# Open Science & FAIR

*Introduction to Data Management Practices course*

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https://nbisweden.github.io/module-open-science-dm-practices/index.html

# Open Science

Make scientific research and its dissemination accessible to all levels of society.

- Open methodology
- **Open source**
- **Open data**
- Open access
- Open peer review
- Open educational resources

# Reasons for Open Science

## What do you think are reasons for Open Data?

# Open Data

- Democracy and transparency
  - Publicly funded research data should be accessible to all
  - Published results and conclusions should be possible to check by others
- Research
  - Enables others to combine data, address new questions, and develop new analytical methods
  - Reduce duplication and waste
- Innovation and utilization outside research
  - Public authorities, companies, and private persons outside research can make use of the data
- Citation
  - Citation of data will be a merit for the researcher that produced it

# Ethical?

*Doing “sloppy” science & not being open and transparent*

Waste of resources

Contributing to the current research credibility crisis

Contributing to the current reproducibility crisis

*Harming the profession*

*Harming public trust in research*

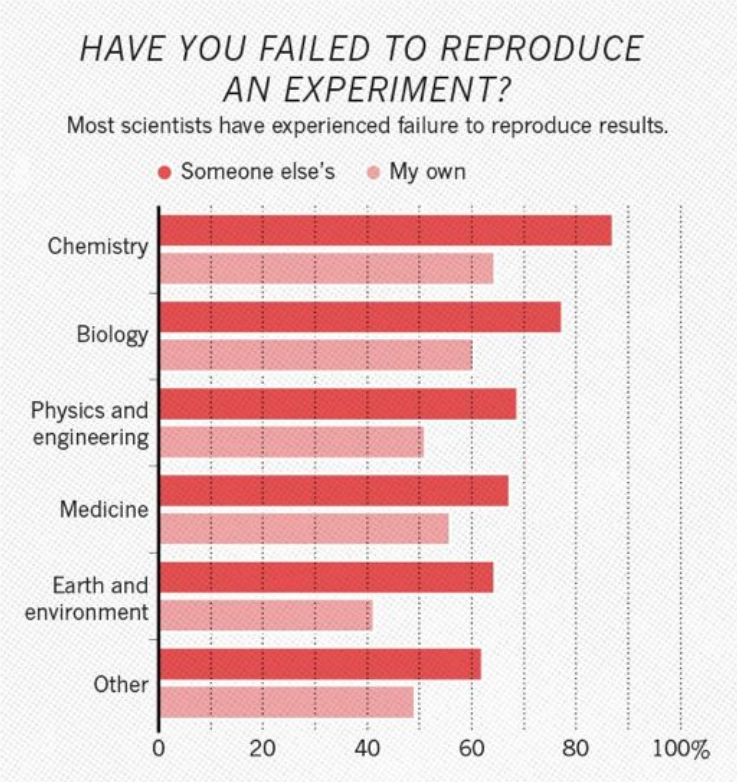
*My take of material by Rochelle Tractenberg “Unexpected Ethical Challenges in Bioinformatics and Genomics.”*

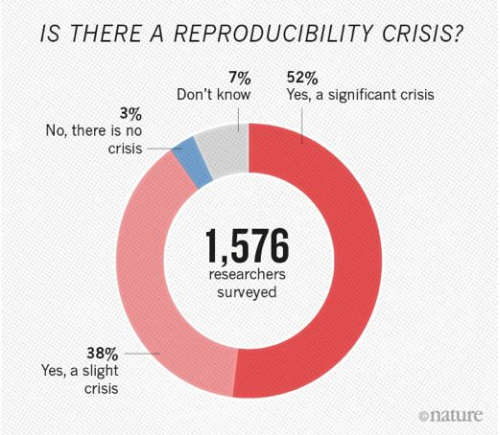
# Crisis?

