take-Home Tips

- Determine characters for separation of metadata – many computer systems cannot handle space
- Use dashes (file-name.xx) or underscores (file_name.xx) or capitalize first letter of each word – camel case (FileName.xx)
- Use default order: alphatically, numericall, or chronologically
- Avoid special characters: .,~!@#€§$%&/()=?{}[]`!

Example: 20240603_Presentation_Course_FFF2024_V01.ppt

✓ 6. Deliberately separate metadata elements – avoid spaces or special characters

gibbons.de, datamanagement.hms.harvard.edu

File Naming

Take-Home Tips

- Name conventions should be documented that others in your lab/group can follow this standard
- Document in a REDME.txt together with your files
- If the file is moved or shared, users will be able to identify the file from its file name

Example: My file naming convention is [SA-MPL-EID]_[YYYYMMDD]_[###]_[status].[tif]
P1_SEC_PS30k_20240423_2_raw.txt

✓ 7. Write down your naming conventions – Include a top-level README file on how to navigate the structure

Describing your data set – Meta data and ReadMe

Meta data – Enrich your data with meaning!

Meta data helps to understand data

Meta data answers questions:

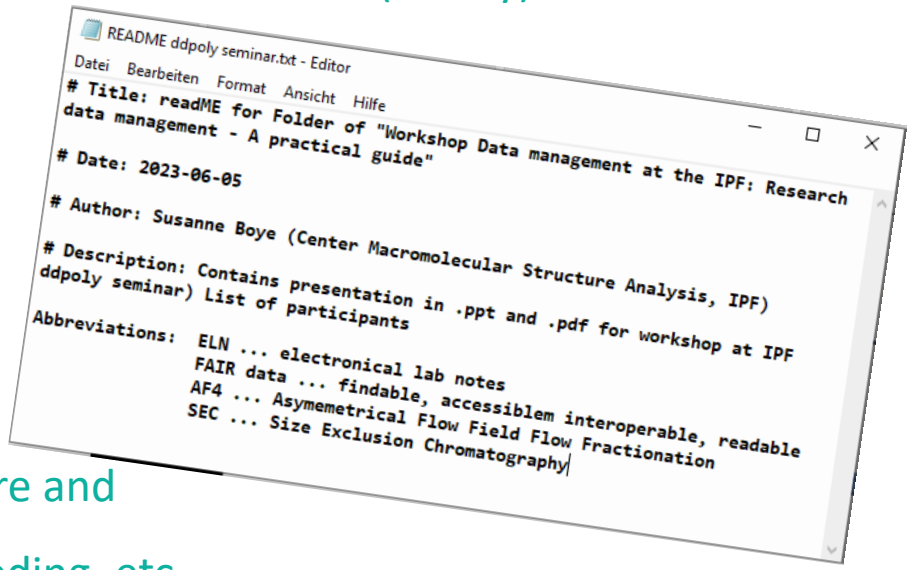
- ✓ **Who** created the data?
- ✓ **Why** was the data created?
- ✓ **When** was the data created?
- ✓ **How** was the data created?
- ✓ **What** is the content of the data?

More information under: https://data.research.cornell.edu/content/readme

Describing your data set – Meta data and ReadMe

Easiest way to make data more understandable and reusable:

ReadMe.txt file "**Love letter to the Future**" – for each folder (ideally)



Content:

- ✓ Title
- ✓ Date
- ✓ Author
- ✓ Description of folder content, structure and organization of files, abbreviations, coding, etc.
- ✓ … as much information as possible

More information under: https://data.research.cornell.edu/content/readme

Structure your data – Folder Management

✓ How to organize your data?

- ✓ Files and data
- ✓ Data growth
- ✓ Change over time
- ✓ Relationships
- ✓ Duplication of data

DATA CHAOS

https://www.industr.com/de/wider-das-kabelchaos-loesungen-fuer-die-elektroinstallation-2252844

