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RAPTOR LOOP BASIC

Best Practices and Services for FAIR Data Management

Regina Albrecht, Martin Spenger
December 16th 2021



Who we are?

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(LMU University Library, IT Department and RDM)



RDM Help Desk ("FDM-Beratungsstelle") @ LMU University Library

- First contact point for questions concerning Research Data Management (RDM)
- Advice for LMU students and researchers
- contact via rdm@ub.uni-muenchen.de or forschungsdaten@ub.uni-muenchen.de



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1. Introduction
2. What are FAIR Data? – Definition and Requirements
3. FAIR Data in Practice
4. Data Management Plans
5. Data Publication
6. Further Resources to help making your data FAIR

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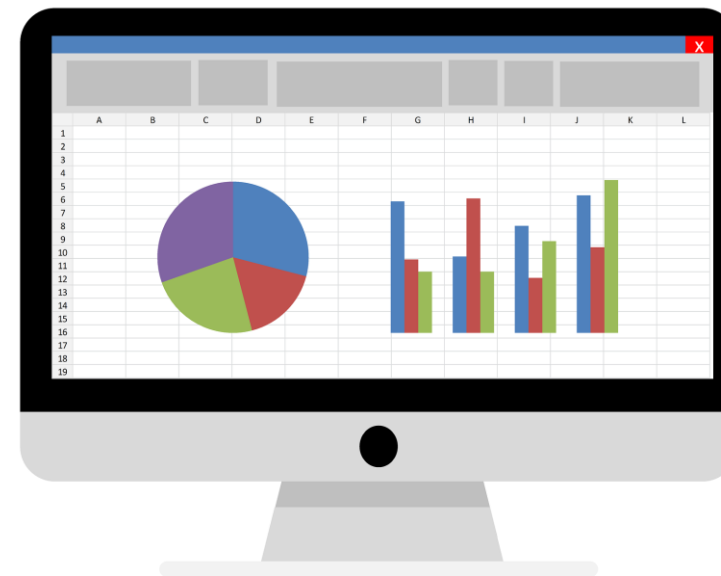
6. Further Resources to help making your data FAIR

What are research data?

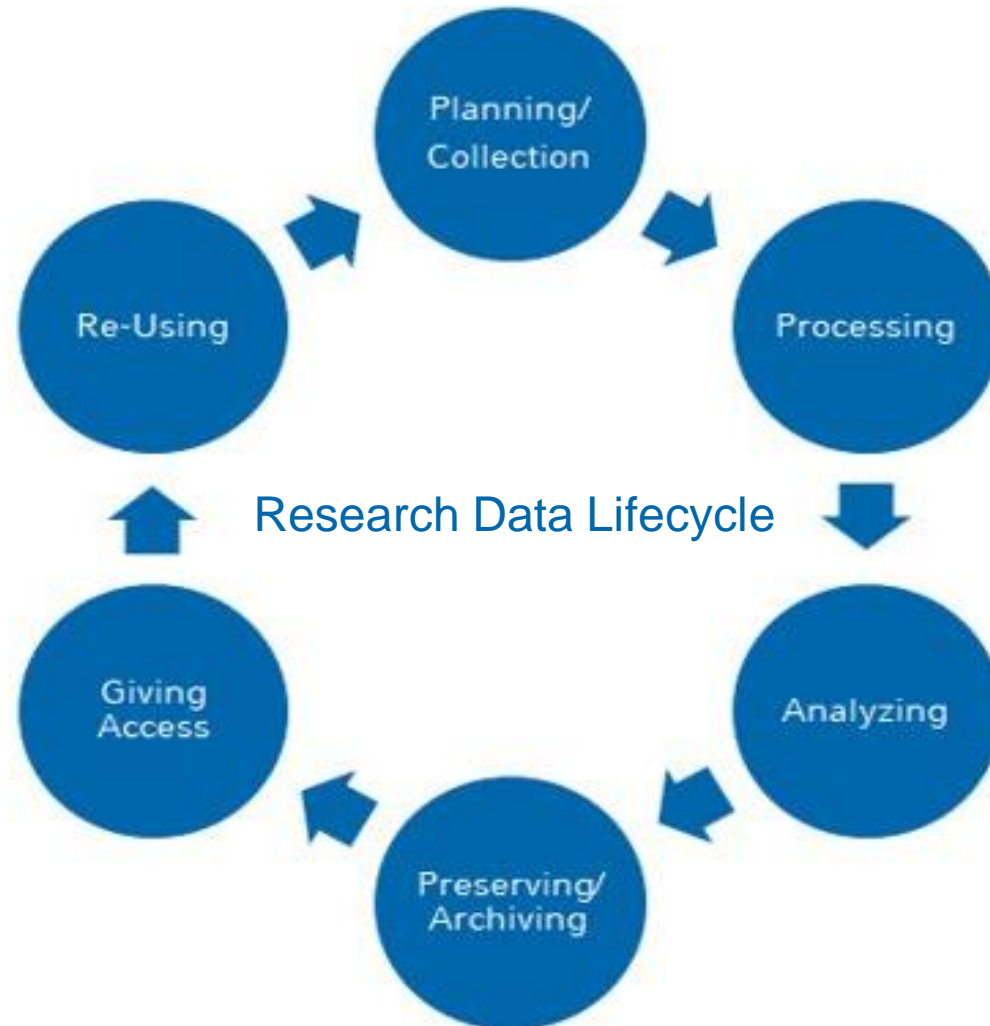
Research Data are all data that are created, developed or evaluated during a research process.

