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Data Management Planning

Reproducibility, Linked Open Data & Semantic Interoperability

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FORS and DaSCH

FORS – Swiss Centre of Expertise in the Social Sciences

- national infrastructure for Social Sciences' research data mainly funded by SNSF
- services: consulting / training / workshops /events for data management and archiving, SWISSUbase repository for the social sciences, mandates around the data collection and analysis, FORS Guides

DaSCH – Swiss National Data and Service Center for the Humanities

- national infrastructure for Humanities' research data mainly funded by SNSF
- services: consulting / training / workshops /events, virtual research environment, FAIR open data repository (DSP) including data publication and persistent identifiers at object level, metadata browser

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Programme

01 Reproducibility

02 The Replication Crisis

03 Practices for Reproducible Research

04 Linked Open Data & Semantic Interoperability

05 Important Standards

06 Q&A

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Reproducibility

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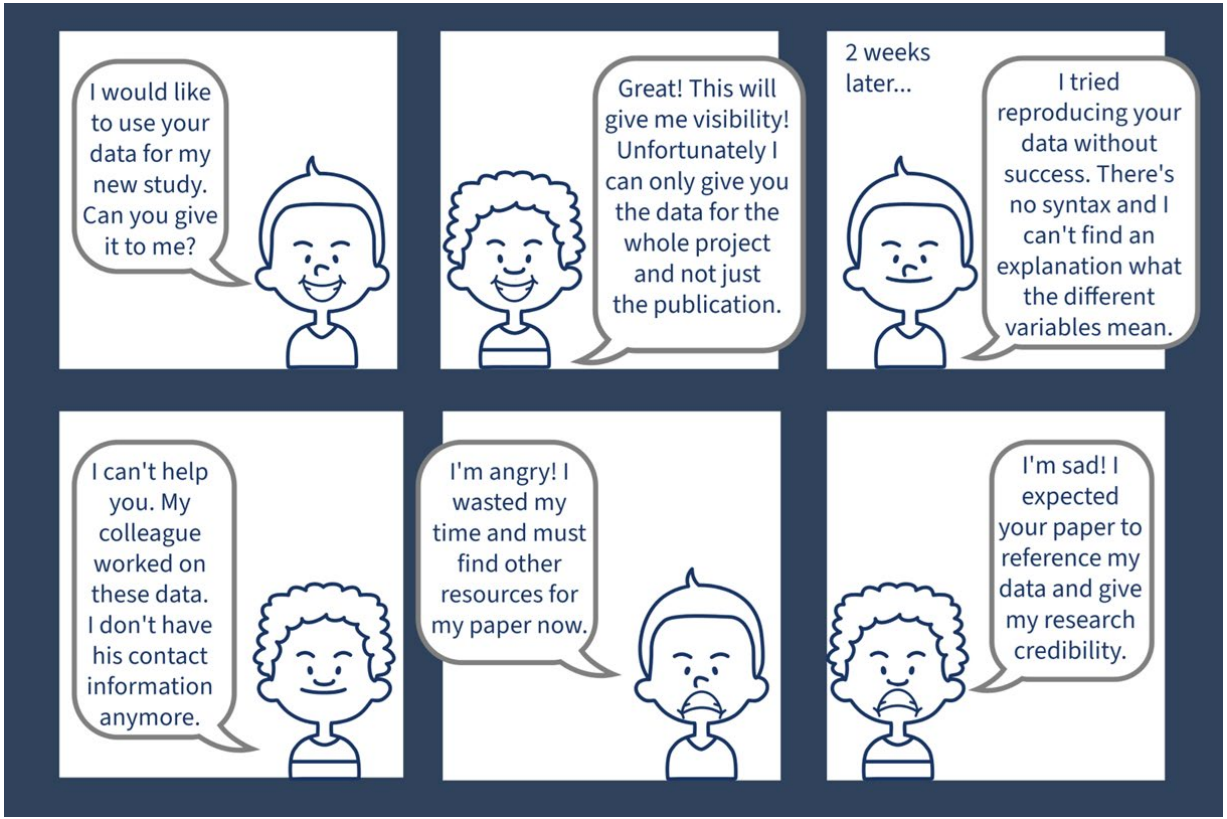
A familiar situation