Structure your data – Folder Management

Data flows

Raw data

↓

Ready-to-analyze data

↓

Processed (computational) results

→

Figures

Tables

Numerical results

→

Report

Manuscript

Poster

Presentation

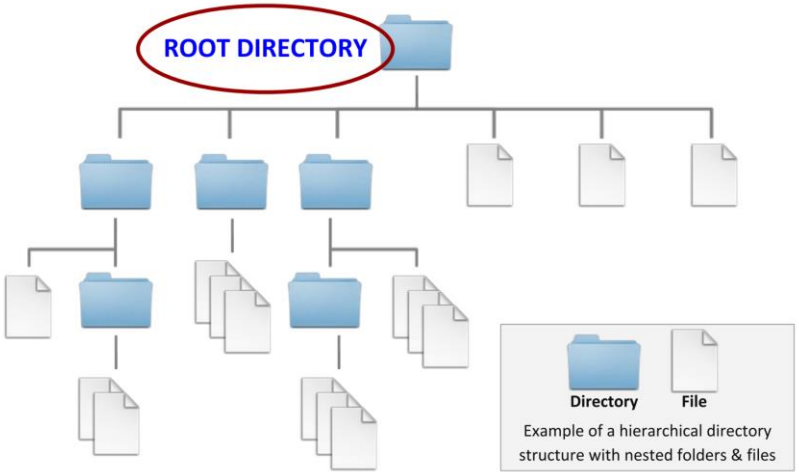
Structure your data – Folder Management

Data hierarchy

- ✓ One project – one folder
- ✓ Consistent structure for each project

AVOID:

- ✓ Overlapping categories
- ✓ Too large folders and too deep structures
- ✓ Repetition of information



Structure your data – Folder Management

Document your structure

- ✓ Make sure to capture metadata about content of folders and files:

  Naming conventions

  Who made it, when, where???

- ✓ Create documentation / ReadMe files
- ✓ Establish standardized structures in your group/department

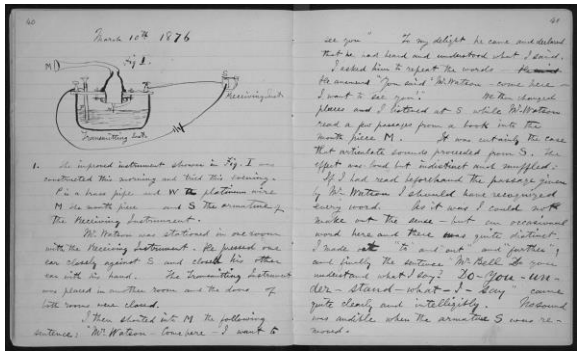
Take-Home Tips:

- ✓ Dump older files cluttering your working directory
- ✓ Delete unneeded files when the project is finished

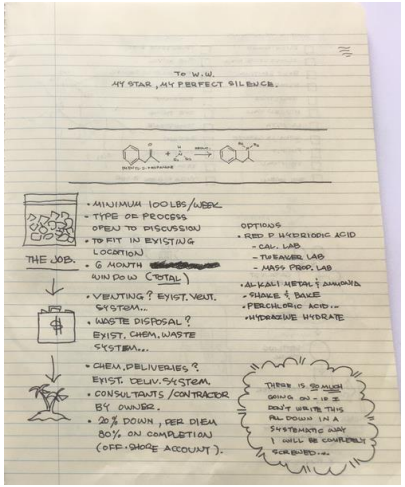
https://www.uni-frankfurt.de/128986468/Abgeschlossene_Projekte?

Document your practical work - Electronical lab notes

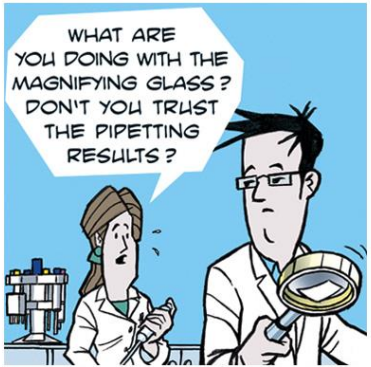
Traditional paper notebooks



Page from a laboratory notebook of Alexander Graham Bell, **1876.**



Page from Gale's lab notes "Breaking Bad"



www.eppendorf.com/pipetting

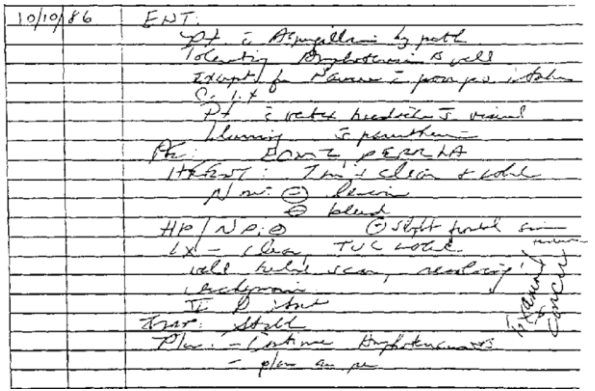
https://en.wikipedia.org/wiki/Lab_notebook, https://www.therpf.com/forums/threads/gale%E2%80%99s-lab-notes-breaking-bad.305036/

