

FAIR DATA & FAIR-by-design methodology

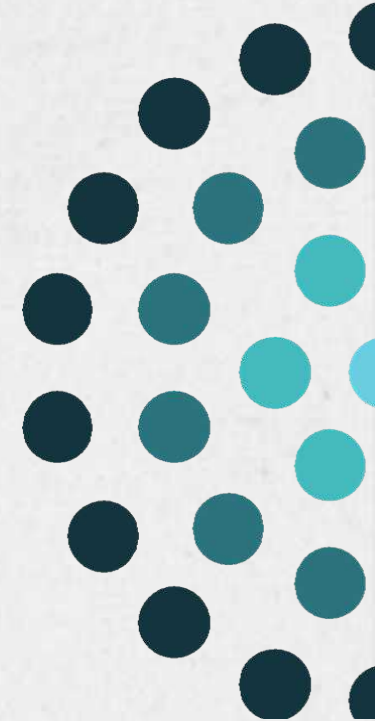
In the Open Science Orbit - Introduction to Open and Responsible Research

Workshop for experienced researchers

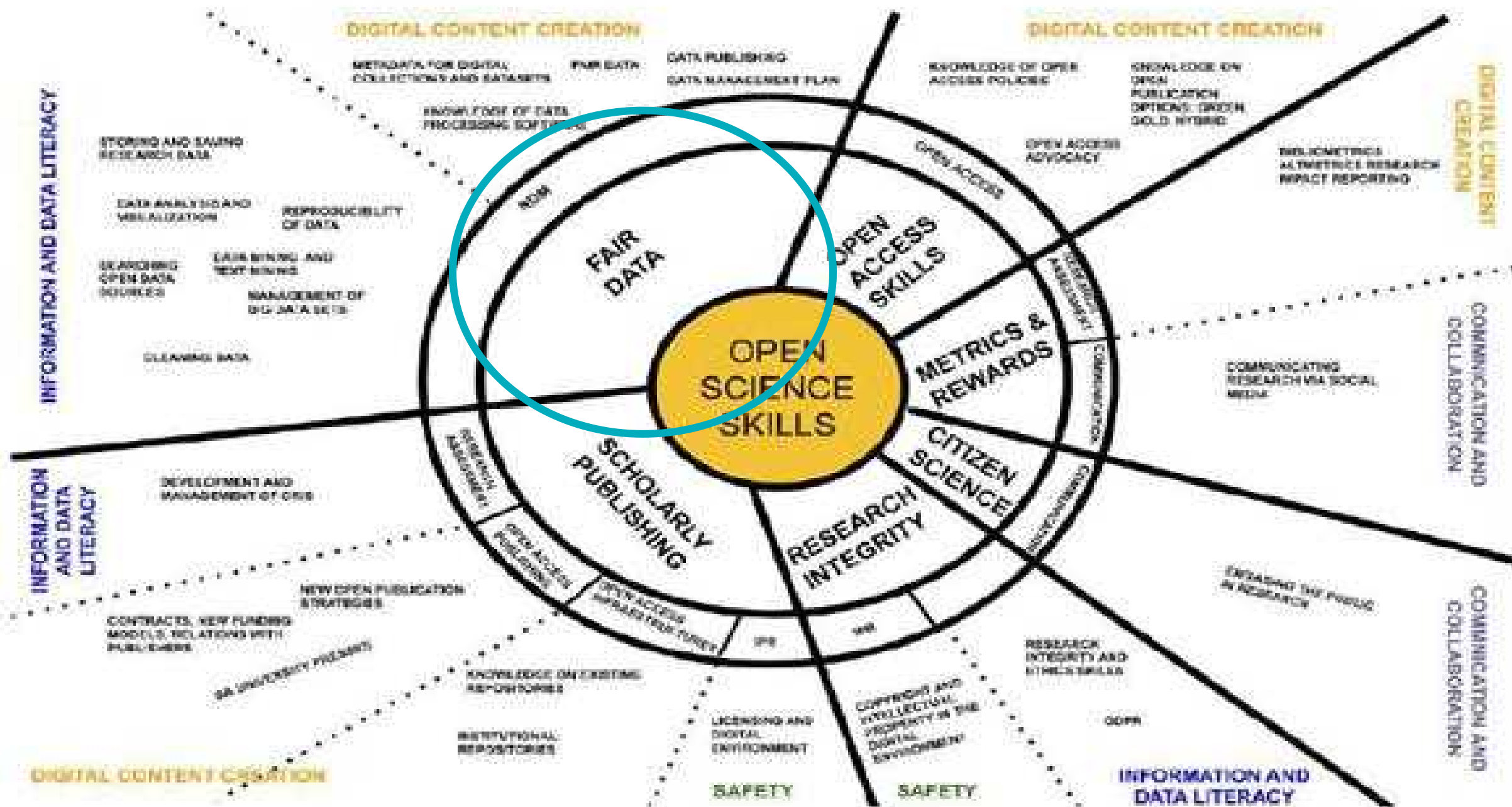
04 February 2025



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Universidad Carlos III de Madrid



A



Stakeholders

FAIR DATA

EOSC

FSP (Future of Scholarly Communication)

Next Generation metrics (new indicators)

Research Integrity

Education and Skills

Citizen science



Citizen Science & Public Engagement Organisations



Publishers



Universities & Research Performing Organisations



Scientific Societies & Academies



Research Funding Organisations



Research Libraries



Research & E-Infrastructures



Policy Making Organisations



Researchers

Open Science Challenges

Shifts in the data landscape in the last 10 years

- From big data → to really really BIG data
- From USBs to Cloud and HPC
- Government (EU) open data policies and platforms
- Increase in compute power
- **Data and software as a first-class research output**
- FAIR Data Principles in practice
- Journal data policies (but...)
- More standards, schemas
- Increased use and value in PIDs, vocabularies, ontologies,
- More data discovery portals (Google Dataset search)
- OpenAI and LLM in the Research landscape
- ... and so much more

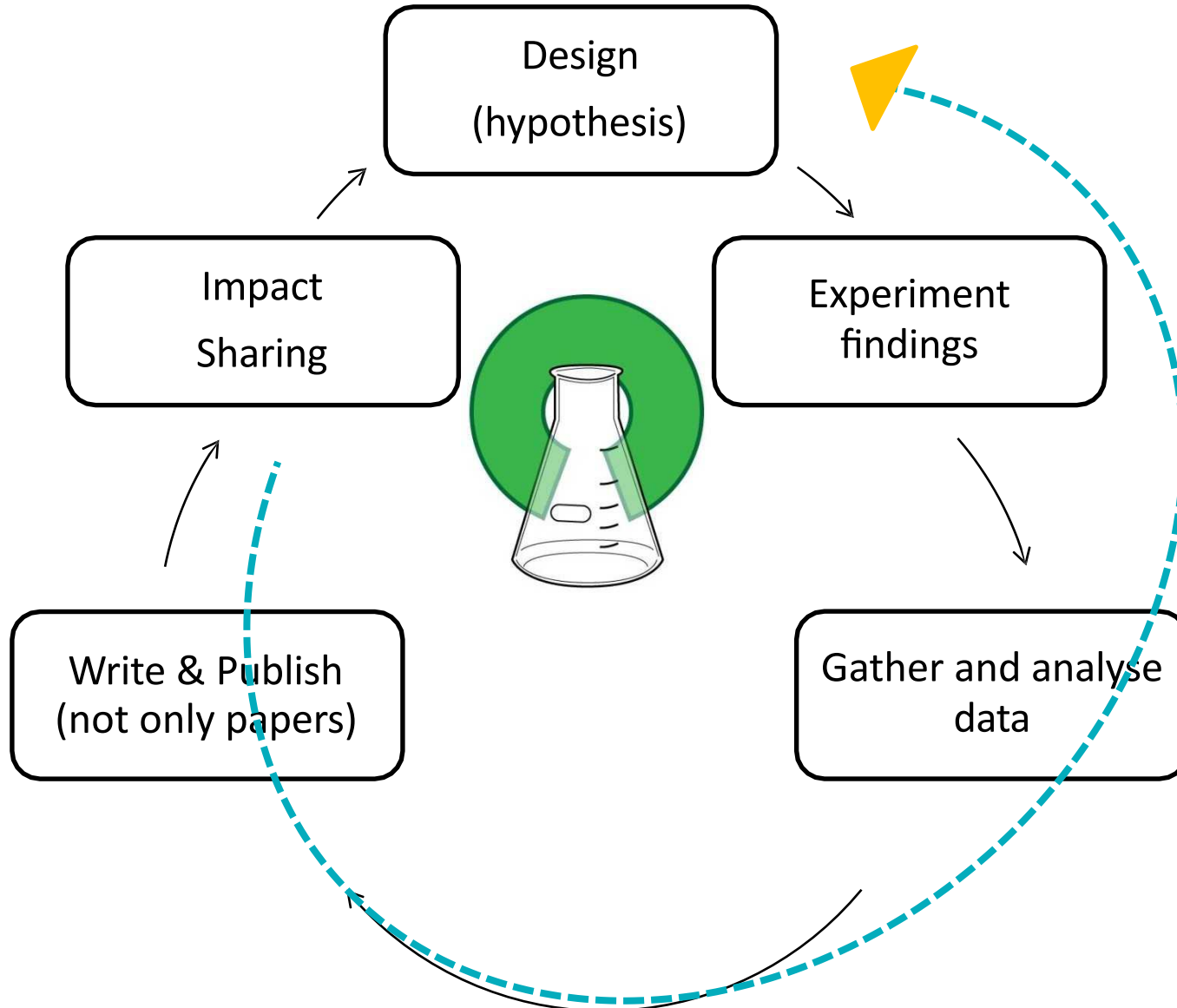




REINFORCING

Research life cycle

Based on: Open science image CC BY-SA 3.0 by Greg Emmerich
www.flickr.com/photos/gemmerich/6365692655



Change in the Research cycle

Open from the beginning

Papers + **Data**

+

Methods + Code...

Foster reproducibility

FAIR



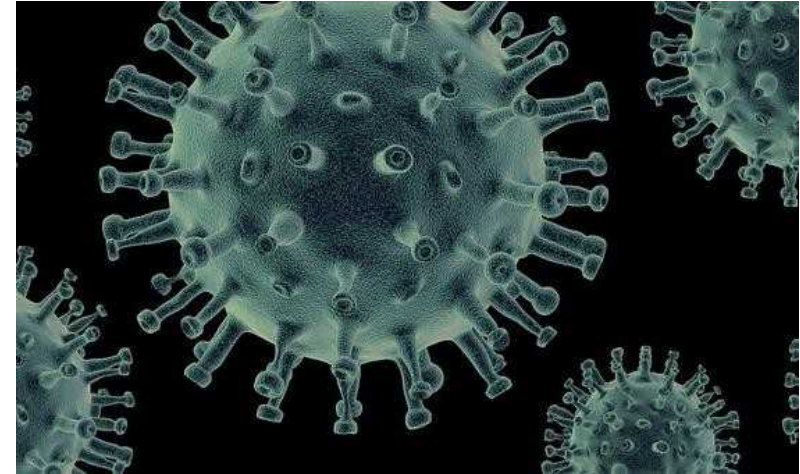
DATA in the new ORRI and RRA



- **Immediate** integration of research data in the research evaluation landscape
- Data as an **object** of research evaluation
- Good research outcomes (publications and data) include **good metadata**
- **(Meta) Data** as an input of curated research evaluation sources
- **FAIR** data as a proxy of good research data
- **AI** and ML to assist new research evaluation



*What kind of
research data
do you work
with?*

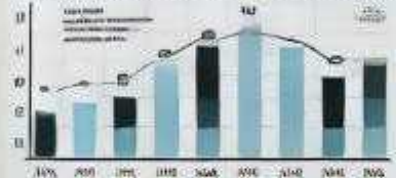


DIVERSITY OF RESEARCH DATA

QUANTITATIVE RESEARCH DATA



QUALITATIVE RESEARCH DATA



DIVERSITY OF RESEARCH CLASSIFICATION

CLASSIFICATION

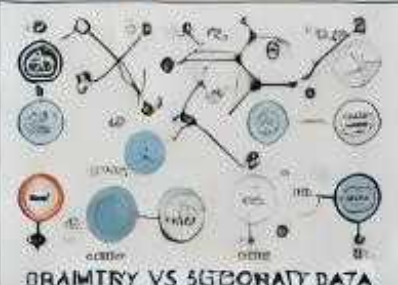
QUANTITATIVE

VS DATA

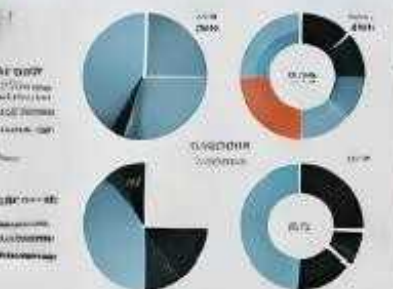
STRUCTURED QUANTITATIVE DATA



STRUCTURED QUANTITATIVE DATA



STRUCTURED VS QUANTITATIVE DATA



STRUCTURED VS UNSTRUCTURED

STRUCTURED VS SUPPORTED DATA

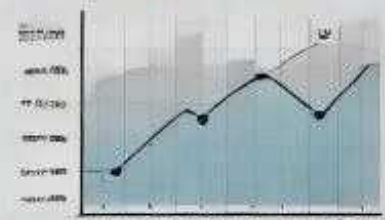


DIVERSITY OF RESEARCH DATA

DATA DATA



QUANTITATIVE DATA



PRIMARY VS SECONDARY DATA

DEFINITION



By Nature

- **Quantitative Data:** Numerical and measurable (e.g., statistics, experiments).
- **Qualitative Data:** Descriptive and narrative (e.g., interviews, field notes).