For example:

- measured data
- texts / notes
- questionnaires
- images
- software



What is research data management (RDM)?



RDM accompanies the research process from the beginning to the end!

The Research Data Lifecycle guides you through this process.

Why do we need Research Data Management?



https://www.youtube.com/watch?v=66oNv_DJuPc
NYU Health Sciences Library
"Data Sharing and Management Snafu in 3 Short Acts (Higher Quality)"

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FAIR Guiding Principles

The aim of research data management is to prepare and store data in such a way that they remain available and reusable in the long term and independently of individuals.





Findable

- (Meta)data are assigned a globally **unique and persistent identifier**
- Data are described with rich metadata
- Metadata clearly and explicitly include the identifier of the data they describe
- (Meta)data are registered or indexed in a searchable resource



Example: Persistent identifiers



Acronym	DOI
Organisation	International DOI Foundation
Introduced	2000
Example	10.1000/182 
Website	www.doi.org  

Digital Object identifier (DOI)

- Persistent and unique identifier to identify objects uniquely
- Standardized by the International Organization for Standardization (ISO)



Citation: Hege, Inga and Kononowicz, Andrzej and Kiesewetter, Jan and Foster-Johnson, Lynn: *Uncovering the relation between clinical reasoning and diagnostic accuracy – an analysis of learner’s clinical reasoning processes in virtual patients*. September 2018. Open Data LMU. [10.5282/ubm/data.120](https://doi.org/10.5282/ubm/data.120)



Microsoft Excel
data_repository.xlsx - Submitted Version
448kB

DOI: 10.5282/ubm/data.120

https://en.wikipedia.org/wiki/Digital_object_identifier

<https://data.ub.uni-muenchen.de/120/>

<https://projects.tib.eu/pid-service/en/persistent-identifiers/digital-object-identifiers-dois/>



Accessible

- (Meta)data are **retrievable by** their identifier **using a standardized communication protocol**
- The protocol is open, free, and universally implementable
- The protocol allows for an authentication and authorization procedure, where necessary
- Metadata are accessible, even when the data are no longer available



Example: Repositories and communication protocols

- make sure that publication platforms offer APIs and Metadata distribution using standardized protocols

```

<OAI-PMH xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/ http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd">
  <responseDate>2021-12-13T18:22:22Z</responseDate>
  <request verb="Identify">http://export.arxiv.org/oai2</request>
  <Identify>
    <repositoryName>arXiv</repositoryName>
    <baseURL>http://export.arxiv.org/oai2</baseURL>
    <protocolVersion>2.0</protocolVersion>
    <adminEmail>help@arxiv.org</adminEmail>
    <earliestDatestamp>2007-05-23</earliestDatestamp>
    <deletedRecord>persistent</deletedRecord>
    <granularity>YYYY-MM-DD</granularity>
  </Identify>
  <eprints xsi:schemaLocation="http://www.openarchives.org/OAI/1.1/eprints http://www.openarchives.org/OAI/1.1/eprints.xsd">
    <content>
      <text>Author self-archived e-prints</text>
    </content>
    <metadataPolicy>
      <text>
        Metadata harvesting permitted through OAI interface
      </text>
      <URL>http://arxiv.org/help/oa/metadataPolicy</URL>
    </metadataPolicy>
    <dataPolicy>
      <text>
        Full-content harvesting not permitted (except by special arrangement)
      </text>
      <URL>http://arxiv.org/help/oa/dataPolicy</URL>
    </dataPolicy>
  </eprints>
</OAI-PMH>

```

<http://export.arxiv.org/oai2?verb=Identify>



Interoperable

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

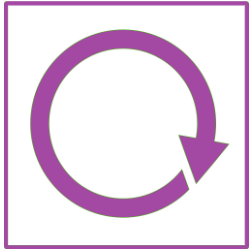


Example: Metadata Schema and controlled vocabularies

- use open formats
- use discipline-specific standards

```
datacite-example-dataset-v4.xml
1 <?xml version="1.0" encoding="UTF-8"?>
2 <resource xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns="http://datacite.org/schema/kernel-4"
3 <identifier identifierType="DOI">10.5072/D3P26Q35R-Test</identifier>
4 <creators>
5 <creator>
6 <creatorName nameType="Personal">Fosmire, Michael</creatorName>
7 <givenName>Michael</givenName>
8 <familyName>Fosmire</familyName>
9 </creator>
10 <creator>
11 <creatorName nameType="Personal">Wertz, Ruth</creatorName>
12 <givenName>Ruth</givenName>
13 <familyName>Wertz</familyName>
14 </creator>
15 <creator>
16 <creatorName nameType="Personal">Purzer, Senay</creatorName>
17 <givenName>Senay</givenName>
18 <familyName>Purzer</familyName>
19 </creator>
20 </creators>
21 <titles>
22 <title xml:lang="en">Critical Engineering Literacy Test (CELT)</title>
23 </titles>
24 <publisher xml:lang="en">Purdue University Research Repository (PURR)</publisher>
25 <publicationYear>2013</publicationYear>
26 <subjects>
27 <subject xml:lang="en">Assessment</subject>
28 <subject xml:lang="en">Information Literacy</subject>
29 <subject xml:lang="en">Engineering</subject>
30 <subject xml:lang="en">Undergraduate Students</subject>
31 <subject xml:lang="en">CELT</subject>
32 <subject xml:lang="en">Purdue University</subject>
33 </subjects>
34 <language>en</language>
35 <resourceType resourceTypeGeneral="Dataset">Dataset</resourceType>
```