Document your practical work - Electronical lab notes

Benefits

- ✓ Helps you to organize yourself and your research.
- ✓ No loose paper on your desk nor any cryptic notes
- ✓ No data loss when researchers move on
- ✓ Simplified summary of your research
- ✓ Documenting helps you to understand old data
- ✓ Easy data sharing
- ✓ Long-term storage and archive

Can you read and understand it?



https://www.geliebte-ordnung.de/project/schreibtisch/, https://www.researchgate.net/figure/Written-entries-are-standard-in-paper-records-yet-handwritten-notes-may-be-illegible_fig4_226157738

Document your practical work - Electronical lab notes

Digitalization of notes:

- ✓ Is easy to read and to edit – no handwriting
- ✓ Is versioned, changes can be reverted and tracked
- ✓ Is searchable and sortable
- ✓ Use of templates – standardization
- ✓ Links to: resources, other experiments, raw data or analysis workflows
- ✓ Application of APIs - Automated analysis + Data science

Samples:

Acronym	Description
FK_AF4_014	Ferrocen-Psome (0.5 mg BCP/ml)
FK_AF4_015	N3-Ferrocen-Psome (0.5 mg BCP/ml)
FK_AF4_016	Psome A (0.5 mg BCP/ml)

Susanne Boye - Apr 18, 2023, 2:31 PM MESZ

Materials / Device

Susanne Boye - Jan 11, 2023, 12:49 PM MEZ

Buffer: 1 mM, pH 7.4, + 0.02 % NaN_3

Channel: LC

Spacer: 490 µm

Membrane: RC (cut-off: 10 kDa)

Pump + AS system: Agilent 1200 series

FFF device: Eclipse Dualtec (Wyatt)

LS detector: DAWN HELEOS-II (Wyatt): λ=660 nm

RI detector: Optilab T-rEX (Wyatt): λ=660 nm

Diode array detector: SPD-M20 (Shimadzu), wavelengths:

AUX1 [nm]	AUX2 [nm]	AUX3 [nm]	AUX4 [nm]
254	280	400	500

Research Data Management

Avoid the scientific data nightmare: watch the video

https://www.scimex.org/newsfeed/imagine-your-worst-nightmare-some-people-just-cant, https://www.youtube.com/watch?v=nNBiCcBlwRA

3. Practical „real-life“ example

STEPS TO A DATA MANAGMENT OF A SCIENTIFIC PROJECT

1

Data sources

- ✓ Idea/Grant
- ✓ WHO
- ✓ Collaboration partners

2

Data collection

- ✓ Experimental Data
- ✓ Discussion
- ✓ Design experiments

3

Data preparation

- ✓ Data Cleaning
- ✓ Data Analysis
- ✓ Structure

4

Manuscript/Report

- ✓ Figures
- ✓ Writing/Revision
- ✓ Submission/Revision

5

Safe & long-term storage

- ✓ Data organization/Read Me Files
- ✓ Supervision
- ✓ Long-term storage, open access

STEPS TO A DATA MANAGMENT OF A SCIENTIFIC PROJECT

- **Cloud (IPF Cloud)➔** Create one folder for each project. The project should be defined upfront.

Data sources Data collection Data preparation Manuscript/Report Safe & long-term storage

Electronic Labbook in combination with an inhouse drive or CLOUD service

- **ELN** https://www.labarchives.com/ **➔** Create one Notebook for each project. All notebooks should have the same structure.