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Definitions

Mapping the Landscape of Reproducibility

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	Same data	Different data
Same Methods	Reproducibility	Replicability
	Analytical or computational reproducibility	Direct replication
Different Methods	Robustness	Generalizability
	Extended or systematic replication	Conceptual replication

Inspired from: Schloss, PD.2018.Identifying and Overcoming Threats to Reproducibility, Replicability, Robustness, and Generalizability in Microbiome Research. mBio9:10.1128/mbio.00525-18. https://doi.org/10.1128/mbio.00525-18 ; Schmidt, S. 2009. Shall We Really Do It Again? The Powerful Concept of Replication Is Neglected in the Social Sciences. *Review of General Psychology* 13(2):90–100. https://doi.org/10.1037/a0015108 ; Brandt, M. J., IJzerman, H., Dijksterhuis, A., Farach, F. J., Geller, J., Giner-Sorolla, R., Grange, J. A., Perugini, M., Spies, J. R., & van 't Veer, A. 2014. The Replication Recipe: What Makes for a Convincing Replication? *Journal of Experimental Social Psychology* 50:217–224. https://doi.org/10.1016/j.jesp.2013.10.005 ; Crandall, C. S., & Sherman, J. W. 2016. On the Scientific Superiority of Conceptual Replications for Scientific Progress. *Journal of Experimental Social Psychology* 66:93–99. https://doi.org/10.1016/j.jesp.2015.10.002 ; Derksen, M. et Morawski, J. (2022). Kinds of Replication : Examining the Meanings of "Conceptual Replication" and "Direct Replication". Perspectives on Psychological Science, 17(5), 1490-1505. https://doi.org/10.1177/17456916211041116

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The Replication Crisis

A Challenge to Scientific Credibility

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What is the replication crisis?

The *replication crisis* refers to a growing realization that many scientific results are **difficult or impossible to reproduce.**

Since reproducibility is **essential to the scientific method**, such failures challenge the **credibility of scientific knowledge** itself.

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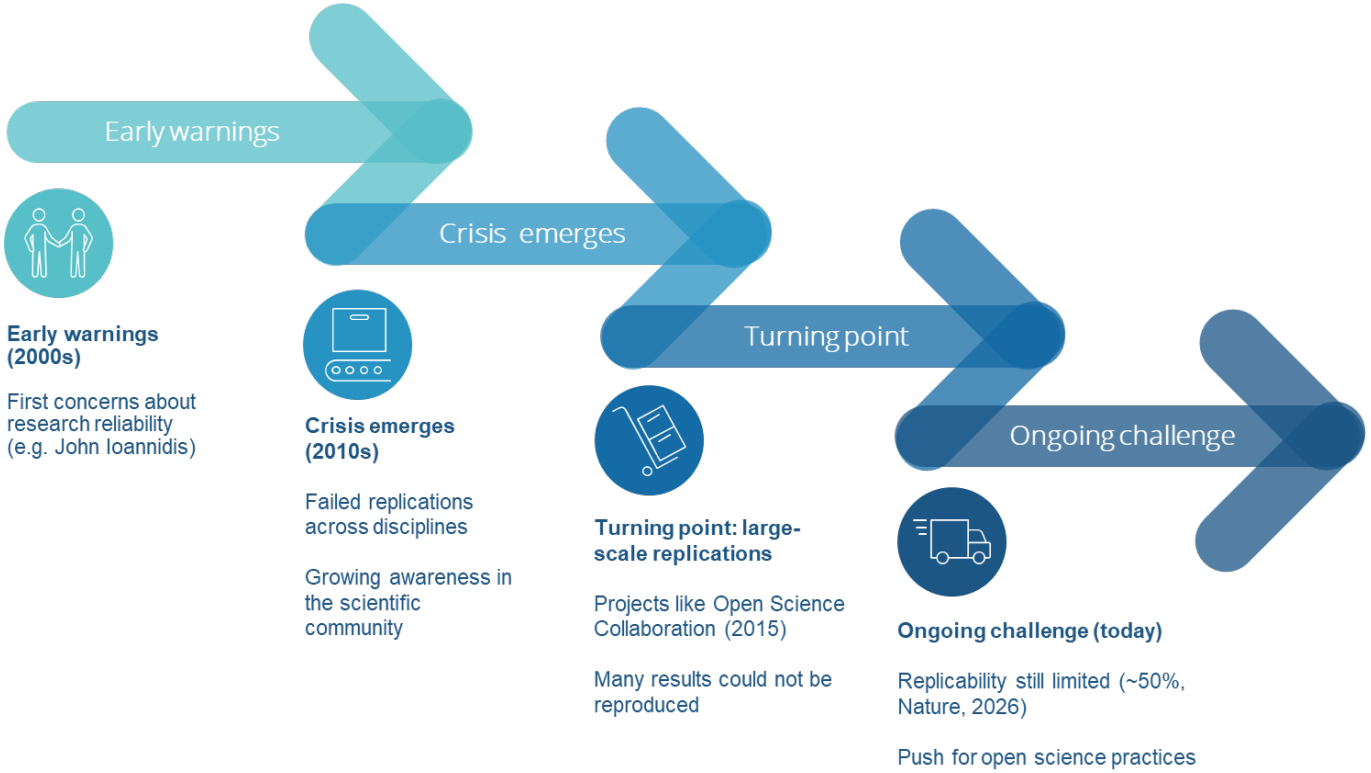
The Rise of the Replication Crisis