Based on: <https://schema.datacite.org/meta/kernel-4.4/example/datacite-example-dataset-v4.xml>



Reusable

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



Example: Clear and accessible data usage licences

Creative Commons Licences:

- allow the creator to easily indicate copyrights
- allow others to easily reuse the data
- allow others to know which rights are allocated



Attribution
CC BY



Attribution-ShareAlike
CC BY-SA



Attribution-NoDerivs
CC BY-ND



Attribution-NonCommercial
CC BY-NC

Based on: <https://creativecommons.org/licenses/?lang=en>

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FAIR in European Context

- Report by the European Commission Expert Group on FAIR Data

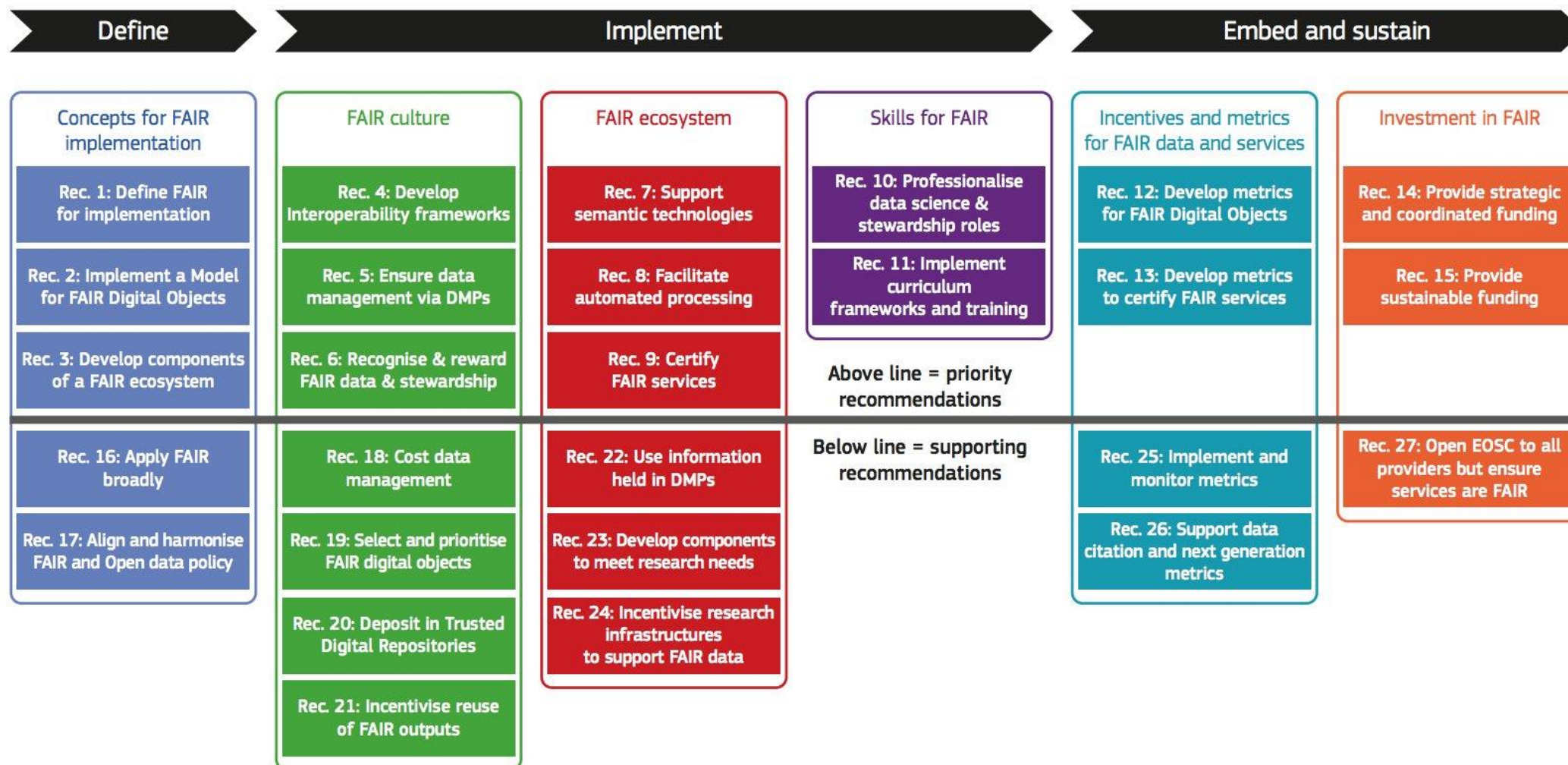
- Published 2018
- <https://doi.org/10.2777/1524>

1. Executive summary
1.1 Concepts for FAIR.....
1.2 Research culture and FAIR
1.3 Technical ecosystem for FAIR data
1.4 Data science and stewardship skills
1.5 Metrics for FAIR data and assessment frameworks to certify FAIR services.....
1.6 Sustainable and strategic funding
1.7 Priority recommendations.....