Data collection Manuscript/Report Safe & long-term storage

STEPS TO AN IDEAL DATA MANAGMENT OF A SCIENTIFIC PAPER

CLOUD structure ***in progress***

Name of Project

- ***Read me*** **file** (people involved into the project, nomenclature, status of the project, new ideas…)
- **Electronic Lab Book/protocols** (divided by person involved into the project)
- **Raw data** (organized by chracterization methods, by operator and by positive/negative results)
- **DataAnalysis**
- **Comunication** (Reports, meetings, working plan, emails)
- **Literature**

Name of Project-Lab Book

- People involved into the project
- Nomenclature and summary of compounds; Tags
- Meeting Notes; Status of the project
- Experimental Data (can be divided by people involved)

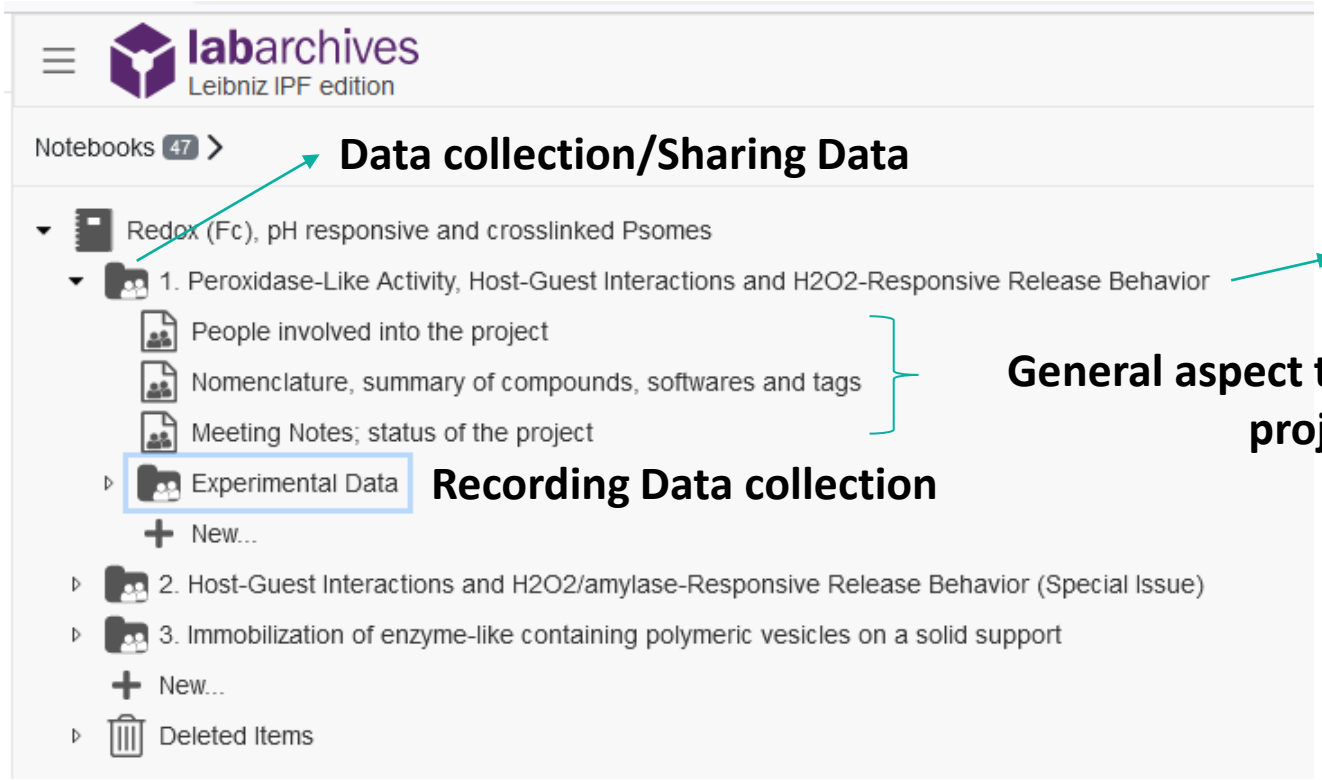
  SM 20210510 Fabrication of FcPsomes

  SM 20210514 Stability of FcPsomes

  SM 20210514 Preparation of FcPsomes for AF4

When a student finishes: 1) change the ownership of the notebook, 2) make a PDF file and 3) added it in the ELN folder in the cloud.

STEPS TO AN IDEAL DATA MANAGMENT OF A SCIENTIFIC PAPER



STEPS TO AN IDEAL DATA MANAGMENT OF A SCIENTIFIC PAPER

Workshop › Redox (Fc), pH responsive and crosslinked Psomes_in progress ›

Name	Date modified
Communication	18/04/2023 12:54
Data Anaylsis_Main Text (Raw Data + Proceed Data + PowerPoint + Pic)	18/04/2023 13:23
Data Anaylsis_Supporting Information (Raw Data + Proceed Data + PowerPoint + Pic)	18/04/2023 13:24
ELN_Protocols → **Experimental Description Collection**	18/04/2023 13:29
Literature	18/04/2023 13:19
Scientific Data (Organized by characterization methods) → **Raw Data Collection**	18/04/2023 13:20
ReadMe	26/09/2022 12:59

Paper preparation

Let´s take a look the content!