Ioannidis, J. P.. Why most published research findings are false. *PLoS medicine*, *2*(8), e124.(2005). https://doi.org/10.1371/journal.pmed.1004085
Open Science Collaboration. Estimating the reproducibility of psychological science.*Science*349,aac4716(2015). https://doi.org/10.1126/science.aac4716
Tyner, A.H., Abatayo, A.L., Daley, M. *et al.*. Investigating the replicability of the social and behavioural sciences. *Nature* 652(8108), 143–150 (2026). https://doi.org/10.1038/s41586-025-10078-y

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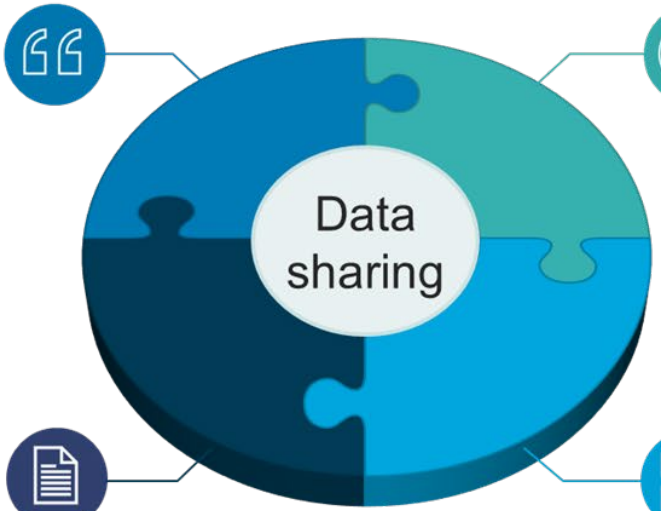
Building a culture of reproducibility



Data citation & Availability Statements
Discoverability of shared data

Preregistration
Transparent design and reduced bias

Preprints
Open communication and early feedback

Replication & Code Sharing
Analytical reproducibility and verification

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Preregistration

Planning for Credibility

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Definition

"Preregistration is the process of detailing research questions, variables, analysis plans, etc. before conducting research." (Manago, 2023)

- **Time-stamped record**: captures decisions on study design, methods, and analysis.
- **Created Before Data Collection**: Established before data is collected or becomes accessible.
- **Public Availability**: Document should be accessible through a registry or repository.

Manago, B. Preregistration and Registered Reports in Sociology: Strengths, Weaknesses, and Other Considerations. *Am Soc* **54**, 193–210 (2023). https://doi.org/10.1007/s12108-023-09563-6

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A solution to the crisis

TRANSPARENCY

RIGOR

CREDIBILITY

INTEGRITY

PLANIFICATION

PUBLICATION BIAS

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What and when?