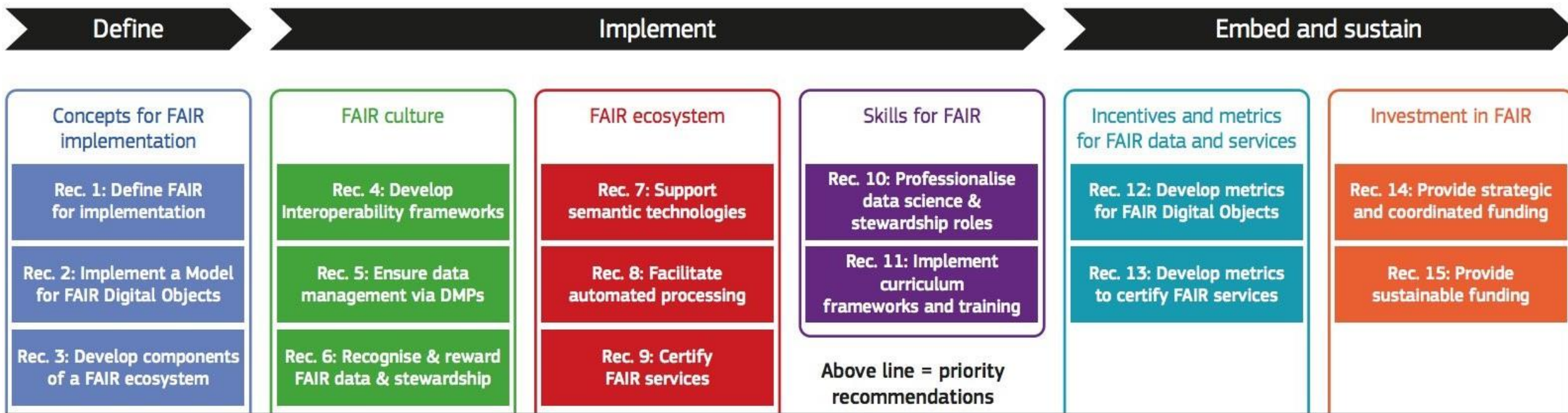


How can FAIR be turned into reality?

FAIR in European Context – Recommendations



FAIR in European Context – Recommendations



FAIR in European Context – Horizon 2020

The screenshot shows the European Commission website for 'Funding & tender opportunities' in the 'Single Electronic Data Interchange Area (SEDIA)'. The page is titled 'HORIZON 2020 ONLINE MANUAL' and features a search bar and a navigation menu on the left. The main content area is titled 'Data management' and includes a breadcrumb trail: '> H2020 Online Manual > Cross-cutting issues > Open access & Data management >'. Below the breadcrumb, there are two buttons: 'Open access' and 'Data management'. The 'Data management' page contains a section titled 'Background - Extension of the Open Research Data Pilot in Horizon 2020' with the following text:

Please note the distinction between open access to scientific peer-reviewed **publications** and open access to research **data**:

- **publications** – open access is an *obligation* in Horizon 2020.
- **data** – the Commission is running a flexible pilot which has been *extended* and is described below.

See also the Guidelines: [Open access to publications and research data in Horizon 2020](#).

This document helps Horizon 2020 beneficiaries make their research data **findable, accessible, interoperable and reusable (FAIR)** to ensure it is soundly managed. Good research data management is not a goal in itself, but rather the key conduit leading to knowledge discovery and innovation, and to subsequent data and knowledge integration and reuse.

Note that these guidelines do not apply to their full extent to actions funded by the ERC. For information and guidance concerning Open Access and the Open Research Data Pilot at the ERC, please see [this specific guidance](#).

https://ec.europa.eu/research/participants/docs/h2020-funding-guide/cross-cutting-issues/open-access-dissemination_en.htm

FAIR in European Context – Horizon 2020



“This document helps Horizon 2020 beneficiaries make their research data findable, accessible, interoperable and reusable (FAIR), to ensure it is soundly managed.

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

H2020 Programme

Guidelines on

FAIR Data Management in Horizon 2020

https://ec.europa.eu/research/participants/data/ref/h2020/grants_manual/hi/oa_pilot/h2020-hi-oa-data-mgt_en.pdf

Research Data Management (RDM)...

- Emphasis shifts **from open research data to RDM**
- **No opting out** of RDM. Projects generating research data **MUST manage their data** responsibly and in line with FAIR principles
- Open access to research data ‘as open as possible as closed as necessary’, i.e. there can be **exceptions to open access to research data**.
- ...




Examples for Research Data Policies

The screenshot shows the IOPscience website interface. At the top, there is a navigation bar with 'IOPscience', a search icon, and links for 'Journals', 'Books', and 'Publishing Support'. Below this, the journal title 'Physics in Medicine & Biology' is displayed, along with a 'Journals > Author guidelines' breadcrumb. A sidebar menu on the left lists various article-related topics, with 'Research data policy' highlighted. The main content area features the title 'Research data policy' and several paragraphs of text explaining IOP Publishing's support for transparency and openness in scientific research. It mentions that many research funders require data availability and refers to the Sherpa Juliet database. It also states that all IOP Publishing journals have a policy on research data, which is listed in the 'about the journal' section. Two bullet points are listed: 'Standard data policy' and 'Data availability policy'. The text concludes by stating that any journal published on behalf of another society or organisation may have its own policy, and authors should check specific journal guidelines before submitting.