STEPS TO AN IDEAL DATA MANAGMENT OF A SCIENTIFIC PAPER

CLOUD structure ***after acceptance publication***

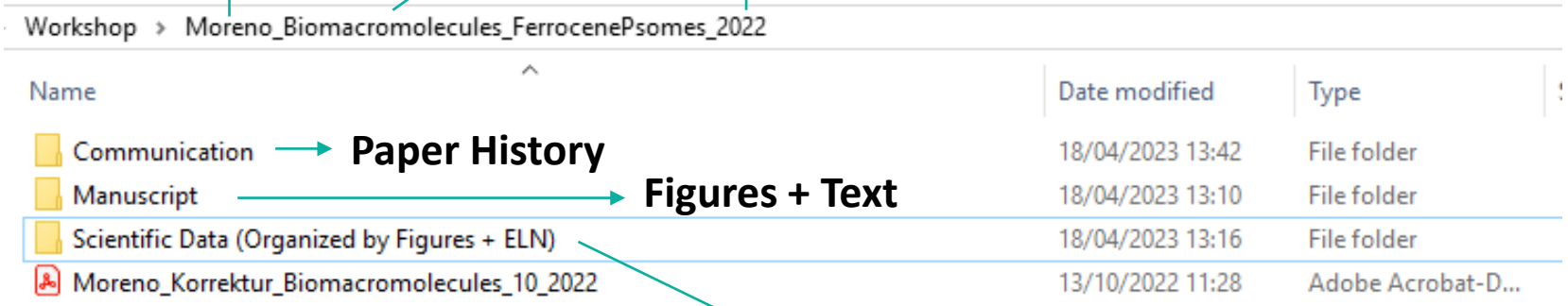
First Author_Name of Paper/Journal_Year

- **Communication**
- **Manuscript** (main text and SI, PowerPoint and pics of the last version of Figures, TOC, Readme File)
- **Scientific Data** (Raw data and Processed Data ordered by Figures)
- **Proof of submission to the library**

The supervisor* is the responsible to check the last version

STEPS TO AN IDEAL DATA MANAGMENT OF A SCIENTIFIC PAPER

First author Journal Year



Paper History

Figures + Text

Submission to the library

Figures + Text + Raw Data + Experimental Descriptions

Let´s take a look the content!

Coding and Version Control: git[5]

Distributed version-control for your source code

- Free and open-source software
- Structured source-code management system
- Easy and simple to use for everyday programming
- Reference your compiled code with unique SHA-hash
- Good scientific practice to comment and archive your code!

USE GIT!!!

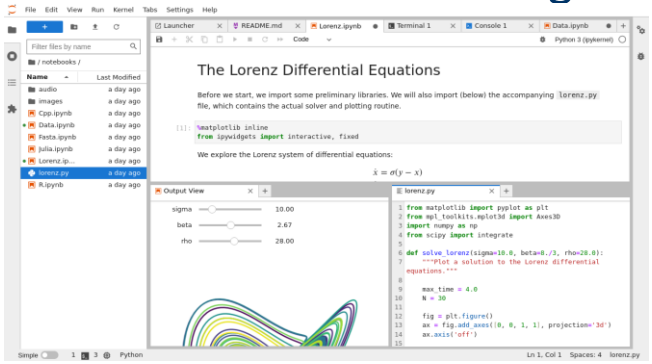
[5] https://git-scm.com/

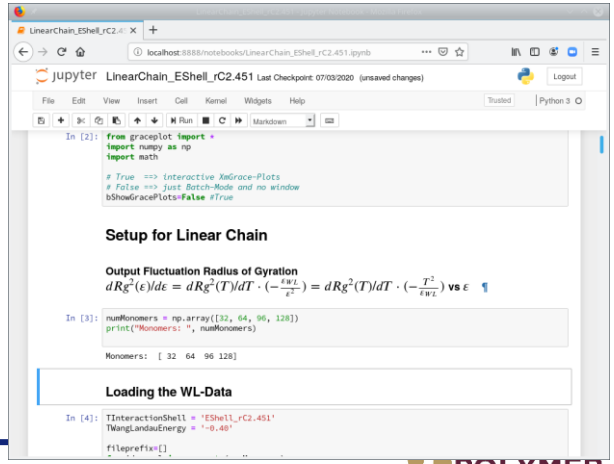
Use IDE: Jupyter and JupyterLab[6]