By Format

- **Structured Data:** Organized in predefined formats (e.g., databases, spreadsheets).
- **Unstructured Data:** Not organized in a systematic way (e.g., videos, images).

By Source

- **Primary Data:** Collected directly by researchers for specific studies.
- **Secondary Data:** Pre-existing data used for new research purposes.

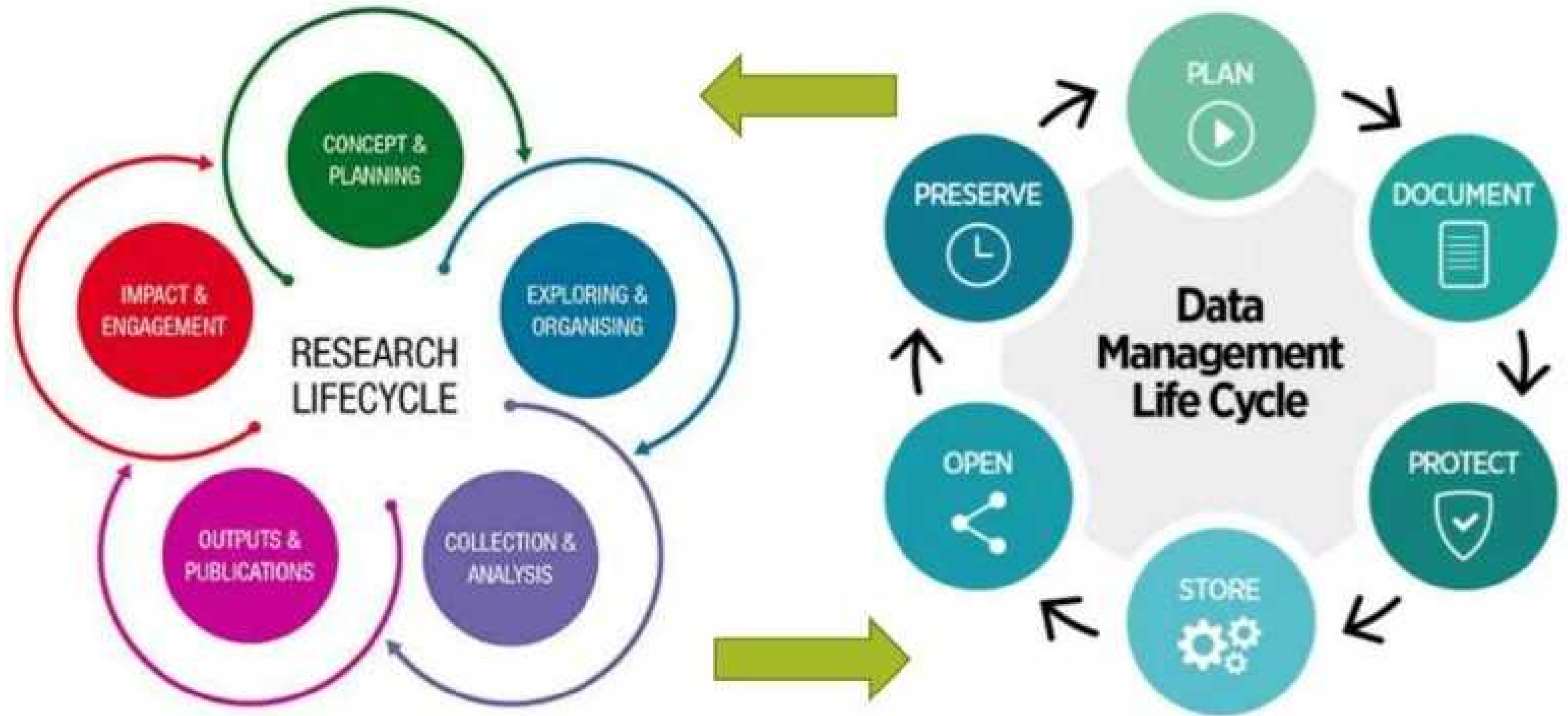
By Availability/Accessibility

- **Open Data:** Freely available for use and sharing.
- **Restricted Data:** Access limited due to privacy, security, or proprietary concerns.



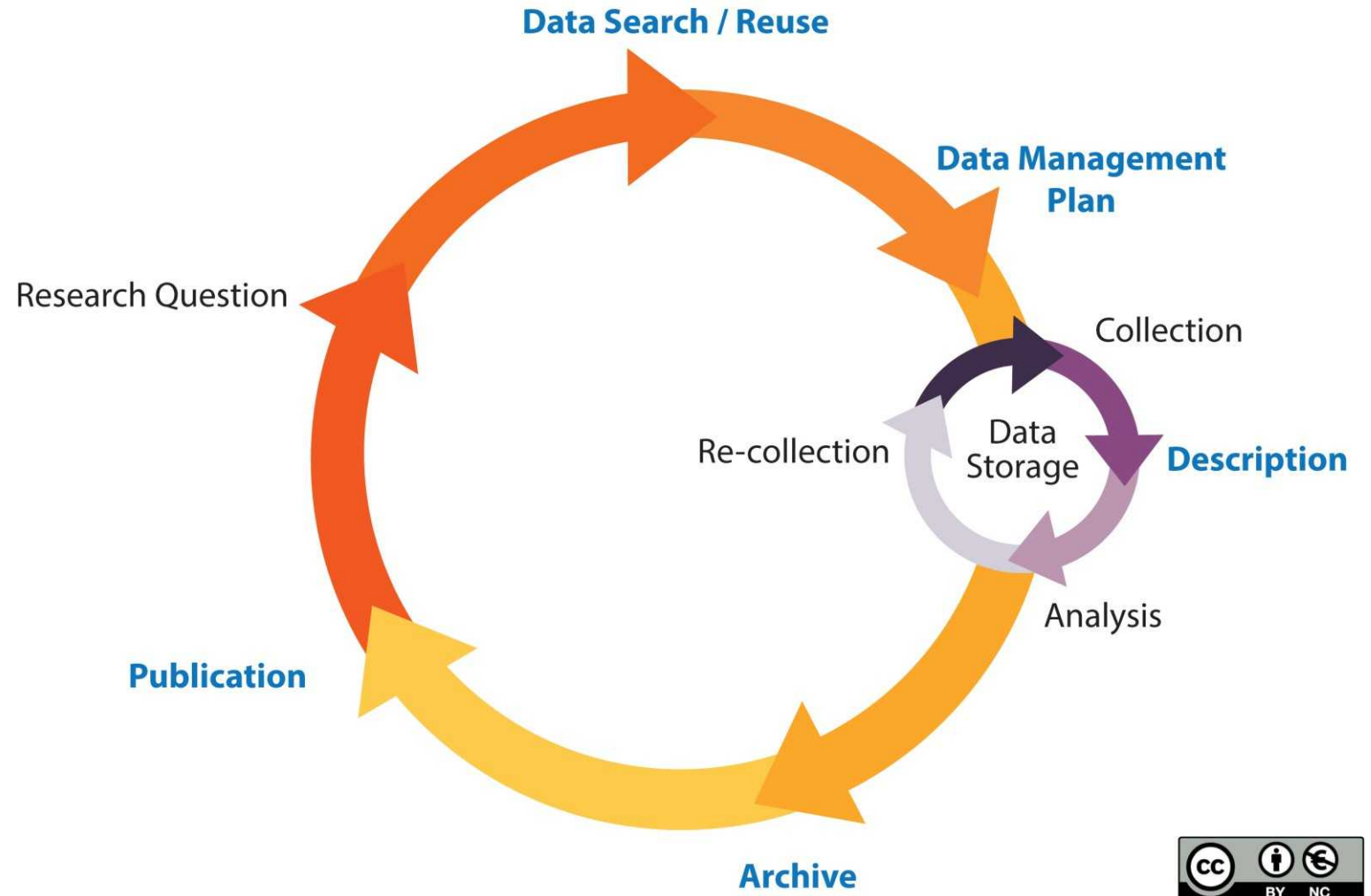
There are 4 types of research data:





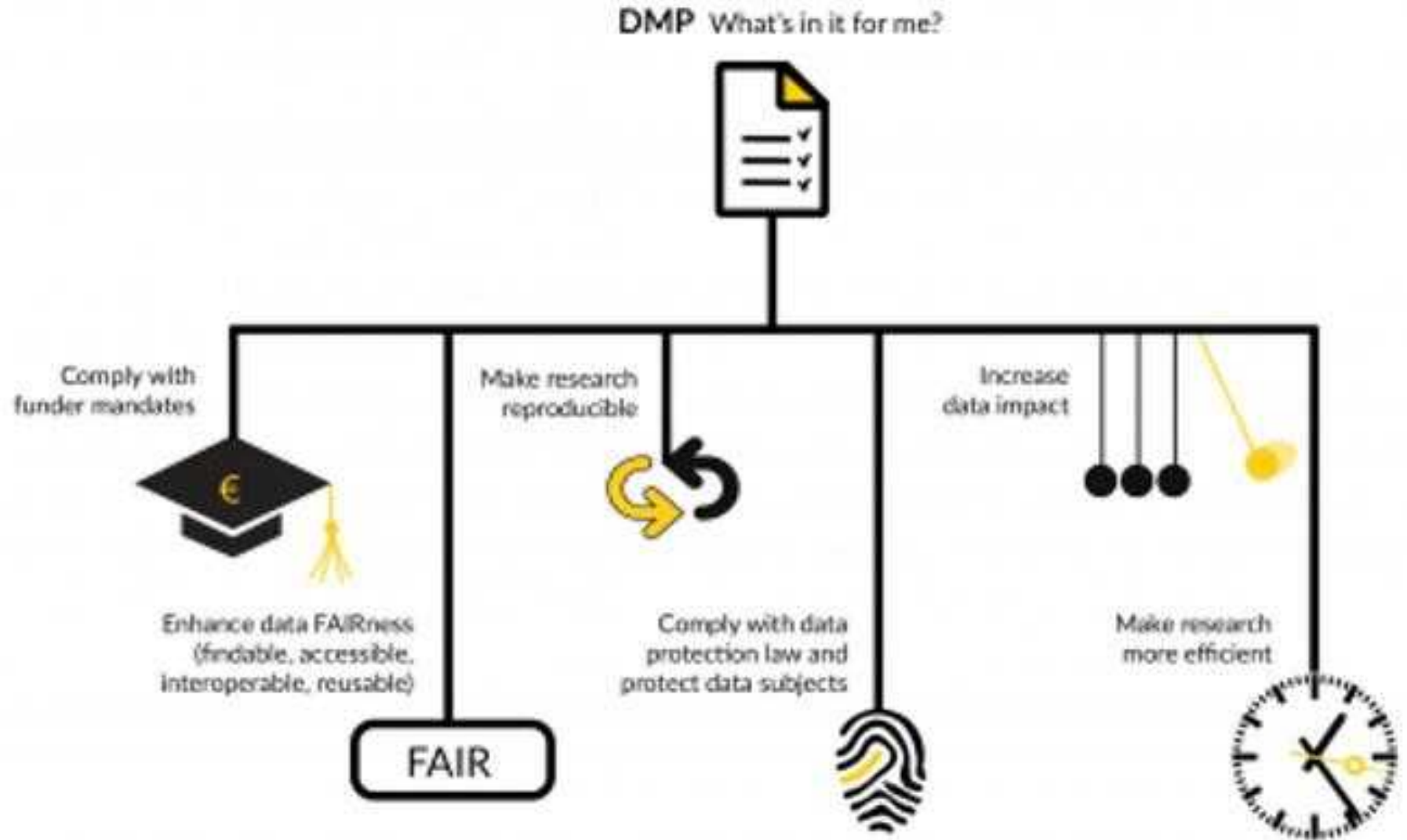
The Research Data Management Lifecycle

- structure
- documentation
- metadata
- storage
- backup
- long-term archive
- access
- publication



Why?

RDM DMPs FAIR



Open
data
is about
MORE
THAN
DISCLOSURE
it must be
Fair

- Findable
- Accessible
- Interoperable
- Reusable

Where?

Why?

Who?

How?