<https://publishingsupport.iopscience.iop.org/journals/physics-in-medicine-biology/#research-data-policy>

Examples for Research Data Policies

Home > Journals > Physics in Medicine > Announcements > New guidelines for research data



PHYSICS
IN MEDICINE

ISSN: 2352-4510

Physics in Medicine

[Submit your Paper](#) [View Articles](#)

[Guide for authors](#) [Track your paper](#) ▾

New guidelines for research data

🕒 September 2017

Authors submitting their research article to this journal are encouraged to deposit research data in a relevant data repository and cite and link to this dataset in their article. If this is not possible, authors are encouraged to make a statement explaining why research data cannot be shared. There are several ways you can share your data when you publish with Elsevier, which help you get credit for your work and make your data accessible and discoverable for your peers. Find out more in the [Guide for Authors](#).

More information on [Research Data Guidelines](#).

<https://www.journals.elsevier.com/physics-in-medicine>

FAIR Assessment Tool "FAIR Aware"



F

A

I

FAIR questions

Glossary

FINDABLE

- 1. Are you aware that a data(set) should be assigned a globally unique persistent and resolvable identifier when deposited with a data repository? Yes No
- 2. Are you aware that when you deposit a data(set) in a data repository, you will need to provide discovery metadata in order to make the data(set) findable, understandable and reusable to others? Yes No
- 3. Are you aware that the data repository providing access to your data(set) should make the metadata describing your data(set) available in a format readable by machines as well as humans? Yes No

ACCESSIBLE

- 4. Are you aware that access to your data(set) may need to be controlled and that metadata should include licence information under which the data(set) can be reused? Yes No
- 5. Are you aware that metadata should remain available over time, even if the data(set) is no longer accessible? Yes No

INTEROPERABLE

- 6. Are you aware that the metadata describing your data(set) should use controlled vocabularies? Yes No



Your first step towards your FAIR data(set)

Thank you for your participation!



Awareness:
Low (4/10)

Willingness to comply:
Moderate (39/50)

Guidance:

Based on your answers, you can find the guidance below to improve your awareness on some FAIR issues.

2. Are you aware that when you deposit a data(set) in a data repository, you will need to provide discovery metadata in order to make the data(set) findable, understandable and reusable to others?

What does this mean?

Metadata is "data about data", meaning that this type of data only contains information that describes or characterizes other data. There are different types of metadata that underlie different FAIR aspects. The focus of this question is on making sure your data(set) has a set of minimum descriptive information elements (also known as "discovery metadata") to adequately communicate the content of your data(set) to others.

Why is this important?

<https://fairaware.dans.knaw.nl/>

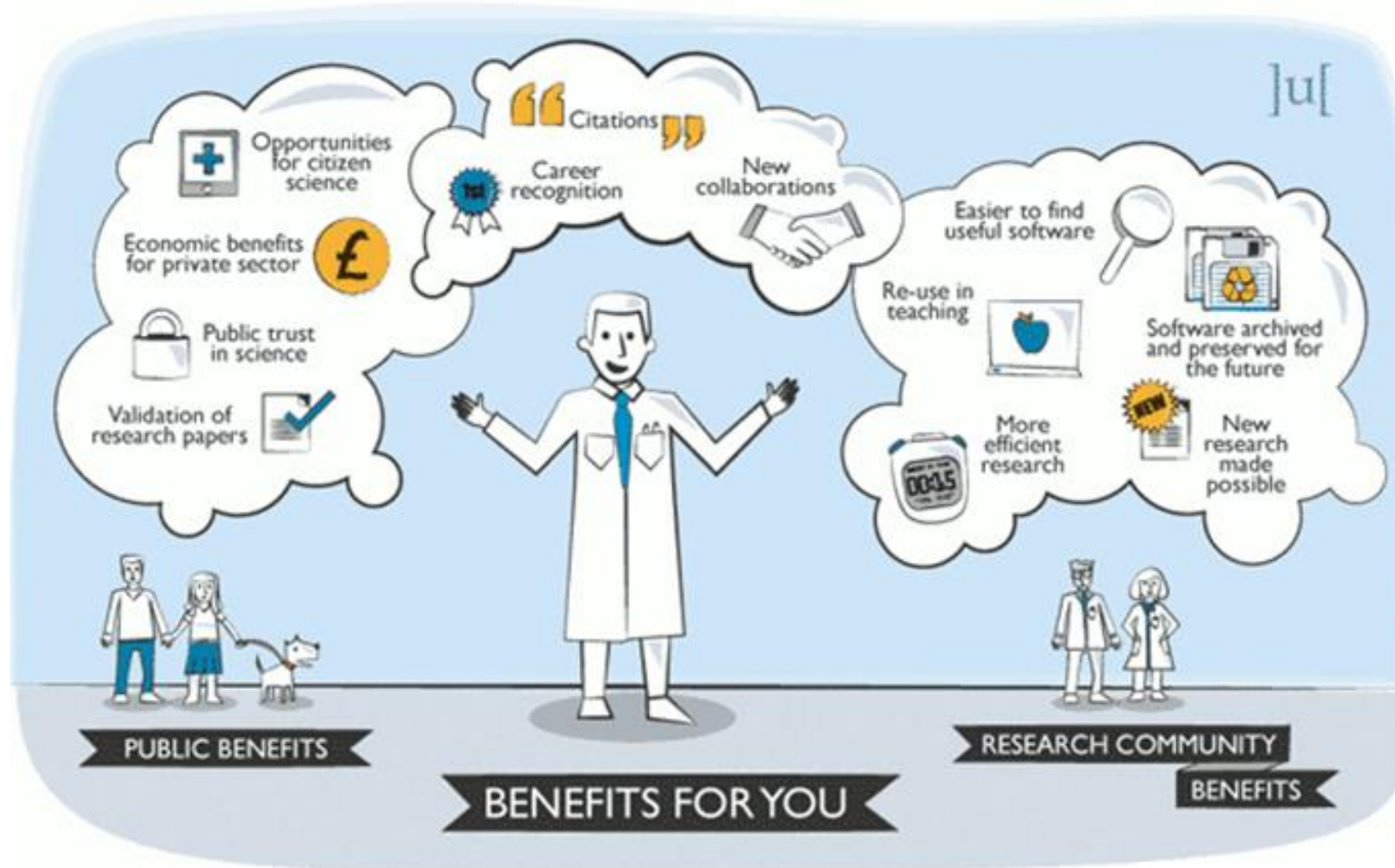
FAIR Assessment Tool "FAIR Aware,, – Our Goal