Jupyter: Interactive Computing and Data Processing

https://jupyter.org/hub

- Free and open-source software
- Native Python binding for easy usage (also R)
- Documentation/Latex using Markdown within the source
- Collaboration and exchange of jupyter notebooks





- [6] https://jupyter.org/

Tools for DMP: DSWizard[7] and DMPTool[8]

Data Management Plan (DMP)

- Which data will be produced (type, format)?
- How large will be the data set probably?
- How and where shall the data be stored during and after the project duration? Backups?
- Is it planned to publish the data, and if yes, under which conditions?
- Could legal or ethical problems occur in collecting, analyzing and publishing the data?
- How much does it cost?
- Who is responsible for all the processes of research data management?

Collaboration Tools and Step-by-Step Survey:

DSW

DMPTool
Build your Data Management Plan

[7] https://ds-wizard.org/
[8] https://dmptool.org/

Connecting data: 5-star-linked-data[9]

Design Pattern for Open Data

★: data is openly available in some format.

★★: data is available in a structured format, such as Microsoft Excel file format (.xls).

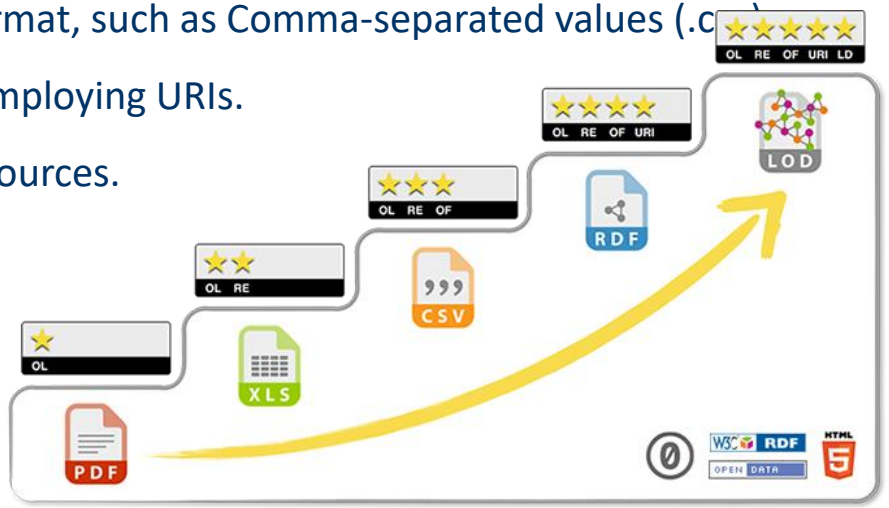
★★★: data is available in a non-proprietary structured format, such as Comma-separated values (.c

★★★★: data follows W3C standards, like using RDF and employing URIs.

★★★★★: all on the other, plus links to other Linked Data sources.

For data publishing use public repositories e.g. Zenodo:

https://zenodo.org/



- [9] https://5stardata.info/en/

Connecting data: Example 1

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Article | Open access | Published: 07 August 2023

Dynamic matrices with DNA-encoded viscoelasticity for cell and organoid culture

Yu-Hsuan Peng, Syuan-Ku Hsiao, Krishna Gupta, André Ruland, Günter K. Auernhammer, Manfred F. Maitz, Susanne Boye, Johanna Lattner, Claudia Gerri, Alf Honigmann, Carsten Werner & Elisha Krieg

Nature Nanotechnology **18**, 1463–1473 (2023) | Cite this article

15k Accesses | **12** Citations | **93** Altmetric | Metrics

An Author Correction to this article was published on 31 January 2024

This article has been updated

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Sections | Figures | References

Abstract

Main

Material concept

CCLs control network formation and matrix stiffn...

DNA sequences encode stress relaxation and he...

High stability, tunable degradation and biocom...

DyNAtrix supports development of diverse cells a...