What:

A timestamped document that contains :

- The hypothesis
- The methods
- The planned analysis and outcome
- Information about the participants

When:

Before the data collection (or in some case before accessing or analyzing research data)

How? Research workflow

- Standard

- With preregistration

Inspired by Henderson, E. L. (2022). A guide to preregistration and Registered Reports. https://doi.org/10.31222/osf.io/x7aqr

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Where to preregister?

- Online dedicated platform providing a DOI
  - Wide range of research disciplines:

OSF

AS PREDICTED

RESEARCH REGISTRY
Register any research study instantly

  - Specific research Fields:

egap EVIDENCE IN GOVERNANCE AND POLITICS

PROSPERO
International prospective register of systematic reviews

NIH ClinicalTrials.gov

SREE

3ie RIDIE Registry for International Development Impact Evaluations

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Preprint

Opening Research to Early Verification

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Definitions

*« **Preprints** are scholarly manuscripts posted by the authors to openly accessible platforms, usually before or in parallel with submission to a journal, that have not yet undergone peer review. » (Bourne et al., 2017)*

- **Early version of a scholarly article**: shared before peer review.
- **Revisions:** Document may be updated based on feedbacks of the community.
- **Publication**: May or may not be submitted for journal publication.
- **Accessibility**: Shared on preprint servers, often open access and free to use.

Source: Bourne, P.E., Polka, J.K., Vale, R.D., & Kiley, R. *Ten simple rules to consider regarding preprint submission.* PLOS Biol 15, e2003995 (2017). https://doi.org/10.1371/journal.pcbi.1005473

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TRANSPARENCY

OPENNESS

FEEDBACK

ACCESSIBILITY

PUBLICATION BIAS

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What and when?

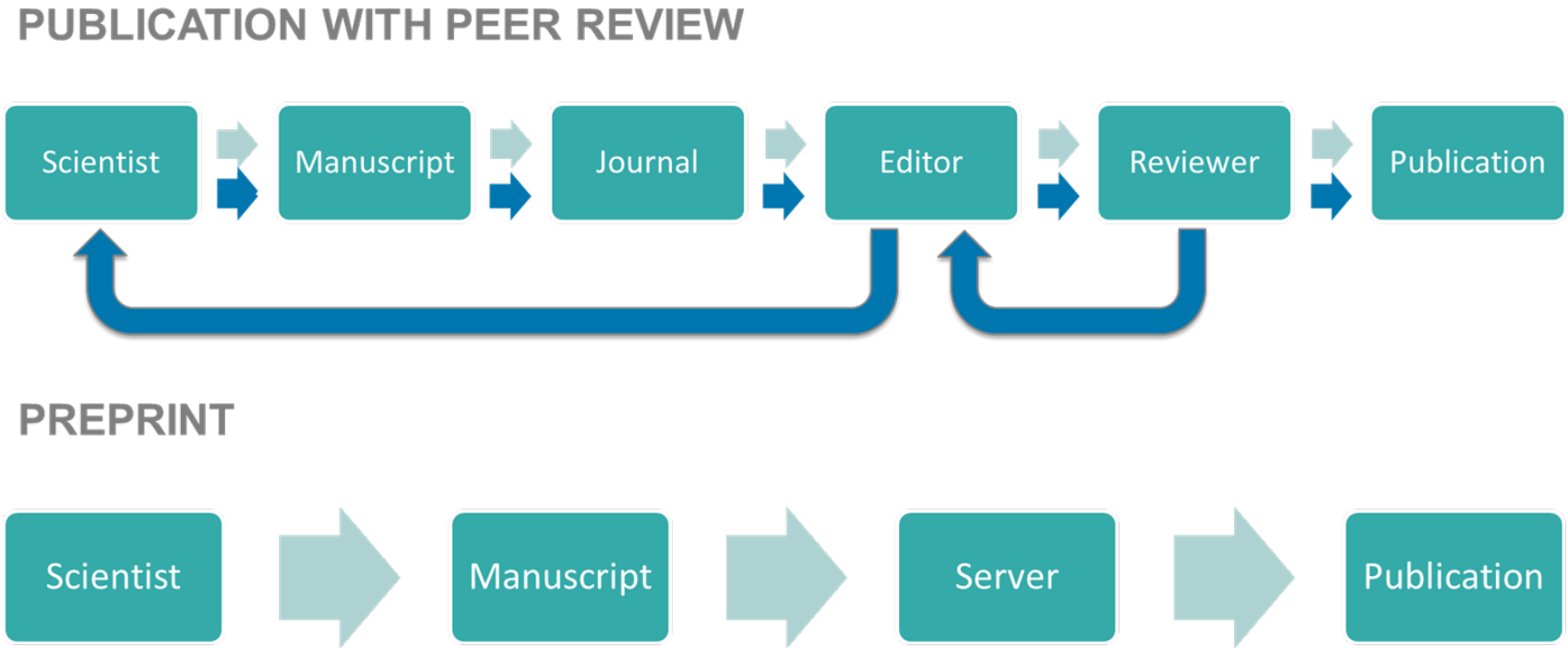
What:

An early version of an article

- That can be updated
- That does not necessarily undergo peer review
- That is open access
- That is on free of charge servers

When: Before an academic journal publication

How? Publication workflow



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Where to submit a preprint?

OSF PREPRINTS

RePEc

SOC ARXIV

arXiv

KNOWLEDGE COMMONS

bioRxiv
THE PREPRINT SERVER FOR BIOLOGY

Preprints.org

PsyArXiv

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES

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Replication & analytical Reproducibility

Testing the Strength of Evidence

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Definition (Recap)

	Same data	Different data
Same Methods	Reproducibility Analytical or computational reproducibility	Replicability Direct replication

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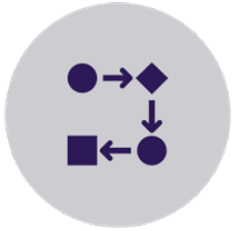
TRANSPARENCY

CREDIBILITY

VALIDATION

CODING INFORMATION



METHODOLOGICAL PROGRESS

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Transparent Code for Reproducibility and Replication

© 2037519 | Dreamstime.com

Reproducibility and replication require that **all** the **analytical steps** are **documented** in **transparent**, **understandable**, and **executable** code that can be shared and reused. .

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How to share the code? Good Practices

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Where to share?

OSF

GitHub

CODE OCEAN

• • •

FORS Replication Service

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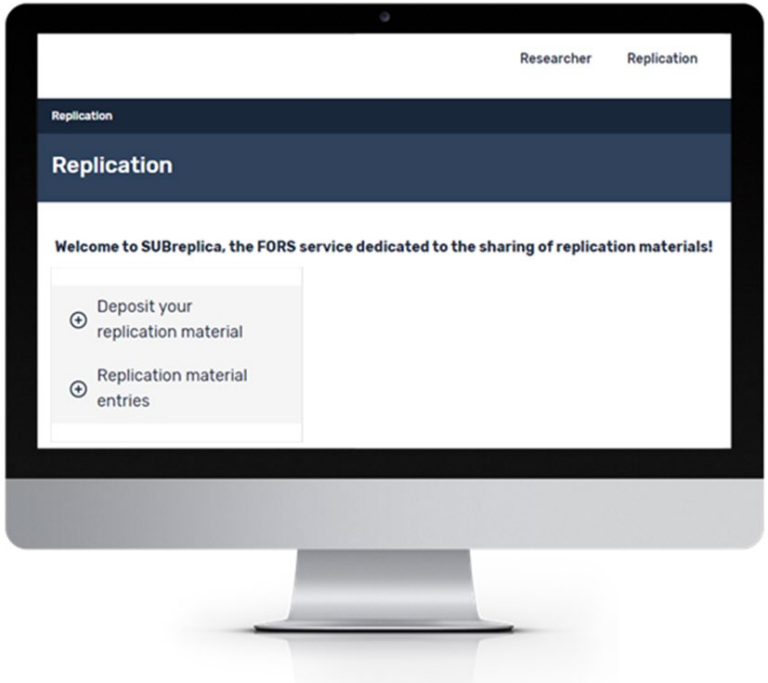
What is FORS Replication Service for?