Findable

- F1. (Meta)data are assigned a globally unique and persistent identifier
- F2. Data are described with rich metadata (defined by R1 below)
- F3. Metadata clearly and explicitly include the identifier of the data they describe
- F4. (Meta)data are registered or indexed in a searchable resource

Accessible

- A1. (Meta)data are retrievable by their identifier using a standardised communications protocol
 - A1.1 The protocol is open, free, and universally implementable
 - A1.2 The protocol allows for an authentication and authorisation procedure
- A2. Metadata are accessible, even when the data are no longer available

Interoperable

- I1. (Meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation.
- I2. (Meta)data use vocabularies that follow FAIR principles
- I3. (Meta)data include qualified references to other (meta)data

Reusable

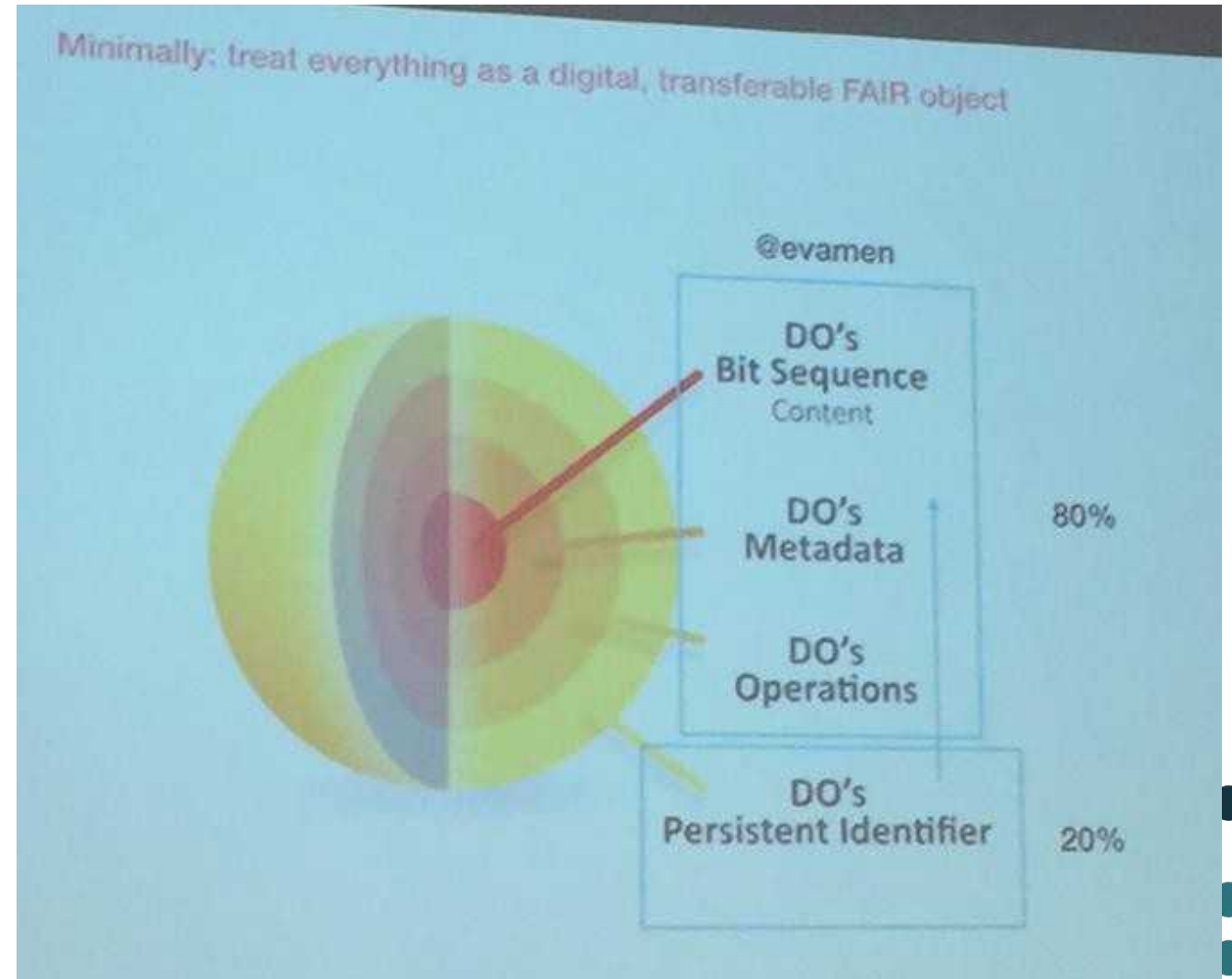
- R1. Meta(data) are richly described with a plurality of accurate and relevant attributes
 - R1.1. (Meta)data are released with a clear and accessible data usage license
 - R1.2. (Meta)data are associated with detailed provenance
 - R1.3. (Meta)data meet domain-relevant community standards



REINFORCING

FAIR Guiding Principles: all about metadata

80% metadata
20% PIDs





How FAIR are your data?

Findable

It should be possible for others to discover your data. Rich metadata should be available online in a searchable resource, and the data should be assigned a persistent identifier.

- ☐ A persistent identifier is assigned to your data
- ☐ There are rich metadata, describing your data
- ☐ The metadata are online in a searchable resource e.g. a catalogue or data repository
- ☐ The metadata record specifies the persistent identifier

Accessible

It should be possible for humans and machines to gain access to your data, under specific conditions or restrictions where appropriate. FAIR does not mean that data need to be open! There should be metadata, even if the data aren't accessible.

- ☐ Following the persistent ID will take you to the data or associated metadata
- ☐ The protocol by which data can be retrieved follows recognised standards e.g. http
- ☐ The access procedure includes authentication and authorisation steps, if necessary
- ☐ Metadata are accessible, wherever possible, even if the data aren't

Interoperable

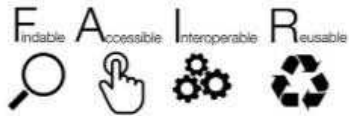
Data and metadata should conform to recognised formats and standards to allow them to be combined and exchanged.

- ☐ Data is provided in commonly understood and preferably open formats
- ☐ The metadata provided follows relevant standards
- ☐ Controlled vocabularies, keywords, thesauri or ontologies are used where possible
- ☐ Qualified references and links are provided to other related data

Reusable

Lots of documentation is needed to support data interpretation and reuse. The data should conform to community norms and be clearly licensed so others know what kinds of reuse are permitted.

- ☐ The data are accurate and well described with many relevant attributes
- ☐ The data have a clear and accessible data usage license
- ☐ It is clear how, why and by whom the data have been created and processed
- ☐ The data and metadata meet relevant domain standards



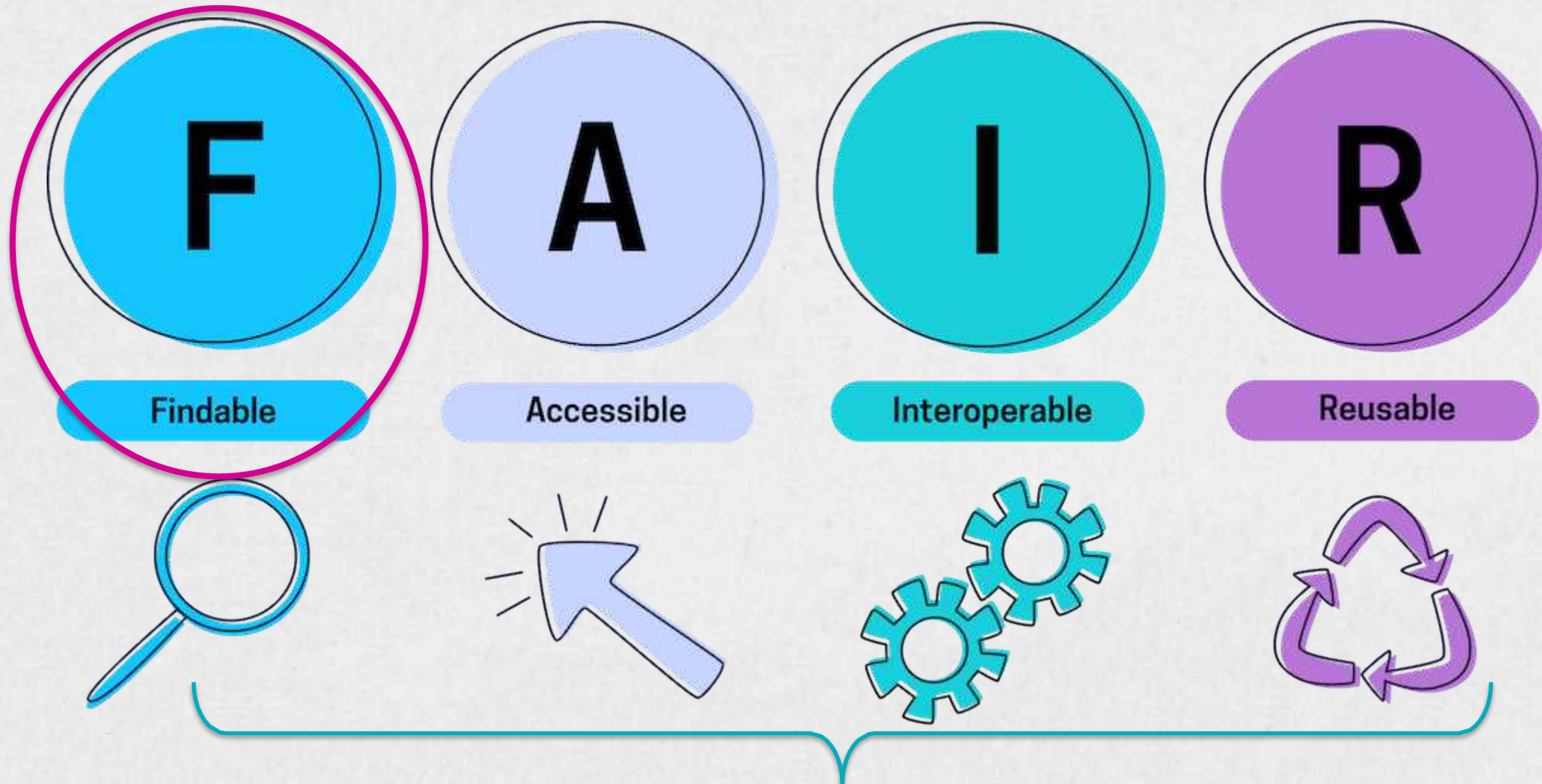
'How FAIR are your data?' checklist, CC-BY by Sarah Jones & Marjan Grootveld, [ELIUDAT](#), Image CC-BY-SA by [SangeetaPundir](#)

Metadata at the core of FAIR data

- Making data findable, including provisions for **metadata**
- What **metadata** will be created? In case **metadata standards** do not exist in your discipline, please outline what type of metadata will be created and how.
- Where will the data and associated **metadata**, ... be deposited?
- Interoperability of your data... What data and **metadata vocabularies**, standards or methodologies will you follow to make your data interoperable?
- The **Research Data Alliance** provides a **Metadata Standards Catalogue** that can be searched for discipline-specific standards and associated tools.



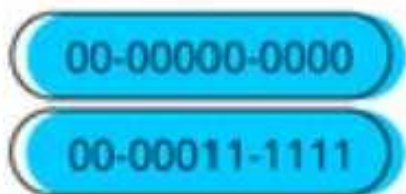
How to make your research data FAIR





Metadata and data should be **easy to find** for both humans and computers. Machine-readable metadata are essential for automatic discovery of datasets and services.

<https://www.go-fair.org/fair-principles>



Data has persistent identifiers



Rich metadata supports dataset



Metadata accurately describes dataset



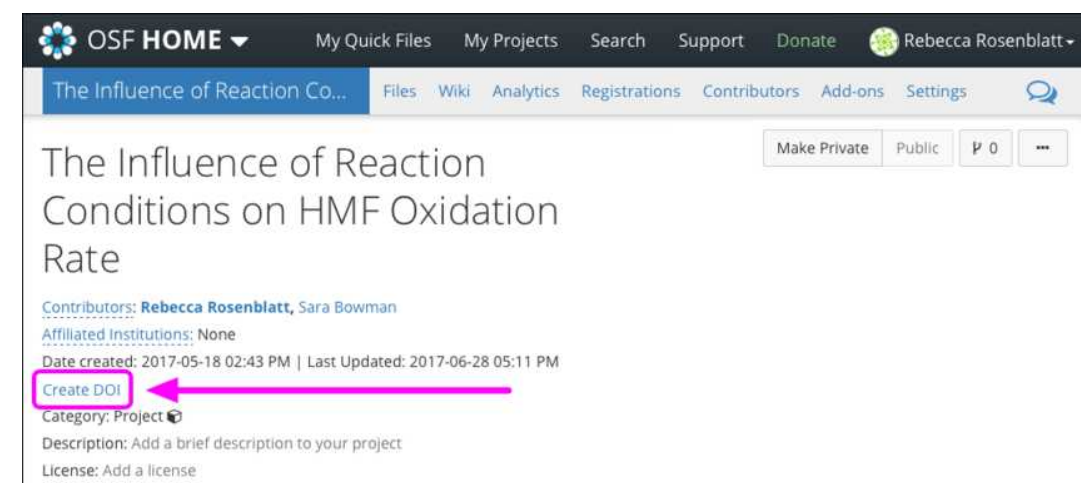
Metadata is indexed and searchable

Make your data



Assign to your data a PID
(DOI or any other persistent identifier)

- Data should have unique and persistent identifiers (DOI, Handle, ARK, etc.).
- Ex: DOI is a unique alphanumeric string assigned by the International DOI Foundation to identify content and provide a persistent link to its location on the Internet.



Make your data



Describe your data with
(rich) metadata

Variable encoding?

Who collected the data?

Data version?

Time of data collection?

Purpose of data collection?

Observation unit?



Dataset dimension?

Data processing?

Place of data collection?

License?





Make your data

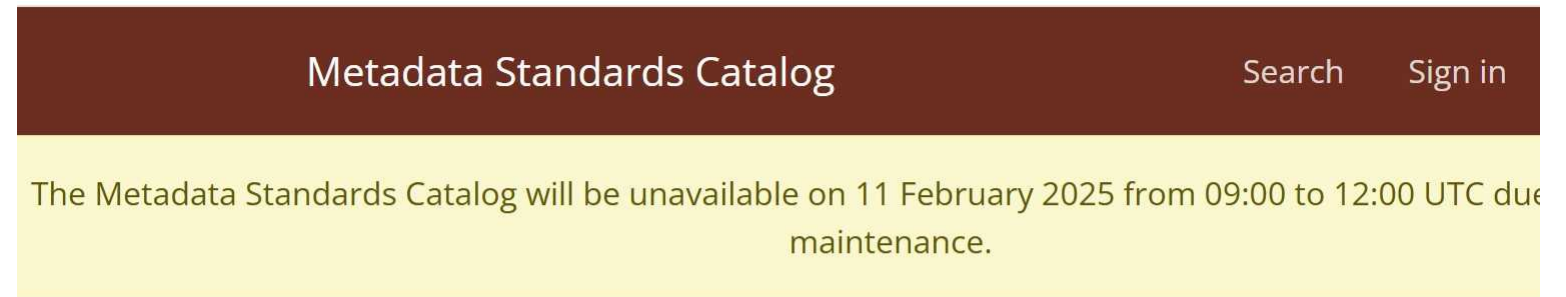


Describe your data with
(rich) metadata

Consider existing
metadata standards



<https://rdamsc.bath.ac.uk>



Metadata Standards Catalog

The RDA Metadata Standards Catalog is a collaborative, open directory of metadata standards applicable to research data. It is offered to the international academic community to help address infrastructure challenges.