**Do you think we have a credibility and/or reproducibility crisis?**

**If so, what are some of its causes?**

# A reproducibility crisis

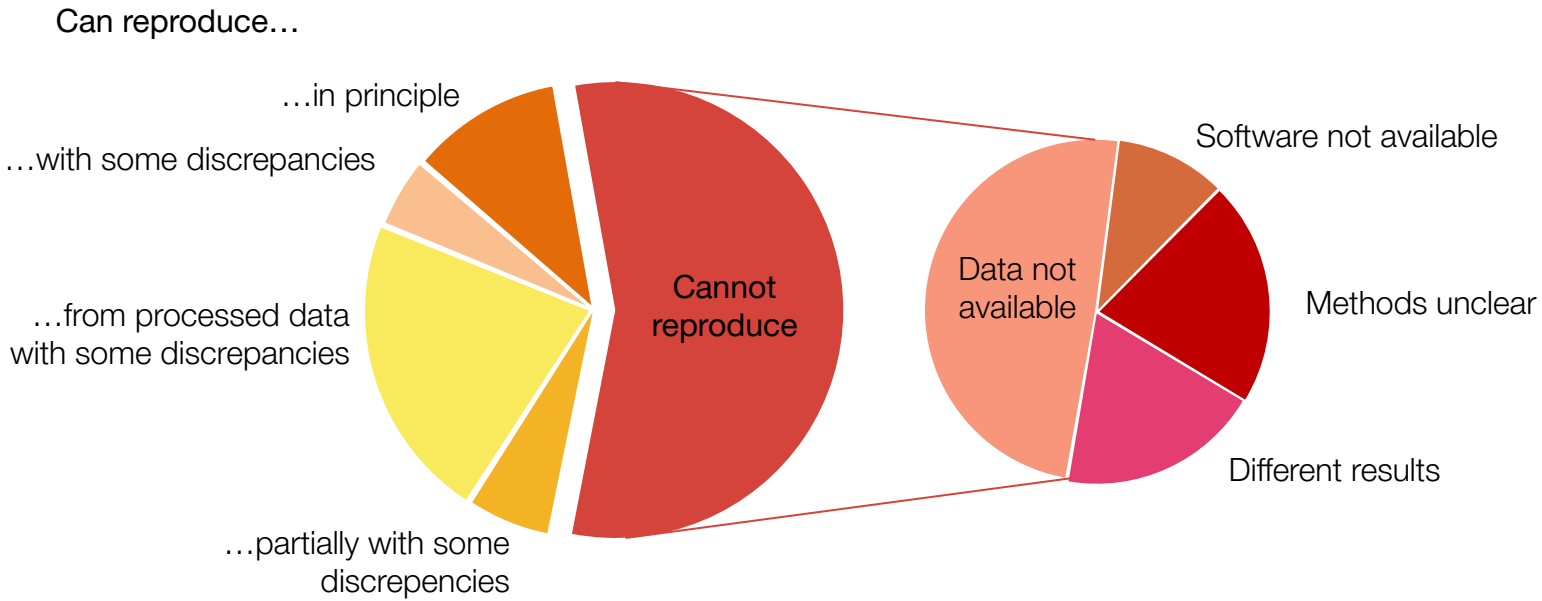



[1] "1,500 scientists lift the lid on reproducibility". Nature. 533: 452–454
[2] Begley, C. G.; Ellis, L. M. (2012). "Drug development: Raise standards for preclinical cancer research". Nature. 483 (7391): 531–533.

# A reproducibility crisis

Reproduction of data analyses in 18 articles on microarray-based gene expression profiling published in Nature Genetics in 2005–2006:




Summary of the efforts to replicate the published analyses.
Adopted from: Ioannidis et al. Repeatability of published microarray gene expression analyses. *Nature Genetics* **41** (2009) doi:10.1038/ng.295

# Data Management Snafu


https://www.youtube.com/watch?v=N2zK3sAtr-4

# FAIR

- To be useful for others data should be
  - ***FAIR*** - Findable, Accessible, Interoperable, and Reusable
    *… for both Machines and Humans*

Wilkinson, Mark et al. *"The FAIR Guiding Principles for scientific data management and stewardship"*. Scientific Data 3, Article number: 160018 (2016) http://dx.doi.org/10.1038/sdata.2016.18

www.nature.com/scientificdata

SCIENTIFIC DATA

OPEN

SUBJECT CATEGORIES
» Research data
» Publication characteristics

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Published: 15 March 2016

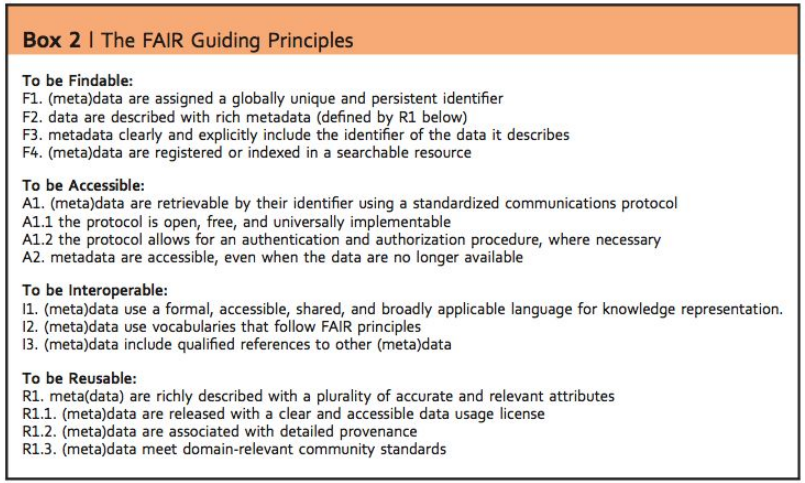
**Comment: The FAIR Guiding Principles for scientific data management and stewardship**

Mark D. Wilkinson *et al.*#

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.