- It is a tool for the dissemination of replication materials related to publications.
- It enables uploading replication materials and obtaining a DOI.
- It provides access to scientific journals or any other interested people to replication materials.

FORS Replication Service. (n.d.). *Home*. Retrived August 26, 2024, from https://resources.swissubase.ch/replication/deposit-your-replication/

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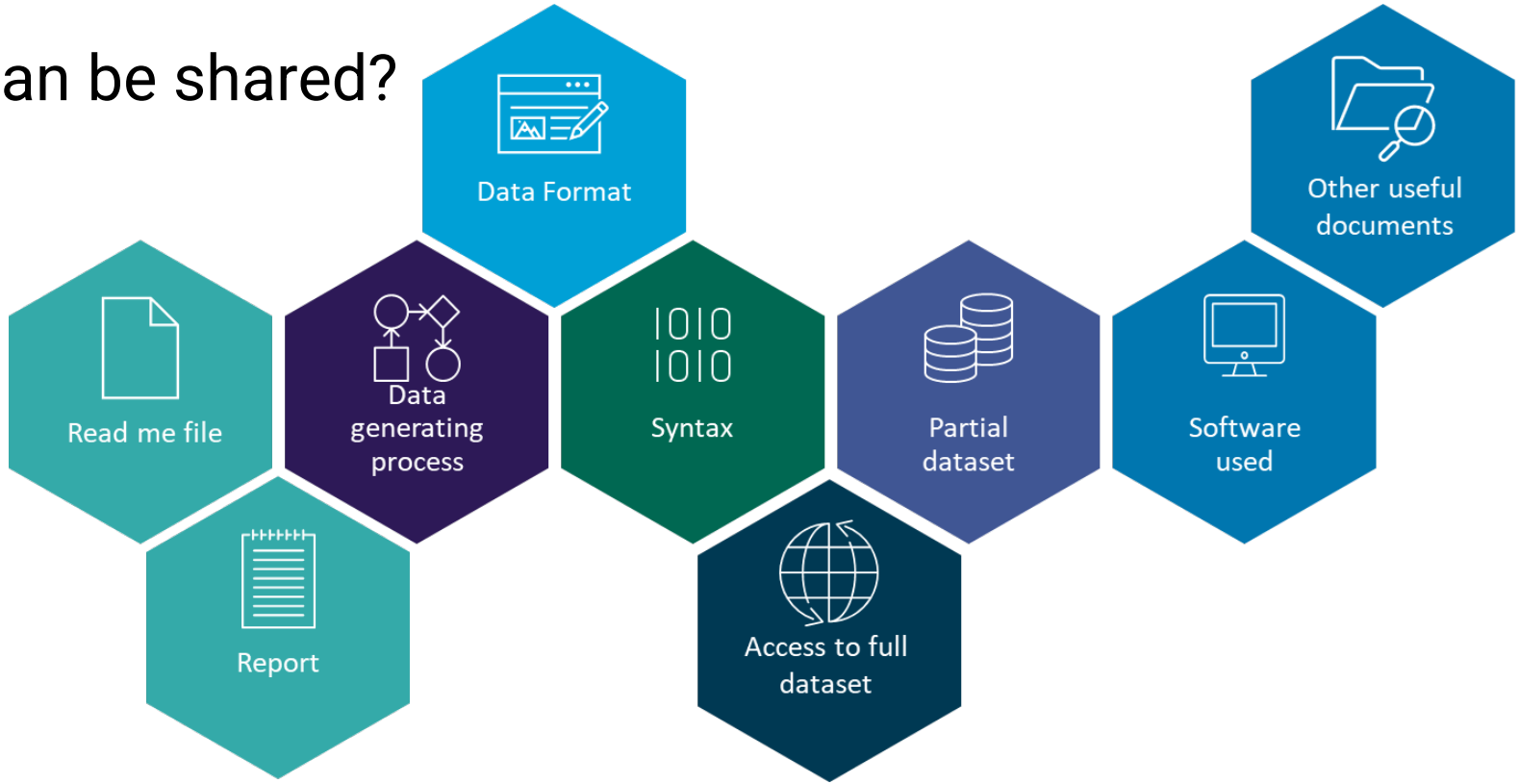
What can be shared?