[Read more details about the scope of the Catalog](#)

[Read our terms of use](#)

Make your data



Find a home for your data

- Domain Agnostic Repositories (Figshare, Zenodo)
- Domain specific repositories: many data repositories are specialized on a field of research



Life Sciences & Medicine



OpenNEURO

Neuroimaging

DATAHUB

Engineering



Archaeology

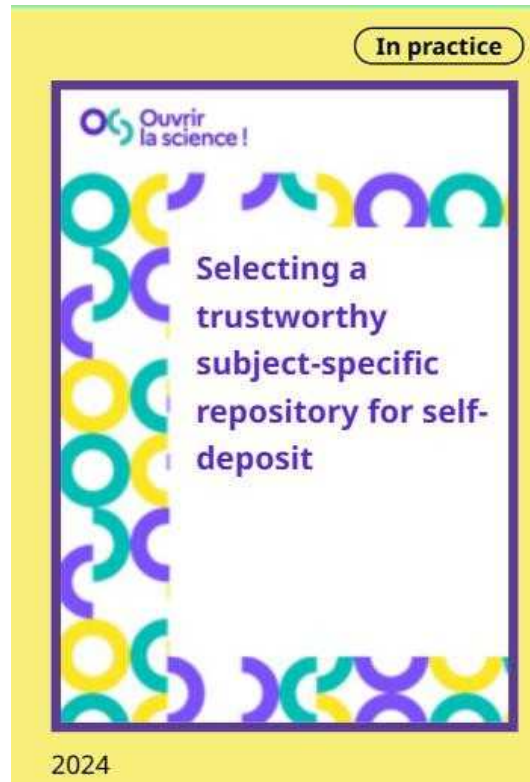
- Geographic region / university (ej. [eCienciaDatos](#) (Madrid))

Make your data



Find a home for your data

- Find **domain specific** repositories re3data.org



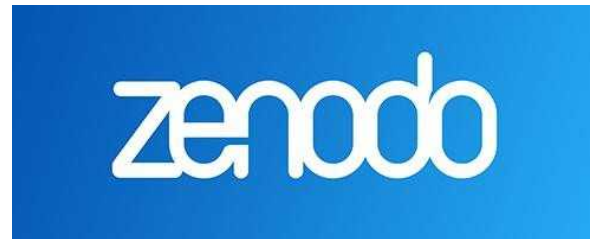
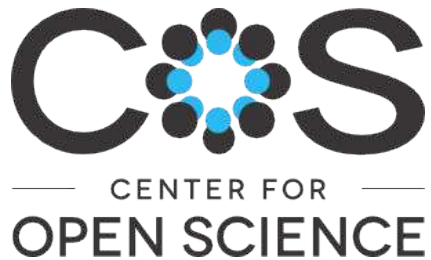
- Selecting a trustworthy subject-s
pecific repository (download the
report)*

Make your data



Find a home for your data

- What can you do if no specialized data repository exists for your research topic?



University data repositories



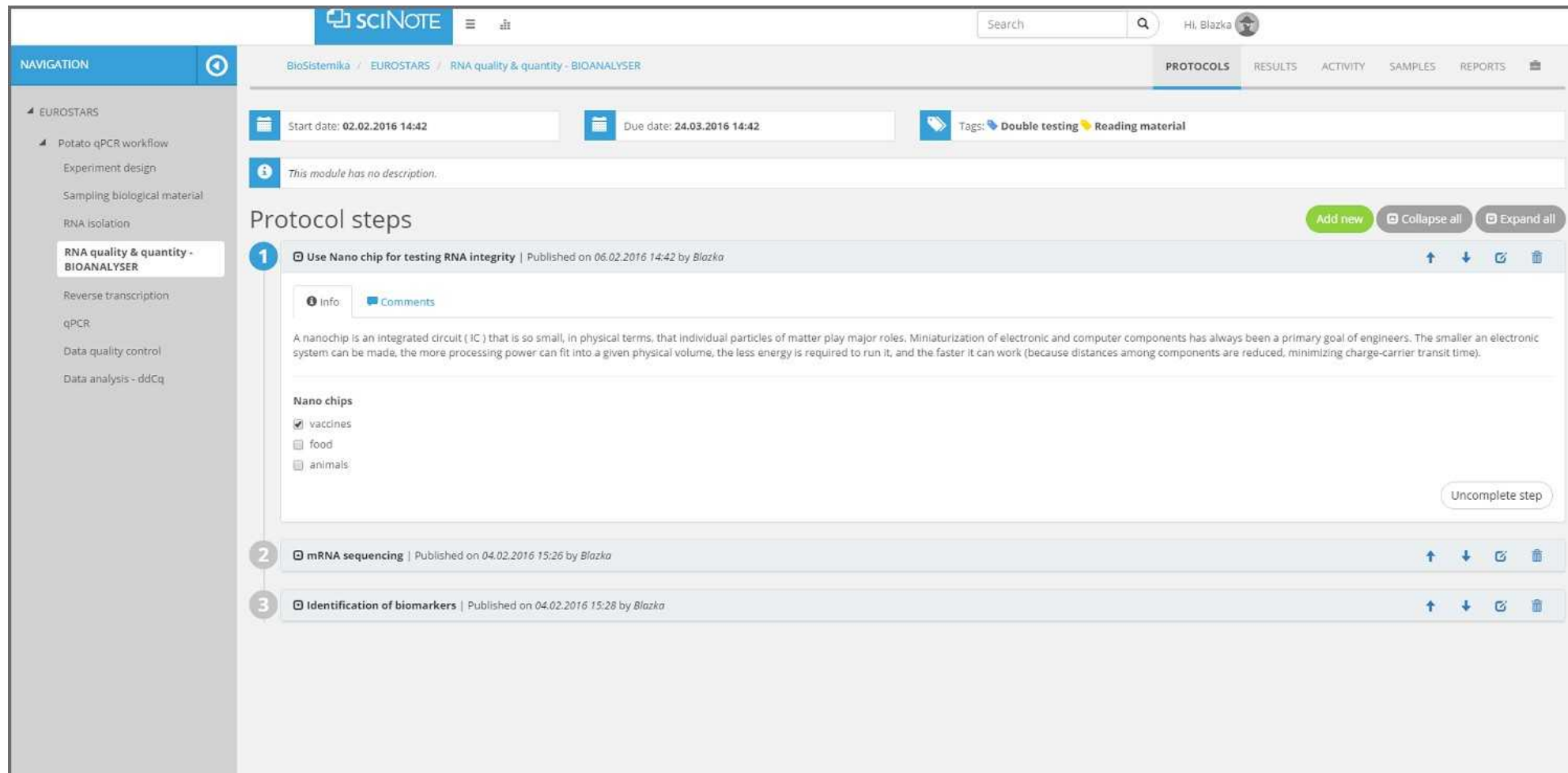
Generic data repositories



Make your data

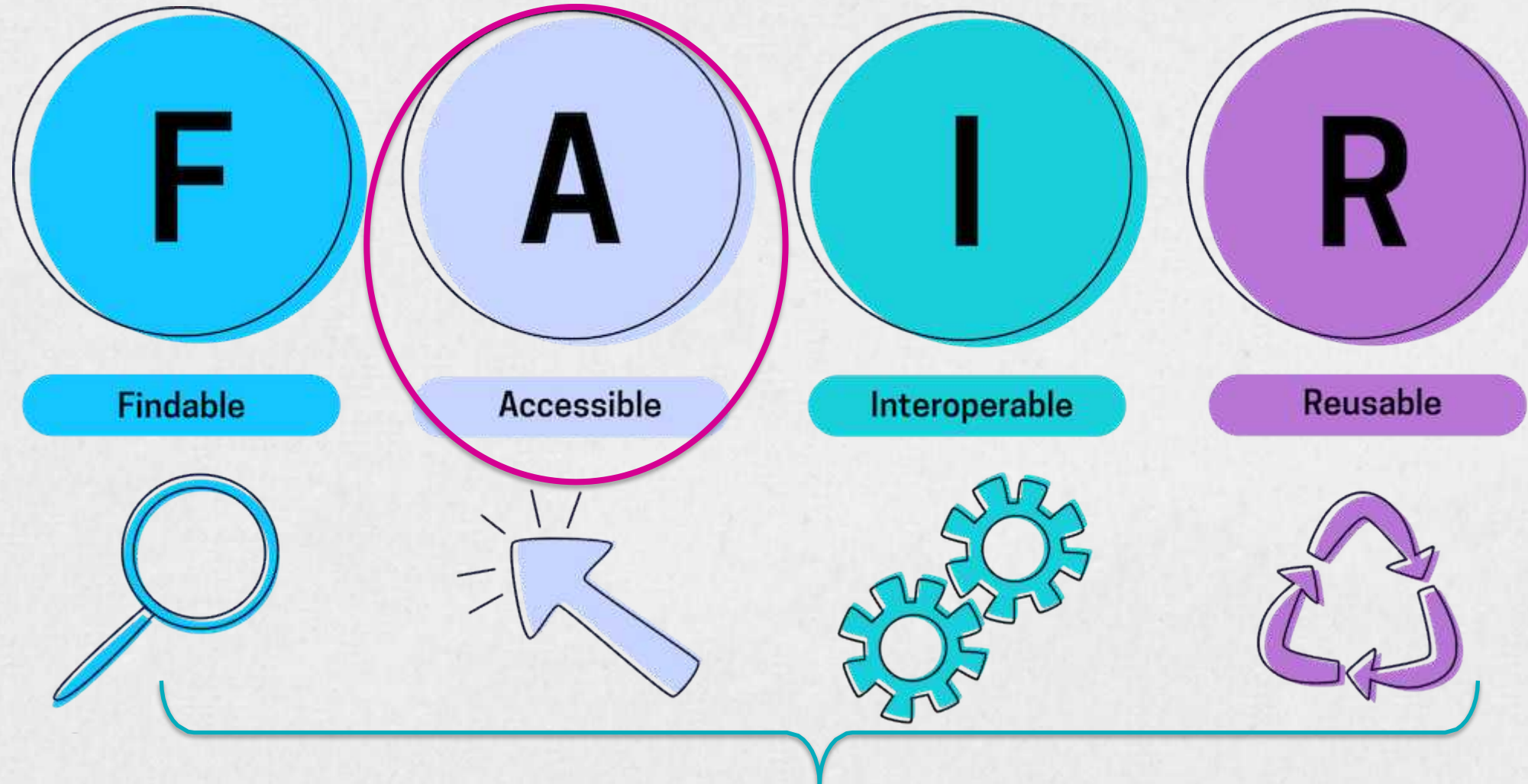


Use tools to improve the findability

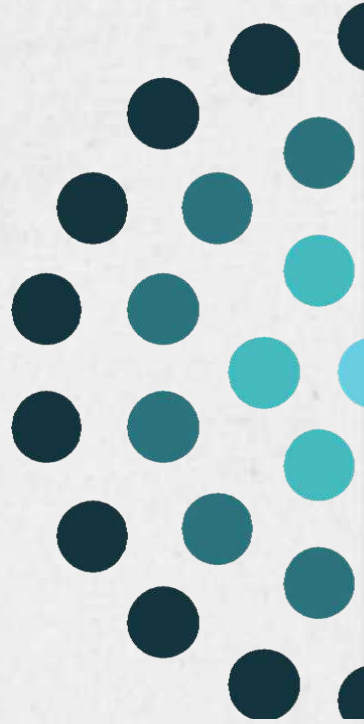


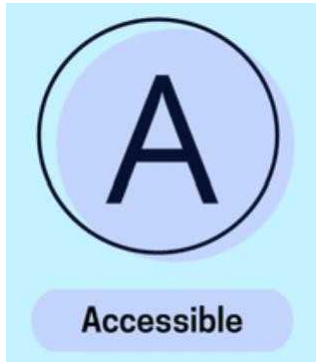
The screenshot displays the SciNote web application interface. The top navigation bar includes the SciNote logo, a search bar, and a user profile for 'Hi, Blazka'. The left sidebar shows a 'NAVIGATION' menu with categories like 'EUROSTARS', 'Potato qPCR workflow', and 'RNA quality & quantity - BIOANALYSER'. The main content area shows a protocol step titled '1 Use Nano chip for testing RNA integrity' published on 06.02.2016 14:42 by Blazka. The step includes a description of a nanochip, a list of tags (vaccines, food, animals), and a button to 'Uncomplete step'. The interface also shows a 'Protocol steps' section with a list of steps: 1. Use Nano chip for testing RNA integrity, 2. mRNA sequencing, and 3. Identification of biomarkers.

How to make your research data FAIR



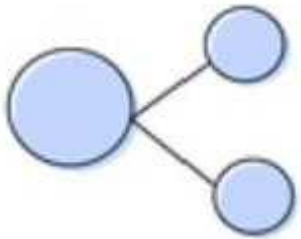
Good research data management





Once the user (researcher) finds the required data, she/he needs to know **how can they be accessed**, possibly including authentication and authorisation.