The screenshot shows a web browser window with the URL <https://fairaware.dans.knaw.nl>. The page features the DANS logo (Data Archiving and Networked Services) in the top right. The main heading is "FAIR | Aware" with the tagline "Your first step towards your FAIR data(set)". Below this, it says "Thank you for your participation!". At the bottom left is the "FAIR" logo, and to its right, the text "Awareness: High (10/10)" is circled in red.

<https://fairaware.dans.knaw.nl/>

FAIR Assessment Tool "FAIR Aware,, – Our Goal



Benefits of Research Data Management



- **Visibility of Research:** citation rate and reputation are improved
- **Research Transparency:** data underpinning publications are available to the scientific community
- **Minimising the Risk of Losing Data** by planning data storage from the beginning
- **Reuse of Data:** good RDM ensures that your data are preserved in the long term
- **Safeguarding Good Scientific Practice:** RDM is regarded as essential in the context of good scientific practice

Based on: <https://ub.fau.de/en/research/data-and-software-in-research/advantages-of-research-data-management/>

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What is a Data Management Plan (DMP)?



A data management plan (DMP) is a document that describes what will happen to the research data during a scientific project and after the end of the project. It is used to structure the data in such a way that it is easier to keep track of it and it's a central element of research data management.

Benefits of a Data Management Plan (DMP)



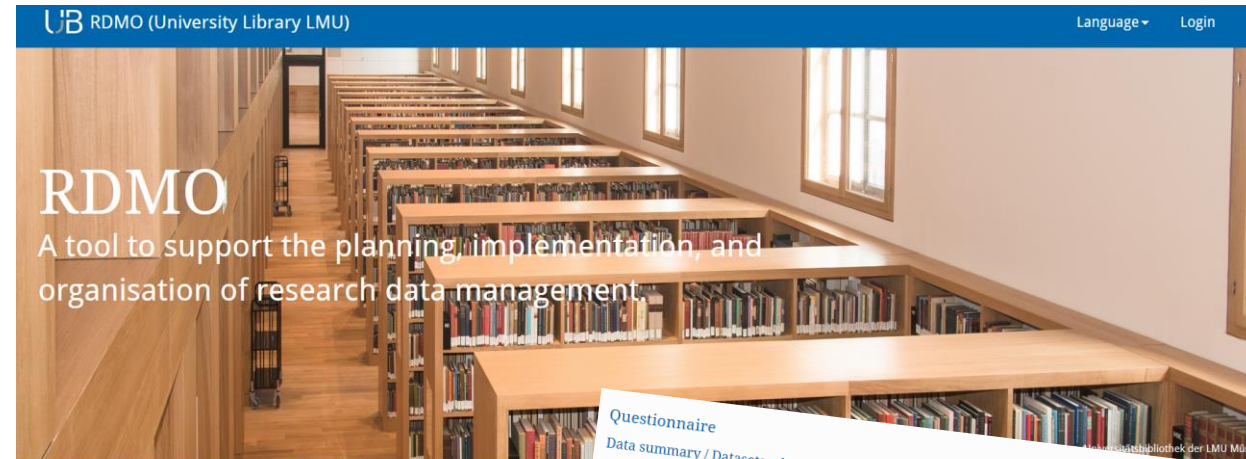
- Guideline for entire duration of a project
- Regulations/recommendations on whereabouts of data after project ends
- Often required by national and international funding programmes for documentation
- Optimization of research data management

Components of a Data Management Plans

- What data will be collected and where does it come from?
- Which **metadata** should be used to describe the data?
- Where should the data be **stored**? During the project phase? After the project?
- What about Open Data? Do you plan to **publish** the data?
- Is sufficient staff provided? Does your project require special **infrastructure**?
- How do you ensure the **quality** of your data?
- Does your project process personal or sensitive data? What **law** will be applied? Are there **ethical aspects** you need to consider?

Based on: <https://www.fdm.uni-hamburg.de/en/fdm/datenmanagementplan.html>

Tools supporting Data Management Plans



Welcome to the RDMO service of LMU Munich

The service is provided by the University Library LMU and uses a web application to administration of the data in a scientific project. Additionally, the gathered informa

Example: Research Data Management Organiser (RDMO)



- Web-based application to support creation of DMP
- Development co-funded by DFG from 2015-2020
- Large and active community
- Local installation on servers at University Library LMU
- H2020-Catalog is implemented and supported

RDMO Data Management Plans

Questionnaire

Data summary / Datasets - description and formats

Please create at least one new dataset to continue!

Please fill in the form for each dataset. The different datasets will be referred to in following questions. You can add a new dataset using the green button. Once created, you can edit or delete datasets using the buttons in the top right corner.