Conclusions

Connecting data: Example 1

Data availability

Supplementary Information containing materials and methods, supplementary figures, tables, datasets and accession numbers for biological materials are available with this paper. Additional datasets and materials generated during and/or analysed during the current study are available from the corresponding author on reasonable request. The supplementary data and code supporting the findings of this study are openly available on figshare (https://figshare.com/projects/Dynamic_matrices_with_DNA-encoded_viscoelasticity_for_cell_and_organoid_culture/168281). Source data are provided with this paper.

Code availability

A Python script for the thermodynamic calculations of CCL interactions is available as Supplementary Code 1 and at figshare (https://doi.org/10.6084/m9.figshare.23309429). A Python script for the statistical simulation of the maximum percentage of intramolecular crosslinks as a function of CCL complexity is available as Supplementary Code 2 and at figshare (https://doi.org/10.6084/m9.figshare.23592636).

Source data

Source Data Fig. 2

Simulation results, rheological data, source data for Fig. 2d and thermodynamic prediction.

Source Data Fig. 3

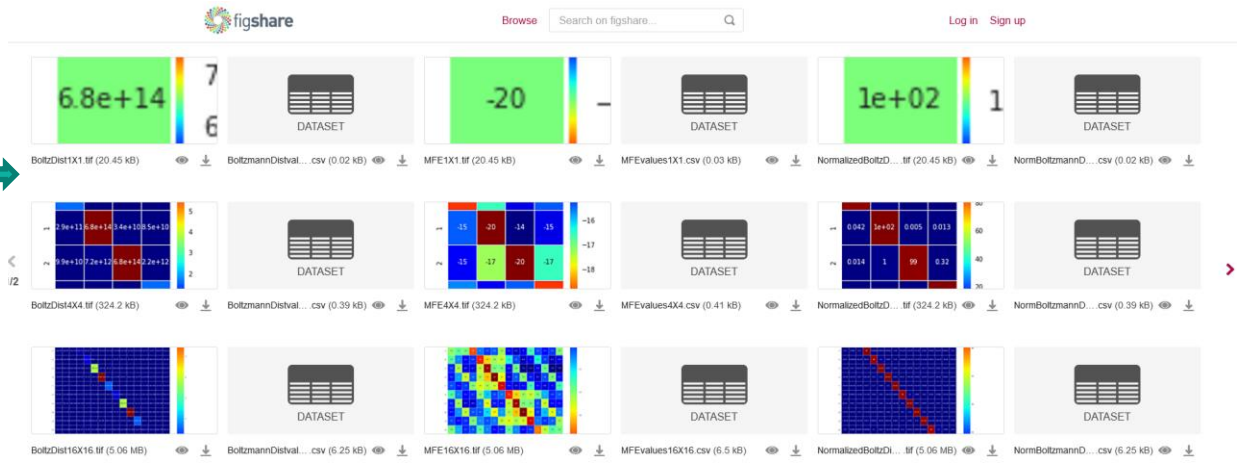
Rheological data.

Source Data Fig. 4

Rheological data.

Source Data Fig. 5

RFU value from qPCR, gel volume quantification, statistical source data of cell viabilities and immune response.

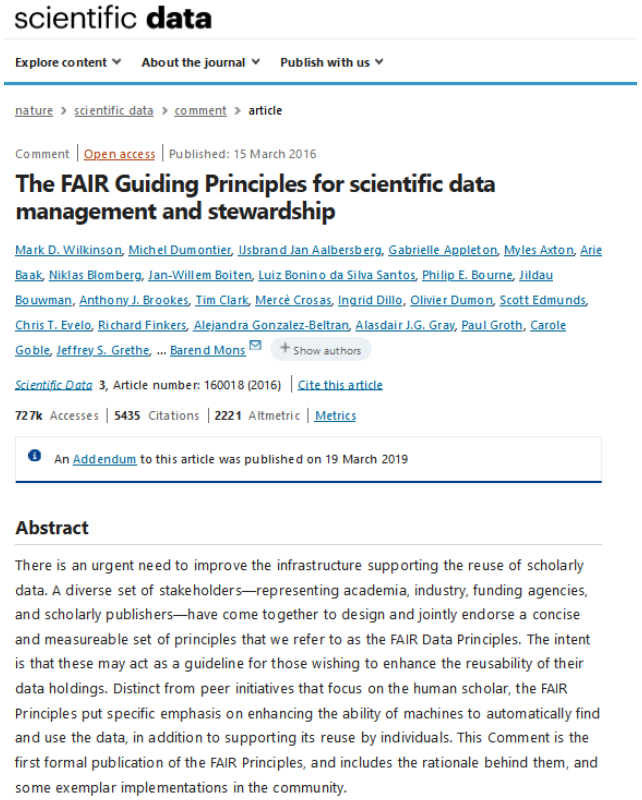


https://static-content.springer.com/.../41565_2023_1483_MOESM12_ESM.**xlsx**

MS Excel sheet with numerical data

POLYMER SEPARATION GROUP

Connecting data: Example 2



scientific data

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nature > scientific data > comment > article