<https://www.go-fair.org/fair-principles>



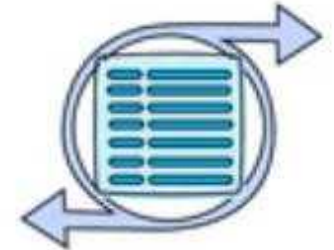
Data uses standard communication protocol



Protocol is open and free



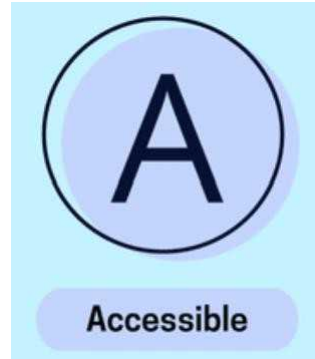
Data authentication and permissions can be set



Metadata is always available, even without dataset

Source: <https://flur.ee/fluree-blog/making-data-fairest>

Make your data



Always available/accessible

- **Data** should be **available to everyone** to access, use, and share → Taking care of the personal information (GDPR) and other sensible information (*as open as possible as closed as necessary*)



political opinion



national security



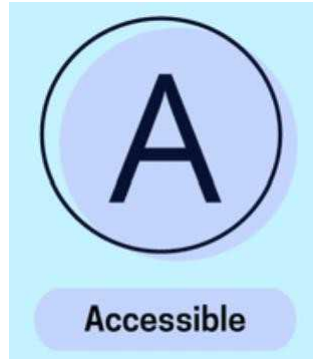
crimes



health



Make your data



Always available/accessible

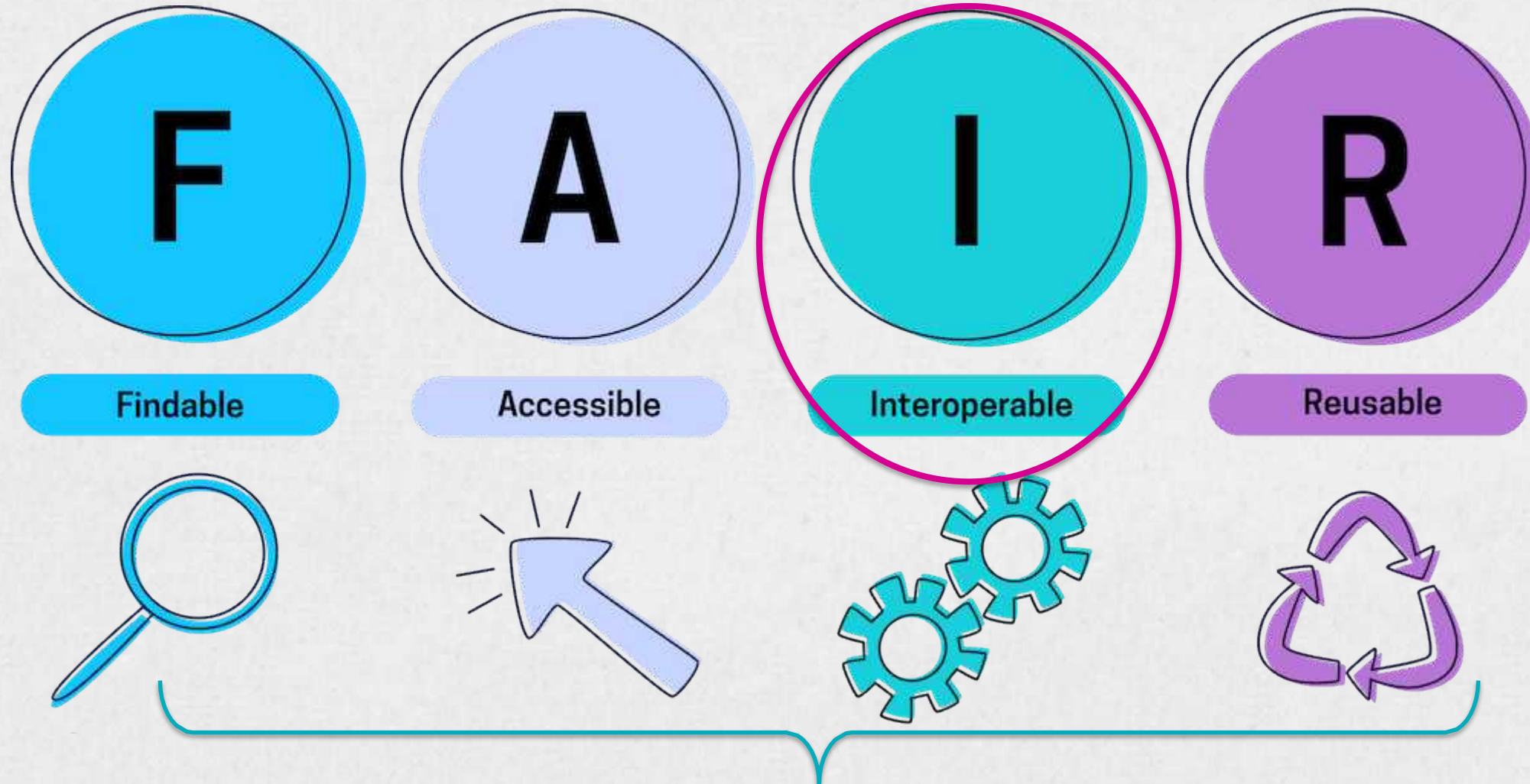
As open as possible as closed as necessary:

Options for sensitive data

- Anonimisation / Pseudo-anonimisation
- Are all your data sensitive? Maybe you can share some of them.
- Restrict the access to your data to a relevant group (e.g., to researchers) and be clear and transparent about why you restrict the access and how people can gain access.
- Publish only metadata.



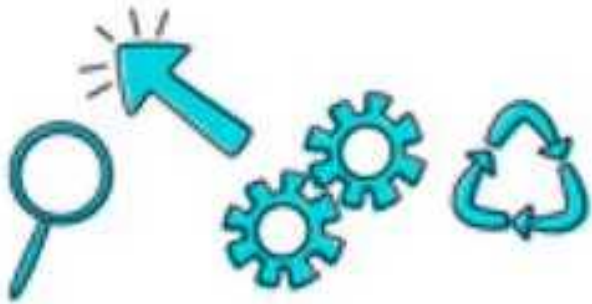
How to make your research data FAIR



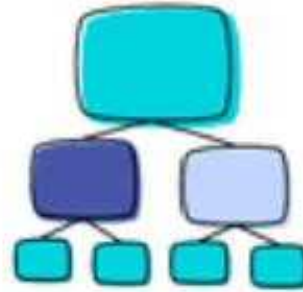


The data usually need to be **integrated with other data**. In addition, the data need to interoperate with applications or workflows for analysis, storage, and processing.

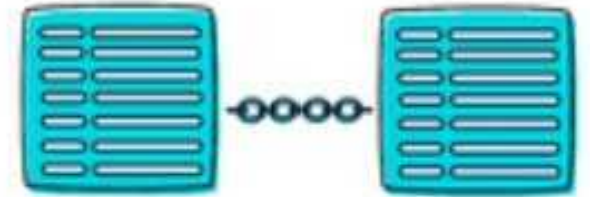
<https://www.go-fair.org/fair-principles>



**Datasets and metadata
are all FAIR**



**Data is easily exchanged
and interpreted via
standard vocabularies**



**Metadata is meaningfully
linked to other metadata**

Make your data



Use standards to encode data

Do not use data proprietary formats

Format / Software	Proprietary	Open
Text files	Word (.doc), Pages (.pages)	Open Office (.odt), .txt, LaTeX
Spreadsheets	Excel (.xls), Numbers (.numbers)	Open Office (.ods), .csv
Video	.avi, .wmv, .mov, .qtv, .rv	.mpg, .mp4
Audio	.wma, .asf, .ra, .wav	.mp3
Presentations	PowerPoint (.ppt), Keynote (.key)	PDF, HTML
Statistical Analyses	SPSS (.sav), Matlab (.m), SAS (.sas), Stata (.dta)	R, JASP (.jasp), Python
Experimental Software / Questionnaires	E-Prime, SurveyMonkey, UniPark	PsychoPy, Limesurvey, formr



Make your data



Use standards to encode metadata

Metadata

are like toothbrushes...



...Everyone thinks that it is a good idea, but nobody wants to use someone else's.



Make your data



Use vocabularies (Semantic Artefacts)

BARTOC.org Vocabularies Registries Software About Contact

<https://bartoc.org/vocabularies>

Vocabularies

Search Filter

Search

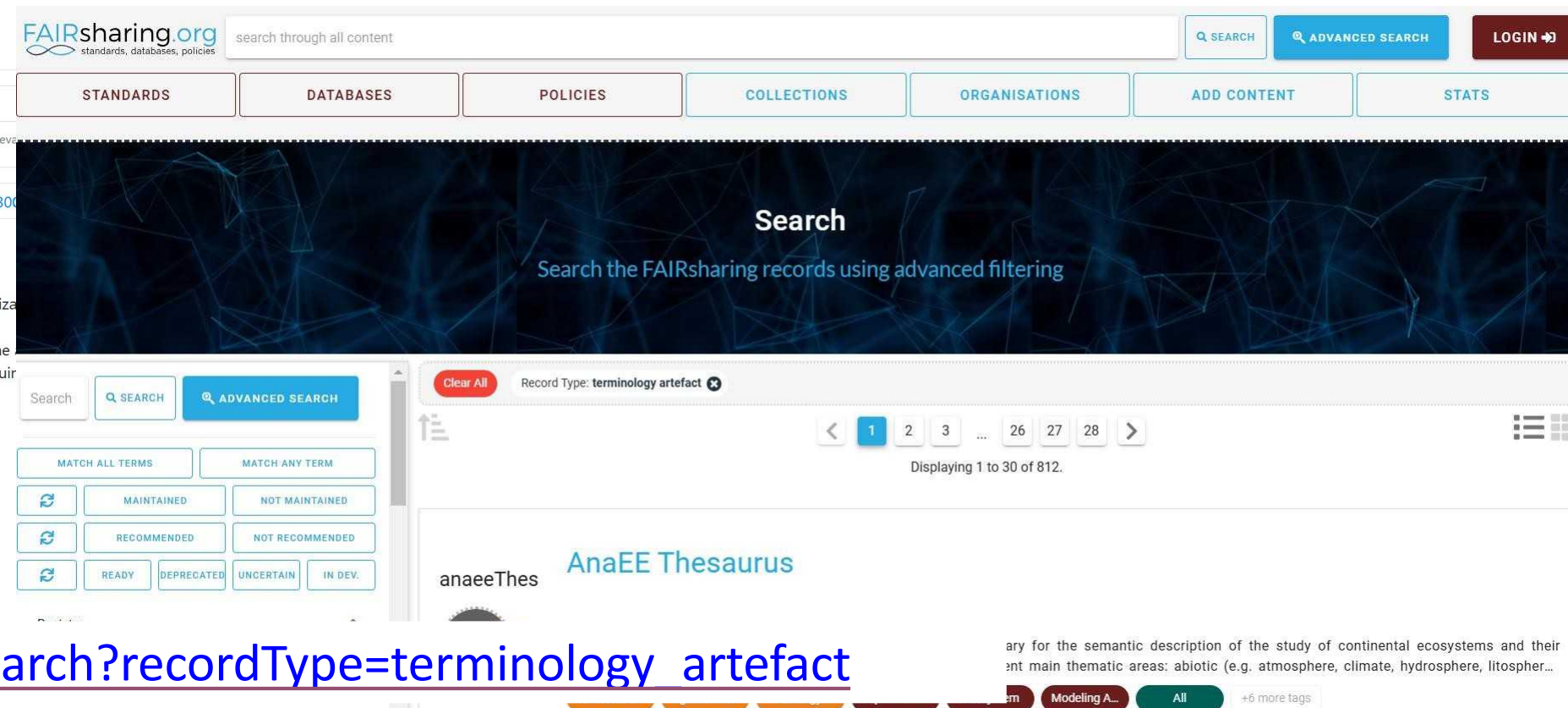
Full-text search across vocabulary description, ranked by relevance