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How? The deposit of replication materials in 4 easy steps

Download

Click on «Deposit your replication material» and download the deposit form

Complete

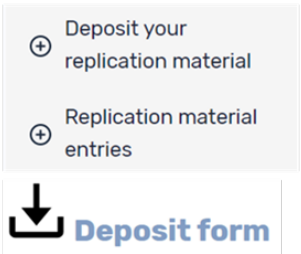
Download the deposit form and complete the metadata

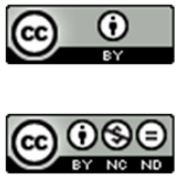
Choose

Choose the creative commons license you want your replication material to be under

Send

Send the completed deposit form and all the replication materials to *dataservice@fors.unil.ch*





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Data Citation & Data availability statements

Recognizing, Tracking and Reusing Data

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What?

Data availability statement:

A short note explaining how and under what conditions the data underlying a publication can be accessed.

Data citation:

A standard reference similar to a regular bibliographic that points specifically to a dataset.

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TRANSPARENCY

CREDIBILITY

INTEGRITY

RIGOR

DISCOVERABILITY

REUSABILITY

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How? Data Availability Statement

Display

- Place **outside the paywall**

Include

- State that data exists
- Where the data can be found
- Persistent identifiers (e.g. DOI)
- Repository or institution identifiers
- Licensing and access conditions

Example: *“The data supporting this study are available in [Repository Name] at [DOI or link], under [license/access conditions].”*

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How? Data Citation

Minimum core components

- Author(s)
- Title of the data
- Publication year
- Version
- Data publisher
- Persistent identifier

Additional components

- Data number
- Ressource type
- Place of publication
- Access date

> ***"data should be considered legitimate, citable products of research"***
>
> Force 11 Joint Declaration of Citation Principles

Examples

APA (7th edition): Author(s) (Publication year). *Data title* (Data number; Version) [Resource type]. Publisher. Persistent identifier

MLA (7th edition): Author(s). *Data title*. Version. Place of publication: Publisher, Publication year. Medium of publication. Date accessed. Persistent identifier

Source: Data Citation Synthesis Group: Joint Declaration of Data Citation Principles. Martone M. (ed.) San Diego CA: FORCE11; 2014 https://doi.org/10.25490/a97f-egyk

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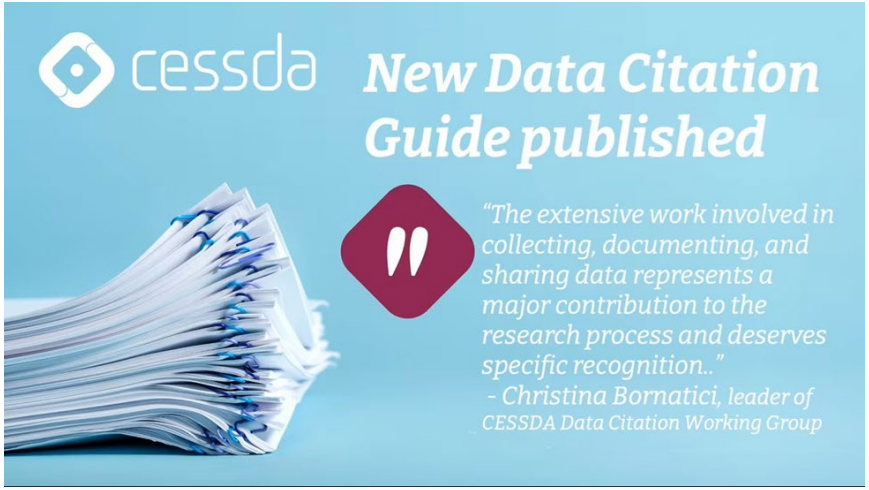
Resources on Data Citation

FORS GUIDES
to survey methods and data management

Data Citation:
How and Why Citing (Your Own) Data

Christina Bornatici and Nicolas Fedrigo

https://doi.org/10.24449/FG-2023-00019



https://datacitation.cessda.eu

Source: Bornatici, C. & Fedrigo, N. (2023). Data Citation: How and Why Citing (Your Own) Data. FORS Guides, 19, Version 1.1, 1-15. https://doi.org/10.24449/FG-2023-00019
Source: Bornatici, C., Jernung, A., Alaterä, T. J., Tveit Sandberg, L., Strand, K., Štebe, J., & Trtíková, I. (2025). *CESSDA Recommendations on Data Citation: Practical Recommendations for Key Stakeholders*. https://doi.org/10.5281/zenodo.15043854

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Why?