Comment | Open access | Published: 15 March 2016

The FAIR Guiding Principles for scientific data management and stewardship

Mark D. Wilkinson, Michel Dumontier, IJsbrand Jan Aalbersberg, Gabrielle Appleton, Myles Axton, Arie Baak, Niklas Blomberg, Jan-Willem Boiten, Luiz Bonino da Silva Santos, Philip E. Bourne, Jildau Bouwman, Anthony J. Brookes, Tim Clark, Mercè Crosas, Ingrid Dillo, Olivier Dumon, Scott Edmunds, Chris T. Evelo, Richard Finkers, Alejandra Gonzalez-Beltran, Alasdair J.G. Gray, Paul Groth, Carole Goble, Jeffrey S. Grethe, ... Barend Mons + Show authors

Scientific Data 3, Article number: 160018 (2016) | Cite this article

727k Accesses | 5435 Citations | 2221 Altmetric | Metrics

An Addendum to this article was published on 19 March 2019

Abstract

There is an urgent need to improve the infrastructure supporting the reuse of scholarly data. A diverse set of stakeholders—representing academia, industry, funding agencies, and scholarly publishers—have come together to design and jointly endorse a concise and measureable set of principles that we refer to as the FAIR Data Principles. The intent is that these may act as a guideline for those wishing to enhance the reusability of their data holdings. Distinct from peer initiatives that focus on the human scholar, the FAIR Principles put specific emphasis on enhancing the ability of machines to automatically find and use the data, in addition to supporting its reuse by individuals. This Comment is the first formal publication of the FAIR Principles, and includes the rationale behind them, and some exemplar implementations in the community.

The FAIR principle:

- **F**indability
- **A**ccessibility
- **I**nteroperability
- **R**eusability

Connecting data: Example 2

Database of Raman and ATR-FTIR spectra of weathered and biofouled polymers

You are here: MicroPlastiX SpecDB

Dataset: MicroPlastiX SpecDB

RADAR Metadata	Content	Statistics	Technical Metadata
Alternate identifier:	(URL of the source repository of the project) https://github.com/robna/MPX_specDB (Citeable release snap shots of the source repository) https://doi.org/10.5281/zenodo.8314801		
Creator/Author:	Lenz, Robin https://orcid.org/0000-0003-4156-7380 [ROR Leibniz Institute of Polymer Research] Fischer, Franziska https://orcid.org/0000-0002-2317-6784 [ROR Leibniz Institute of Polymer Research] Arnold, Melinda [ROR Leibniz Institute of Polymer Research] Fernández-González, Verónica https://orcid.org/0000-0002-6890-6154 [ROR University of A Coruña] Moscoso Pérez, Carmen María https://orcid.org/0000-0002-2451-3535 [ROR University of A Coruña] Andrade-Garda, José Manuel https://orcid.org/0000-0003-1020-5213 [ROR University of A Coruña] Muniategui-Lorenzo, Soledad https://orcid.org/0000-0001-5946-3366 [ROR University of A Coruña] Fischer, Dieter [ROR Leibniz Institute of Polymer Research]		
Contributors:	(Other) Frias, João https://orcid.org/0000-0001-9943-1035 [ROR Atlantic Technological University] (Other) Casotti, Raffaella https://orcid.org/0000-0002-9876-4601 [ROR Stazione Zoologica Anton Dohrn] (Other) Pedrotti, Maria Luiza https://orcid.org/0000-0002-9963-0402 [ROR Sorbonne University] (Research Group) The JPI Oceans Project MicroPlastiX consortium members		

FAIR4Chem Award 2024
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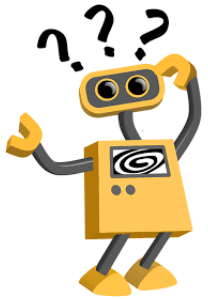
Thank you for your attention!

Questions???



If you have further questions, just contact us:

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Dr. Martin Geisler (geisler@ipfdd.de)