1...500 501...1000 1001...1500 1501...2000 2001...2500 2501...3000

Name

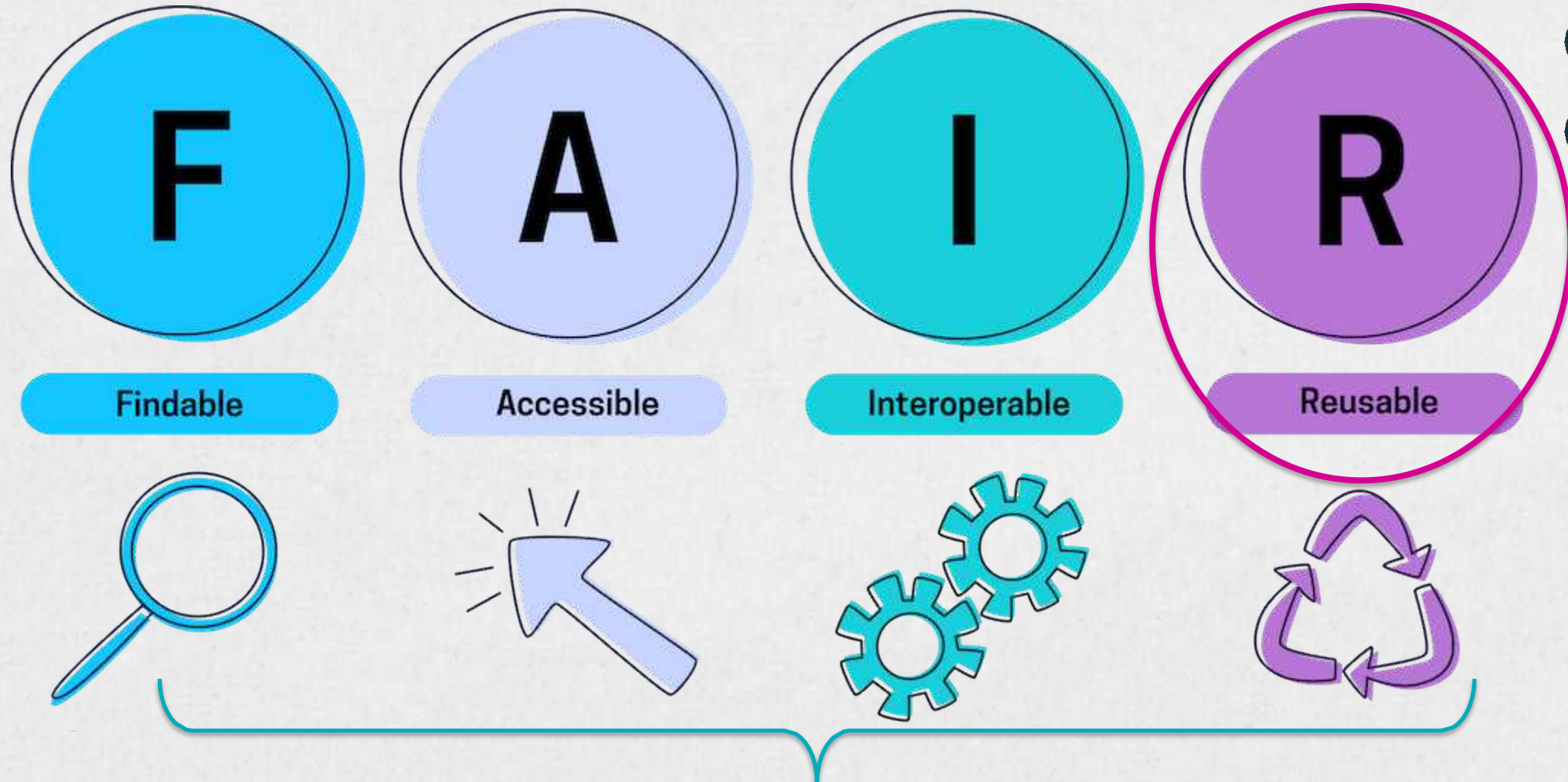
BARTOC data formats ([bartoc-formats](#)) Data formats for Knowledge Organization

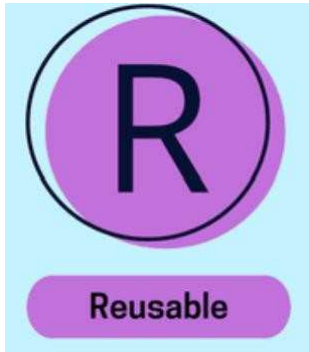
BARTOC access modes ([bartoc-access](#)) This vocabulary is used to specify the BARTOC.org: free (the vocabulary is freely available), registered (access requires



<https://fairsharing.org/search?recordType=terminology artefact>

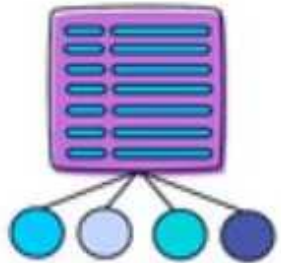
How to make your research data FAIR





The ultimate goal of FAIR is to **optimise the reuse of data**. To achieve this, metadata and data should be well-described so that they can **be replicated** and/or combined in different settings.

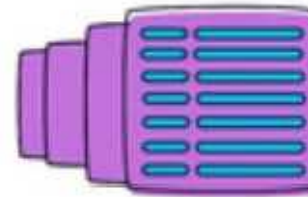
<https://www.go-fair.org/fair-principles>



Metadata is described using rich attributes



Metadata is available under an open-usage license



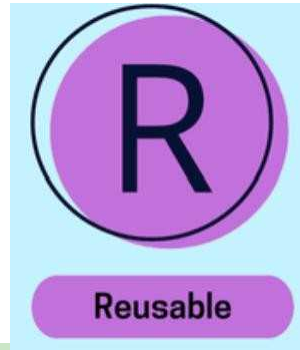
Historical provenance is associated with all data



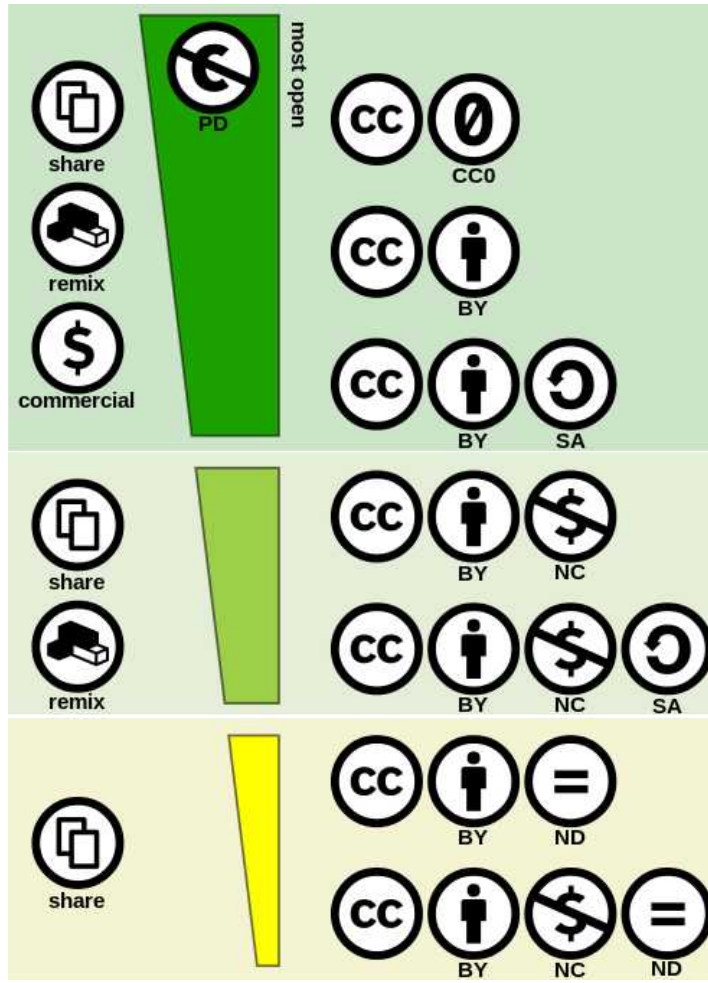
Data matches common community standards

Source: <https://flur.ee/fluree-blog/making-data-fairest>

Make your data



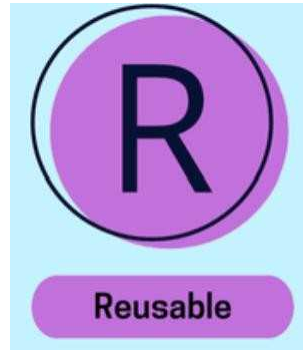
Choose and encode the right license



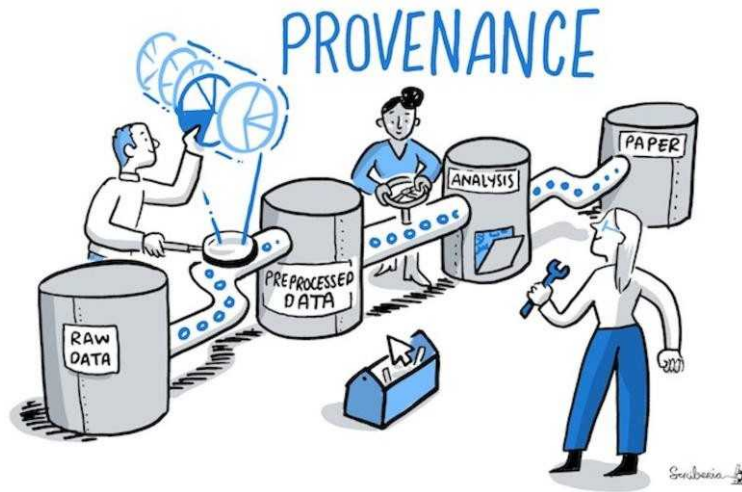
Regulate and describe clearly and appropriately, what others are allowed to do with the data



Make your data



Ensure data provenance and reproducibility



Always comment your code !!!

- Choose a coherent file / function naming system and coding style.
- Consider version control.
- Record the used packages and software.
- Write a README with details on the workflow if code fragments need to be combined.



FAIR data cost?



Cost of not having FAIR research data

Cost-Benefit analysis for FAIR research data

Written by PwC EU Services
March – 2018

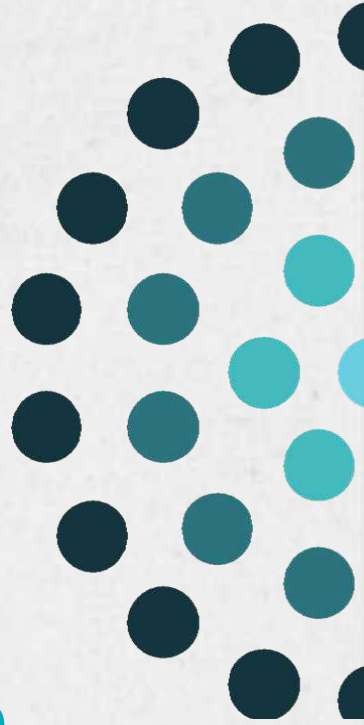
Research and
Innovation

How to make your RD FAIR, FAIR (EST), CARE...

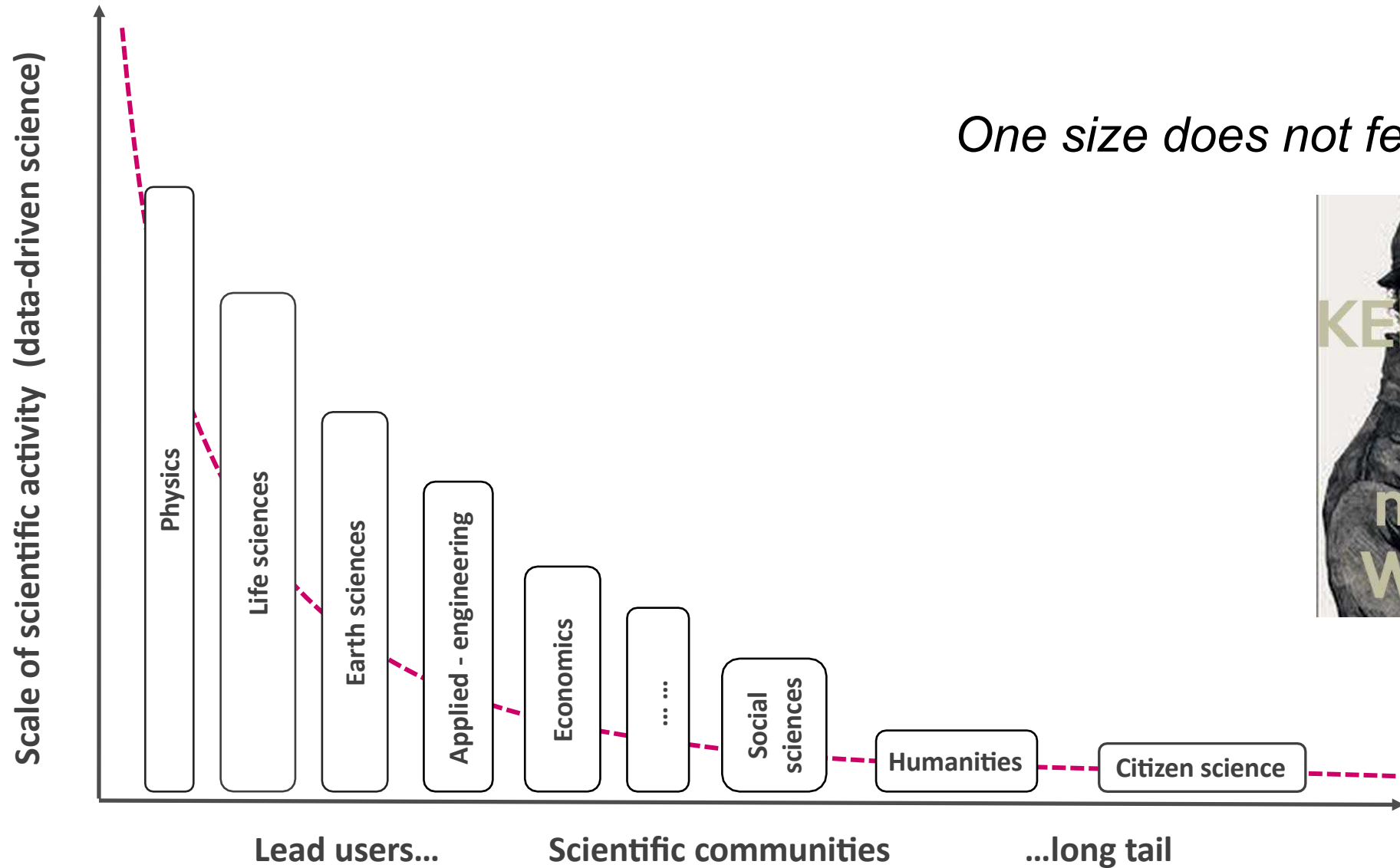


Better (research) data management

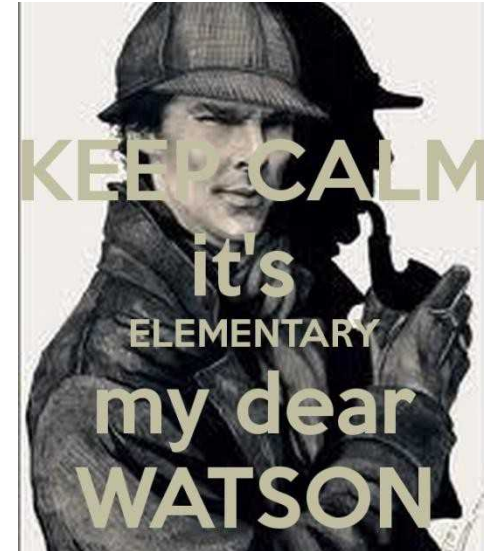
Research infrastructures for Open Science and FAIR DATA EOSC