**Supporting discovery through good data management**

Good data management is not a goal in itself, but rather is the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse by the



**Box 2** | The FAIR Guiding Principles

**To be 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 it describes
F4. (meta)data are registered or indexed in a searchable resource

**To be Accessible:**
A1. (meta)data are retrievable by their identifier using a standardized communications protocol
A1.1 the protocol is open, free, and universally implementable
A1.2 the protocol allows for an authentication and authorization procedure, where necessary
A2. metadata are accessible, even when the data are no longer available

**To be 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

**To be 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

# Findable

- Data have a **globally unique persistent identifier**
  - *e.g. a DOI, database accession number, etc*
- Data are described by **metadata**
  - *Information that explains the data*
- Data and metadata are findable in a **search resource**
  - *There must be ways of searching for the data*

# Accessible

- Data is retrievable through a **standardised communication protocol** (open, free, allowing authentication & authorisation where necessary)
  - *e.g. http, sftp, etc*
- Metadata are accessible, **even if data is no longer available**
  - *Information about the data can be found even if data is no longer available*

# Interoperable

- Metadata use a formal, accessible, shared **language for knowledge representation**
  - *Metadata is available in a form that even a computer can make use of*
- Metadata use **vocabularies** that follow the FAIR principles
  - *Standardised ways of capturing information about the data (that are in themselves FAIR)*
- Metadata include qualified **references** to other metadata
  - *If the data relies on other data, there must be links to those*

# Reusable

- Data have a clear **data usage license**
  - *It is obvious under what conditions the data can be reused*
- Metadata are associated with **detailed provenance**
  - *The metadata is detailed enough to understand for what research questions it is relevant to reuse*
- Metadata meet domain-relevant community **standards**
  - *Metadata is described according to existing standards in the research field*

# FAIR

- Both humans and machines are intended users of data
- The principles are not necessarily about *open* data
  - "As open as possible, as closed as necessary"
- FAIRness is not something absolute
  - Different levels of FAIR maturity
- FAIR does not enforce any particular technical standards

# When to be FAIR?

FAIR at source?


© rassco

Retroactively?

# Good Data Management Practices

- **Data Management Plans**, to do your thinking ahead of time
- **Using standard metadata descriptions**, to clearly define your data
- **Organising your analysis**, so you and others can understand what you have done
- **Use versioning control** to keep track of changes you do
- **Clean up metadata and data** to be consistent with the standards you have chosen
- **Submit your data to international public repositories**, so others can find and reuse your data
- **Use scripted analysis of your data**, that can be understood by others

# The Political landscape

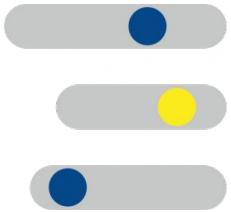
- Strong international movement towards Open Science
- European Commission recommended the member states to establish national guidelines for Open Access
  - Swedish Research Council (VR) submitted proposal to the government Jan 2015
- Research bill 2017–2020 – *28 Nov 2016*
  - "*The aim of the government is that all scientific publications that are the result of publicly funded research should be openly accessible as soon as they are published. Likewise,* ***research data*** *underlying scientific publications should be* ***openly accessible*** *at the time of publication.*" [my translation]
- 2018 – VR assigned by the government to coordinate national efforts to implement open access to research data


# The Political landscape

# EOSC

## EUROPEAN OPEN SCIENCE CLOUD

The EOSC will offer 1.7 million European **researchers** and 70 million professionals in science, technology, the humanities and social sciences a virtual environment with **open and seamless services for storage, management, analysis and re-use of research data**, across borders and scientific disciplines by federating existing scientific data infrastructures, currently dispersed across disciplines and the EU Member States.



## EOSCFAIR

Executive Board Working Group

https://www.eosc-portal.eu/

# “Open Data Directive”

- Directive (EU) 2019/1024 of the European Parliament and of the Council of 20 June 2019 on open data and the re-use of public sector information
- To be implemented into national member state laws by 16 July 2021

*"EU countries must adopt policies and take action to make **publicly funded research data openly available**, following the principle of ‘**open by default**’ and support the dissemination of research data that are findable, accessible, interoperable and reusable (the ‘**FAIR’ principles**)"*

## Funders

Data Management Plans

Open Data

*Vetenskapsrådet*, *FORMAS*, *Riksbankens Jubileumsfond*


## Universities

Research Data Policies

# Motivators

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