Dataset1 [Add dataset](#)

What is the purpose of the data collection / generation and its relation to the objectives of the project?

Purpose of data collection

What types and formats of data will be generated in the project?

Common data types are:

- textual data (transcriptions, translations, personal names,...)
- images (scans of manuscripts, microscope images, objects, ...)
- survey data
- 3D model / digital reconstruction (e.g. of a stone age settlement)
- experimental measurements
- software developed within the project
- audio or video recordings (e.g. a qualitative interview)

When choosing a data format, one should consider the consequences for collaborative use, long-term preservation as well as re-use. Outline why these data formats are used, especially if you use formats that are not standardised, open, non-proprietary or established in the scholarly community. More criteria and detailed explanations can be found e.g. in the [WissGrid-Leitfaden](#), pp. 22 f.

Further information on data formats for archival purposes

images

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Overview

Project: Testprojekt Horizon
Catalog: Horizon 2020 Grants

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Navigation

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[Data summary](#)

[Datasets](#)

[→ Datasets - description and formats](#)

[Datasets - re-use](#)

[Datasets - size and utility](#)

[FAIR data principles](#)

[Allocation of resources](#)

[Data security](#)

[Ethical Aspects](#)

[Other](#)

UB RDMO (University Library LMU)

<https://rdmo.ub.uni-muenchen.de/>



Questionnaire

Data security / transfer and storage

Please fill in the form for each dataset. The different datasets will be referred to in following questions. You can add a new dataset using the green button. Once created, you can edit or delete datasets using the buttons in the top right corner.

Dataset1 [Add dataset](#)

What provisions are in place for data security (including data recovery as well as secure storage and transfer of sensitive data)?

You can consider the questions:

- Where and how will you store the master copy of your raw research data?
- Where and how will you and your collaborators store the data during the analysis phase?
- If the project involved non-digital data or non-digital versions of the data, how will these be stored?
- How often will the data be backed up? What tools are used for this?
- Will there be multiple redundant copies of the datasets?
- If the data can be accessed via the internet: What authentication procedures are in place? Is the data transfer encrypted (e.g., in case of https via SSL/TLS)?

Especially, if you are working with sensitive data, you may want to consider especially strict security measures, e.g., by physical security measures (e.g. locked rooms, safes), removal of personal information that may allow identification (e.g. anonymisation), encrypting the data storage or authentication procedures for access to the data.

Is the dataset safely stored in certified repositories for long term preservation and curation?

Certificates include: Data Seal of Approval, the nestor Seal or certification via ISO 16363. For many repositories you can check this using re3data.org.

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In theory:

- Previously outlined in DMP
- strategy should be clear at project start

But, often questions come up:

- What happens to data after research project ends?
- Can the data be published?
- Are there aspects that need to be considered prior publication?
- Are there reasons why data should not be published?

Research data repositories are a part of web-based information infrastructure that supports the accessibility of digital research data.

Based on the requirements of a defined target group the repository ensures, that:

- the research data will be provided in a **data format which is appropriate for re-use,**
- the research data are **citable and described by established schemes for meta data,**
- the research data are **enriched with informations on terms of use.**

Research Data Repositories

Examples:

- subject-specific
 - [Dryad](#) (Medicine & Natural sciences)
 - [Pangaea](#) (Earth & Environmental Science)
- institutional
 - [Open Data LMU](#)
- generic
 - [Zenodo](#)



Research Data Repositories

Assistance with the selection of a repository :

- <https://www.re3data.org/>



- <https://v2.sherpa.ac.uk/opensoar/>





Example for institutional repository:

- 600 Natural sciences and mathematics (47)
 - 510 Mathematics (5)
 - 530 Physics (2)
 - 540 Chemistry and allied sciences (1)
 - 550 Earth sciences (10)
 - 560 Paleontology, Paleozoology (12)
 - 570 Life sciences (19)
 - 590 Zoological sciences (17)
- 600 Technology, Medicine (13)
 - 610 Medical sciences and medicine (10)
 - 630 Agriculture (1)

<https://data.ub.uni-muenchen.de/>

Example for institutional repository:



Publication at University Library LMU stores your data according to FAIR:

- Persistent identifier (PID):
 - DOI
 - ORCID (& ROR)
- Metadata Services:
 - DataCite Best Practice Guide: <https://zenodo.org/record/3559800>
 - DataCite Metadata Generator: <https://dhvlab.gwi.uni-muenchen.de/datacite-generator/>
- Reliable Storage and Backup Strategies
- API to distribute Metadata

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B2 SERVICE SUITE

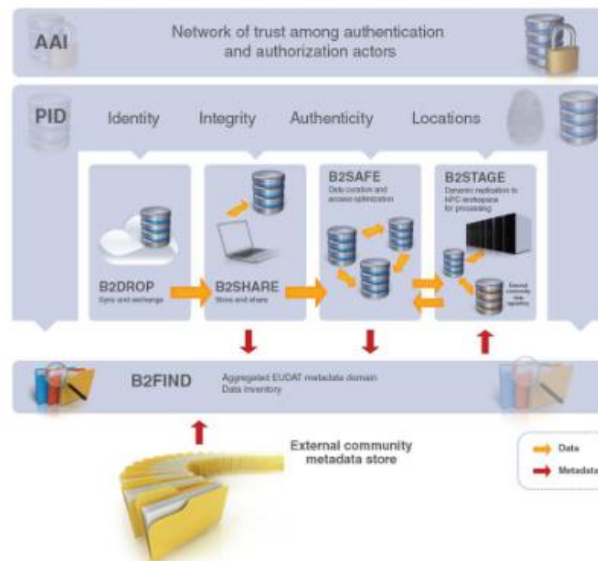
 **B2DROP**
Sync and Exchange Research Data