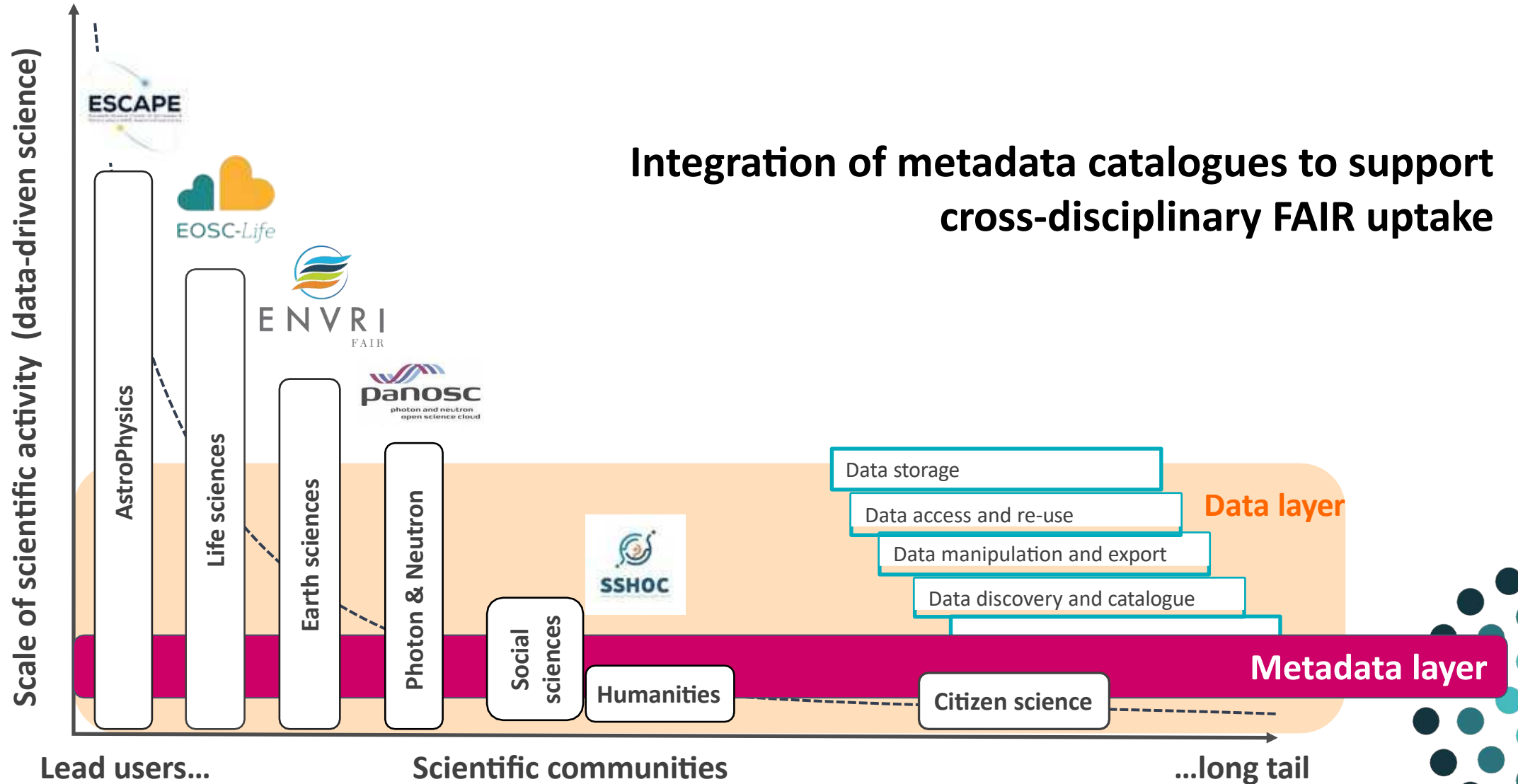
Scientific data landscape (EOSC)

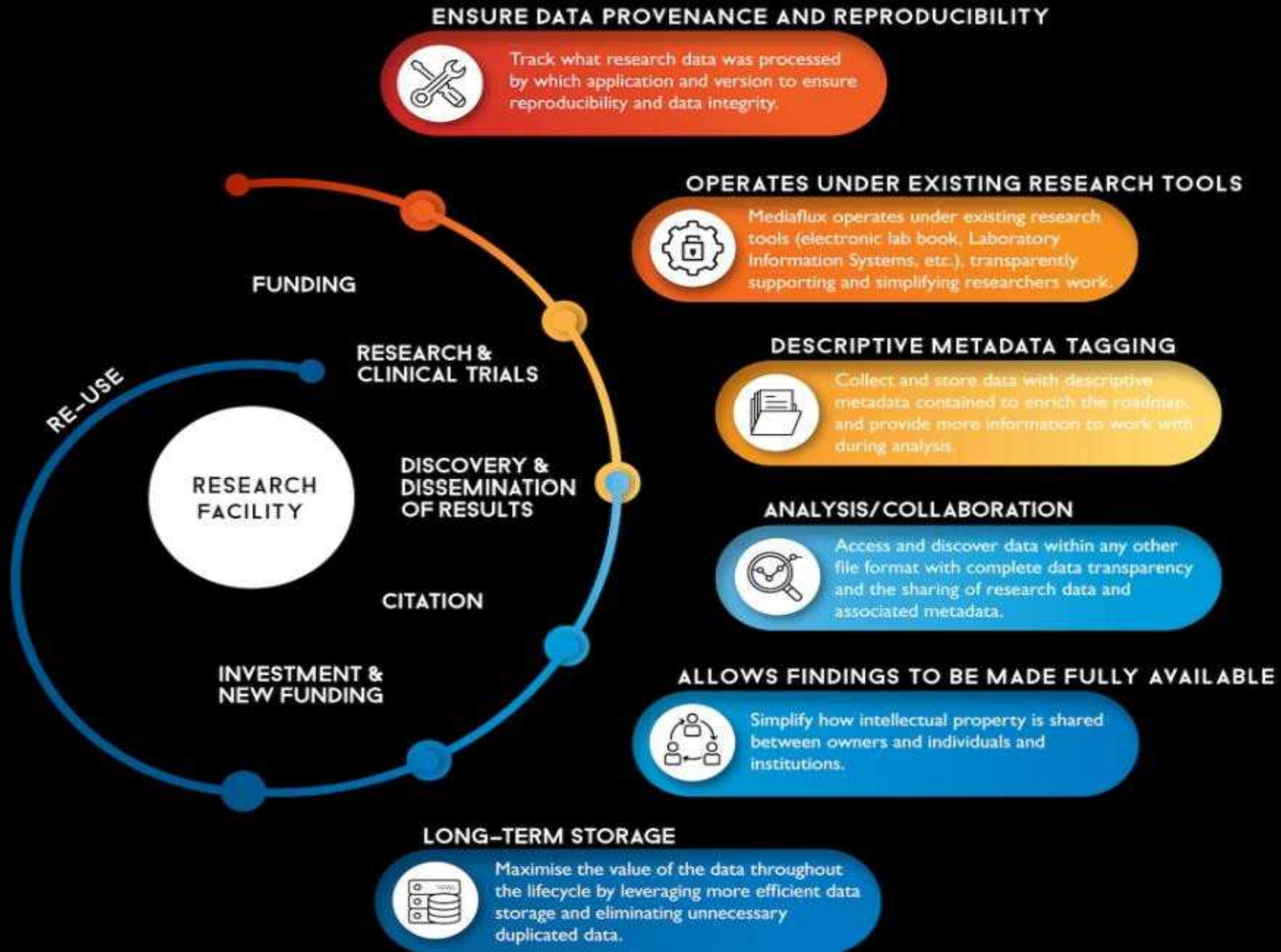


One size does not feet all!!!



EOSC and FAIR DATA





What

EOSC is the European web of FAIR data and related services for research
Research data that is easy to find, access, interoperate and reuse (FAIR)
Trusted and sustainable research outputs are available within and across scientific disciplines

Why

Unlock the full potential of research data to accelerate discoveries and innovation

How

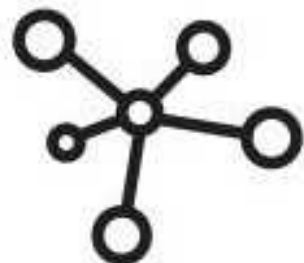
- Ensure that Open Science practices and skills are rewarded and taught, becoming the 'new normal'
- Enable the definition of standards, and the development of tools and services, to allow researchers to find, access, reuse and combine results
- Establish a sustainable and federated infrastructure enabling open sharing of scientific results



Strategic
Research and
Innovation
agenda (SRIA)
eosc.eu/sria-mar

eosc From vision to implementation: “the EOSC federation”

The EOSC vision is to set up a 'Web of FAIR Data and Services' for science in Europe. Central to this ambition is the deployment of a trusted, virtual, federation of existing infrastructures in Europe to store, share and reuse FAIR research outputs across borders and scientific disciplines also called the “EOSC Federation”.



- EOSC is **NOT** a new digital infrastructure
- The EOSC ambition is to **federate existing data, research and e- infrastructures** nodes to make them all **available to European researchers across borders and across disciplines** (distributed EOSC ‘system of systems’)
- In doing so, **the federation will be augmented with new additional services and tools** that will enable the EU web of FAIR data and related services (EOSC can be seen as a thin federation layer based on FAIR principles)
- The federation will provide **coordinated entry points primarily for researchers in Europe (the so called “nodes”)** to find and access FAIR data and interoperable services that address elements of the whole research cycle (from discovery and mining to storage, management, analysis, publication, and re-use)
- **The entry points for EU researchers will be via their traditional channels** (e.g. via the national, regional, pan-European or thematic infrastructure nodes they are currently using) **or via the EU EOSC node central instance** (for the researchers that do not have existing access channels in place)
- **EOSC rules of participation and access policies** will be developed for the users and providers of the federation

eosc Who is EOSC for?

EOSC aims to support all European researchers

How?

- **Enhancing scientific research** by providing access to a wealth of data and research outputs from various fields and institutions
- **Fostering innovation** by making it easier for researchers to share, collaborate and build on each other's work
- **Improving transparency and reproducibility** of research by making data and methods more open and accessible
- **Reducing data silos and duplication of efforts** by promoting data sharing and reuse
- **Facilitating interdisciplinary research and cross-sectoral collaboration** by making data and resources from different domains more easily available



Individual researchers will benefit from EOSC through their existing channels (e.g. universities, research institutes, research infrastructures, associations, science clusters, etc.) that will act as intermediaries.

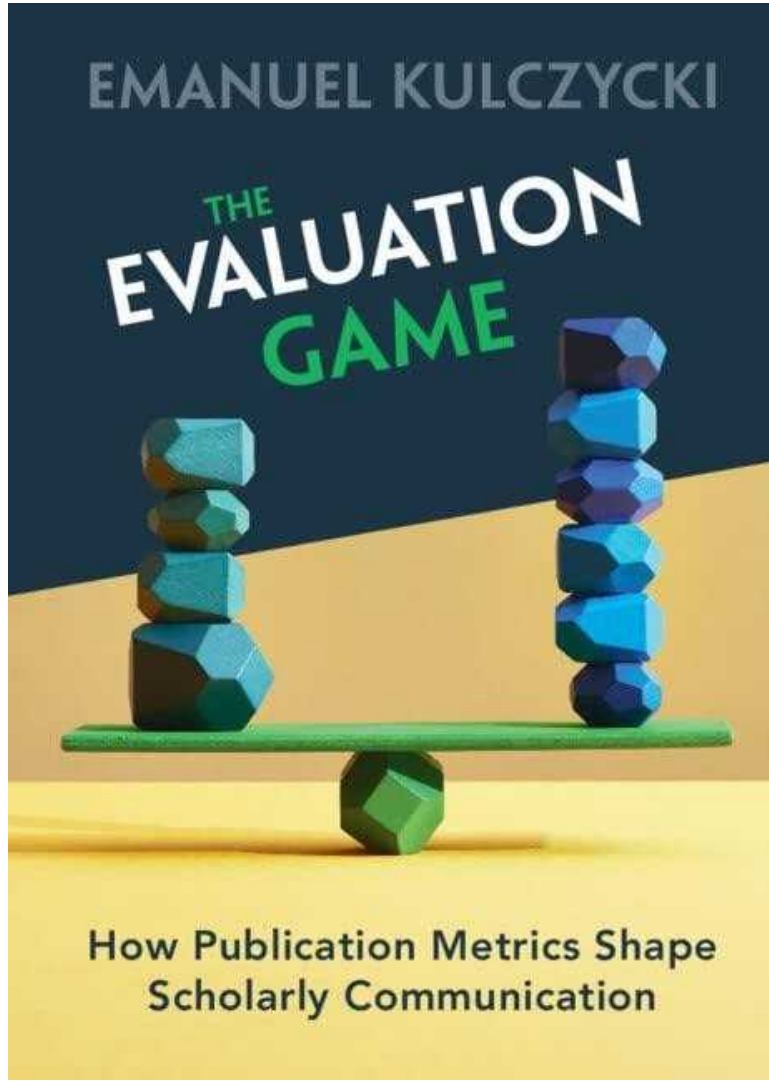
- **EOSC as Open Science (OS) & FAIR culture booster:** Working with policy makers and European initiatives (such as the CoARA coalition), EOSC will support the cultural change towards OS and FAIR principles in the EU countries and institutions.
 - All EU researchers will indirectly benefit from the cultural change brought by EOSC. The EOSC vision aims to have Open Science and FAIR practices fully encouraged, supported and recognised at institutional and national level.
- **EOSC as point of reference for building the new OS / FAIR related skills and career paths:** Working closely with universities and research institutes, EOSC will support the creation of the workforce of the future and of the necessary competence support centers.
 - All EU researchers will benefit from the training material, guidelines and support provided by EOSC.
- **EOSC as web of FAIR data and related services:** The EOSC federation will make available the resources of existing data, research and e-infrastructures across borders and disciplines
 - All the EU researchers will be able to access an extended offer in terms of FAIR data and related services.

**I want to recommend
you several resources on
Open Science for EARLY
CAREER RESEARCHERS**



- **1 Book**
- **1 MOOC**
- **1 Paper**
- **1 Passport (extended)**
- **1 Guide**
- **1 Website**
- **2 Communities**
- + **Several tools**





*The use of metrics and the focus on increasing productivity impacts the weakest persons in academia most severely, notably **young researchers** and researchers from peripheral countries* (Kulczycki, 2023)



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Open science challenges, benefits and tips in early career and beyond

Christopher Allen  , David M. A. Mehler  

Version 2

Published: May 1, 2019 • <https://doi.org/10.1371/journal.pbio.3000246>


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Authors


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Correction

Abstract

Introduction

 Correction

6 Dec 2019: Allen C, Mehler DMA (2019) Correction: Open science challenges, benefits


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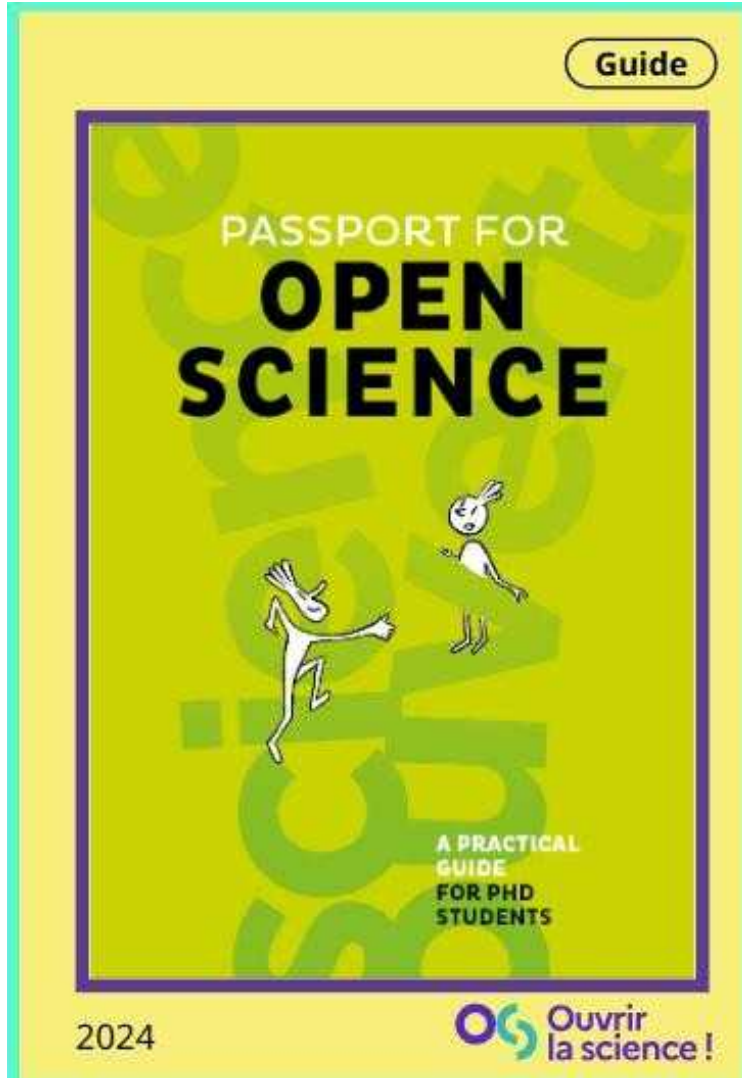
 Check for updates

Passport for Open Science (French OS policy 2020)

https://www.ouvrirlascience.fr/wp-content/uploads/2020/11/Passport-for-Open-Science-A-Practical-Guide-For-PhD-Students_30-10-2020_WEB.pdf



NEW EDITION IN 2024<https://www.ouvri.la.science.fr/passport-for-open-science-a-practical-guide-for-phd-students/>



NEW EDITION IN 2024

<https://www.ouvrirlascience.fr/passport-for-open-science-a-practical-guide-for-phd-students/>



Vidéos



► 00:05:08



**DATA MANAGEMENT AND THE
LIFE CYCLE OF RESEARCH DATA**

HEUSON Egon



► 00:04:04



**DISSEMINATION OF
SCIENTIFIC WORK IN OPEN
ACCESS**

HODENCQ Sacha



► 00:03:52



THE OPEN ACCESS THESIS

VANDEVELDE Ségolène

This video teaches you the steps



► 00:04:04



OPEN RESOURCES TO DISCOVER

This video allows you to discover how open science aims to facilitate access to scientific content and encourage its reuse.



► 00:03:14



WHAT IS OPEN SCIENCE ?

The Passport characters will help you discover how open science represents a different way of doing science, and of disseminating and evaluating research.

Collection of short videos for PhD students

Open Science

A Practical Guide for Early-Career Researchers



Universiteiten
van Nederland

DANS



<https://doi.org/10.5281/zenodo.7716153>

(Brinkman, et al. 2023)

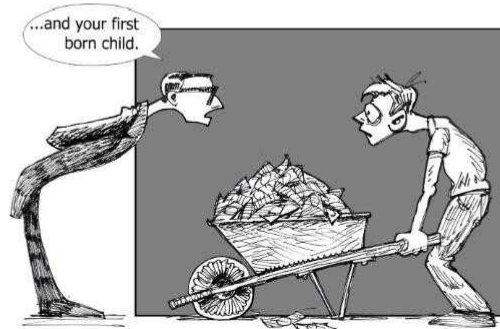
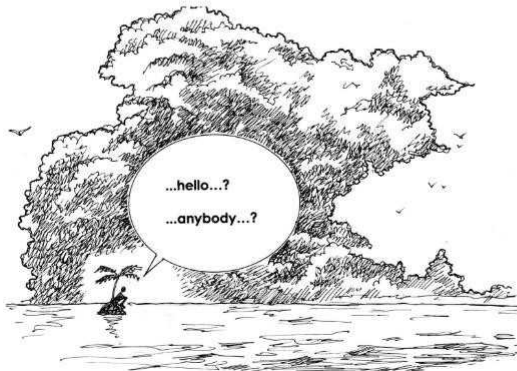
<http://whyopenresearch.org>

Why Open Research?

Advance your career by sharing your work.

Share your work. Be successful.


Open scholarship is good for the public and for you.



Community 1:



<https://www.rd-alliance.org/groups/early-career-and-engagement-ig>



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IG

Early Career and Engagement IG

 Taxonomy:


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Create Wiki index


Events


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Outputs


Charter


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Members

[create new content](#) 

Group Status:  **IG Established** **Join Group**

Please make sure the group follows the new [RDA Groups Policy](#), which came into effect on 1 April 2021. Please contact [enquiries\[at\]rd-alliance.org](mailto:enquiries[at]rd-alliance.org) if you have any questions.



Group details

Status: Recognised & Endorsed

Chair (s): Devan Ray Donaldson, Fotis Psomopoulos, Elli Papadopoulou, Maria Tsagiopoulou

Community 2:



CoARA

<https://coara.eu/working-groups/working-groups/wg-early-and-mid-career-researchers-emcrs-assessment-and-research-culture/>

WG Objectives

Working Group: Early- and-mid-Career Researchers (EMCRs) – Assessment and Research Culture

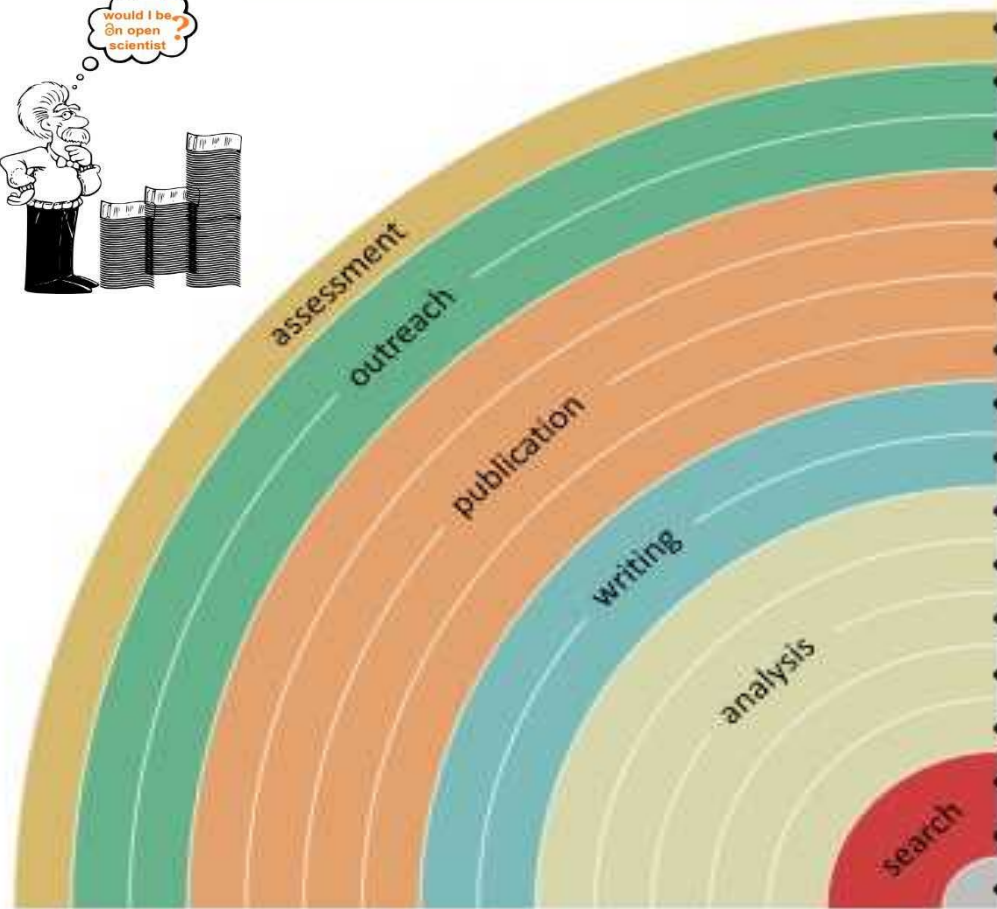
Objective 1: Gather information and exchange experiences, collect good and best practices – and bad practices to avoid – from a range of different countries and organisations with different levels of implementation of the reform of research assessment and diverse types of institutions as well as different institutional autonomy levels about the impacts of different assessment procedures/methods on EMCRs career paths and the cultures of research systems they are active in.

Objective 2: Develop pilot actions to:

- (i) monitor the outcomes and impacts,
- (ii) support EMCRs during the change through training and consultation,
- (iii) instruct assessors of careers towards novel research assessment practices, and
- (iv) implement an inclusive and positive culture (change)

Objective 3: Based on the gathered insights, develop guidelines, models and a toolbox for implementation, which will include monitoring templates, training recommendations, guidelines for EMCR assessment, and methodologies to drive an inclusive research culture change.

You can make your workflow more open by ...



- adding alternative evaluation, e.g. with altmetrics
- communicating through social media, e.g. Twitter
- sharing posters & presentations, e.g. at FigShare
- using open licenses, e.g. CC0 or CC-BY
- publishing open access, 'green' or 'gold'
- using open peer review, e.g. at journals or PubPeer
- sharing preprints, e.g. at OSF, arXiv or bioRxiv
- using actionable formats, e.g. with Jupyter or CoCalc
- open XML-drafting, e.g. at Overleaf or Authorea
- sharing protocols & workfl., e.g. at Protocols.io
- sharing notebooks, e.g. at OpenNotebookScience
- sharing code, e.g. at GitHub with GNU/MIT license
- sharing data, e.g. at Dryad, Zenodo or Dataverse
- pre-registering, e.g. at OSF or AsPredicted
- commenting openly, e.g. with Hypothes.is
- using shared reference libraries, e.g. with Zotero
- sharing (grant) proposals, e.g. at RIO



благодаря ви!



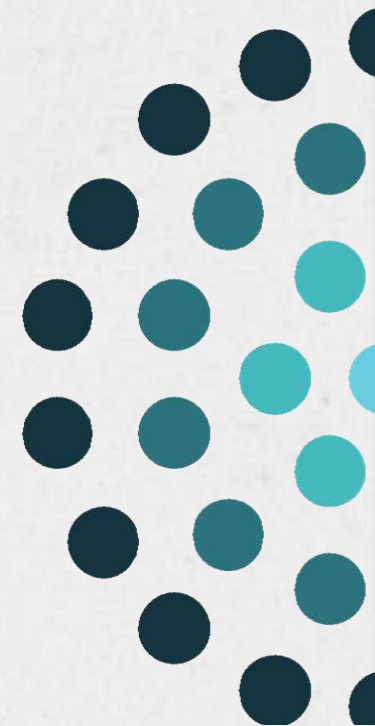
@evamen

Universidad Carlos III de Madrid

Member of the Steering Board of CoARA (2023-24)

Chair Open Science Policy Platform (2018-20)

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