 **B2SHARE**
Store and Share Research Data

 **B2SAFE**
Replicate Research Data Safely

 **B2STAGE**
Get Data to Computation

 **B2FIND**
Find Research Data



<http://www.eudat.eu/services>

<https://www.eudat.eu/sites/default/files/The%20B2%20SERVICE%20SUITE.pdf>

European Open Science Cloud (EOSC) Marketplace

Welcome to the EOSC Portal Catalogue and Marketplace

Integrated platform that allows easy access to lots of resources for various research domains along with integrated data analytics tools. Browse by scientific domain, resource category or provider and, if you need help, we are here for you!

Find EOSC Resources that suit your use case yourself → [Browse through catalogue](#)

Describe your use case and get support from our experts → [Go to your projects](#)

Scientific Domains | Categories

 Access physical & eInfrastructures	 Aggregators & Integrators	 Processing & Analysis
 Security & Operations	 Sharing & Discovery	 Training & Support

EUROPEAN OPEN SCIENCE CLOUD

Home > Resources

All Resources **320**

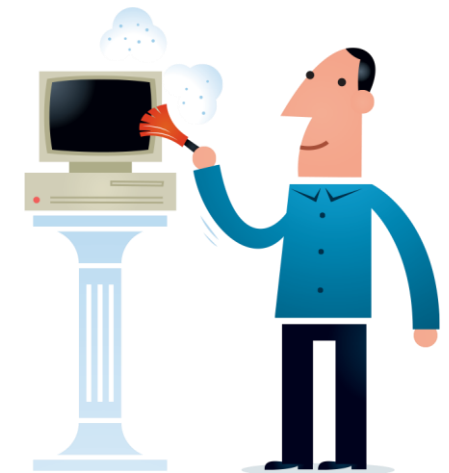
CATEGORIES

Access physical & eInfrastructures	64
Aggregators & Integrators	21
Processing & Analysis	147
Security & Operations	29
Sharing & Discovery	62
Training & Support	32
Other	9

<https://marketplace.eosc-portal.eu/>

Data Stewards and Data Literacy

- Project-specific infrastructures to assure data management according to FAIR
- Development, implementation and monitoring of the RDM policy / strategy
- Ensuring legal compliance
- Sufficient support on RDM
- Request and acquisition of tools and infrastructure for RDM
- Responsibility for an adequate level of knowledge and skills on RDM within an organization



Based on: <https://zenodo.org/record/2561723#.YbcHXpGZO70>

Research Data Infrastructures at Universities

Universities offer services regarding data management. They often include:

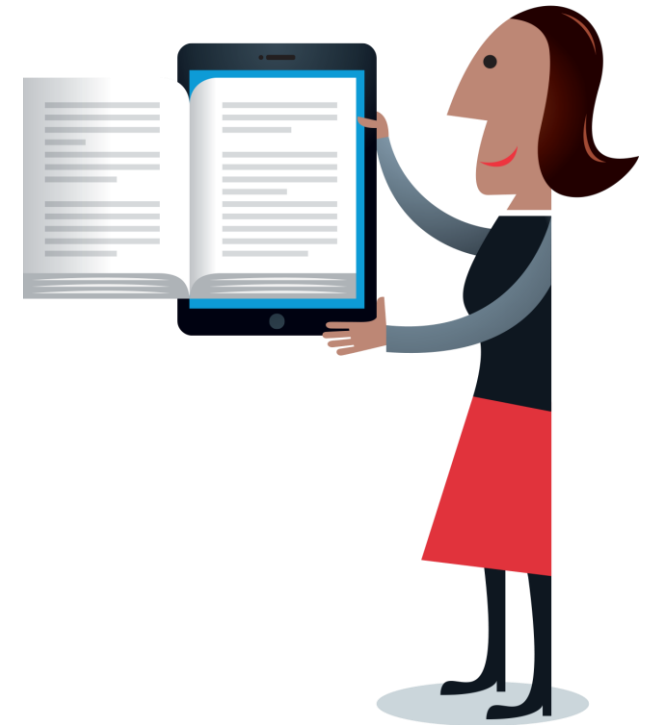
- Advice on RDM and Tools supporting your RDM
- Departments for Legal Affairs or Research Funding
- Cooperations with supercomputing centres (e.g. [LRZ](#) in Munich)
- Open Science Initiatives (e.g. [Open Science Center](#) @ LMU)
- Advice and training offers



Research Data Infrastructures at University Libraries

Academic Libraries are also reliable partners in RDM:

- Knowledge in preserving (digital) publications
- Repositories and reliable storage and backup strategies
- Experience in making knowledge accessible
- Experts in metadata management
- Established networks and standards
- Support with assigning of PIDs



Research Data Infrastructures at University Libraries – Example LMU

The University Library LMU (UB der LMU) offers many services that help to make your data FAIR:

- RDM specific advice and training courses
- Support with Data Management Plans and [RDMO](#)
- Advice on data publication options
- Storage & Archiving Research Data ([Open Data LMU](#) and [Discover](#))
- Persistent identifier services and registry for DOIs
- [Public relations concerning RDM](#) (Flyer, Videos, Social Media...)



LMU

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Thank You!

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