Advantages for the public

- Greater visibility of research data, during and after peer review
- Stable links between articles and data
- Support reproducibility, reuse and reduce waste

Advantages for researchers

- Credit for data producer
- Increase in citations
- Access to datasets for reuse or further research
- Compliance with the requirements of funders and institutions

Advantages for publishers

- Promote open science and reproducible research data
- Strengthen journal and repository collaborations
- Support authors in meeting funder requirements

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Linked Open Data & Semantic Interoperability

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Semantic Web

- Semantic Web extends the web by enabling data to be shared and reused across systems
  - Traditional web is human-readable
  - Semantic Web enables machine-readable data
- Tim Berners-Lee (Scientific American 284.5, 2001, S. 37)

  «*The Semantic Web is not a separate Web but an extension of the current one, in which information is given well-defined meaning, better enabling computers and people to work in cooperation.*»

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Semantic Web

- Core technologies
  - Standards such as Resource Description Framework (RDF), Web Ontology Language (OWL), SPARQL query language
- Publication of structured and semi-structured data in standardised formats on the internet
- Publication of data elements and their relationships on the internet – using Uniform Resource Identifiers (URIs) or International Resource Identifiers (IRIs) to identify data elements and their relationships
- Formalisation of the intended semantics through ontologies

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Ontologies

- shared understanding of a domain is necessary to overcome terminological differences
- Terminological inconsistencies are common challenges
- **Common problems/inconsistencies**
  - 2 ontologies use the same term with different meanings

    Example: ‘monument’ in architecture and archaeology
  - 2 ontologies use different terms but mean the same thing

    Example: ‘Ptolemaic period’ vs. ‘Greek period of Egypt’

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Ontologies

- **Possible solutions**
  - Use of a common ontology (e.g. dcterms, schema, CIDOC-CRM, fbroo)
  - Define direct mappings between different ontologies & data models
- Ontologies support semantic interoperability
  - Improving search accuracy
  - Generalisation/specialisation in web searches
- Ontologies can be interpreted by both humans and machines

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Authority data

- Controlled vocabulary for the standardisation of names, terms and identifiers
- Purpose: To ensure consistency and accuracy in cataloguing and data retrieval
    - Unique identification: Distinguishing between entities with similar or identical names
    - Consistency: Uniform use of names and terms across different datasets
    - Standardisation: Standard formats for names, titles, etc.
    - Interoperability: Enables collaboration between different systems

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Authority data

Examples

- Gemeinsame Normdatei (GND)
- Identifiants et Référentiels pour l'enseignement supérieure et de la recherche (IdRef)
- Virtual International Authority File (VIAF)
- Library of Congress Name Authority File (LCNAF)

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Authority data

Examples: Getty Vocabulary

- Art and Architecture Thesaurus (AAT)
- Iconography Authority (IA) Online
- Union List of Artist Names (ULAN)
- Getty Thesaurus of Geographic Names (TGN)
- Cultural Objects Name Authority® Online (CONA)

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Linked (Open) Data

- **Linked data**
  - is structured data that is linked to other data
  - makes it more useful for semantic queries
- Term coined by Tim Berners-Lee (2006) in a design note (https://www.w3.org/DesignIssues/LinkedData.html)
- **Linked Open Data** (LOD) is structured data that is linked to other data and, furthermore, published under an open licence (CC0, CC BY)
  - Examples: Wikidata, DBpedia

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Linked (Open) Data

- **Key components of Linked (Open) Data**
  - URIs
  - HTTP
  - Structured data using controlled vocabularies and data model definitions, expressed in Resource Description Framework serialisation formats such as RDFa, RDF/XML, N3, Turtle or JSON-LD
  - Linked Data platform

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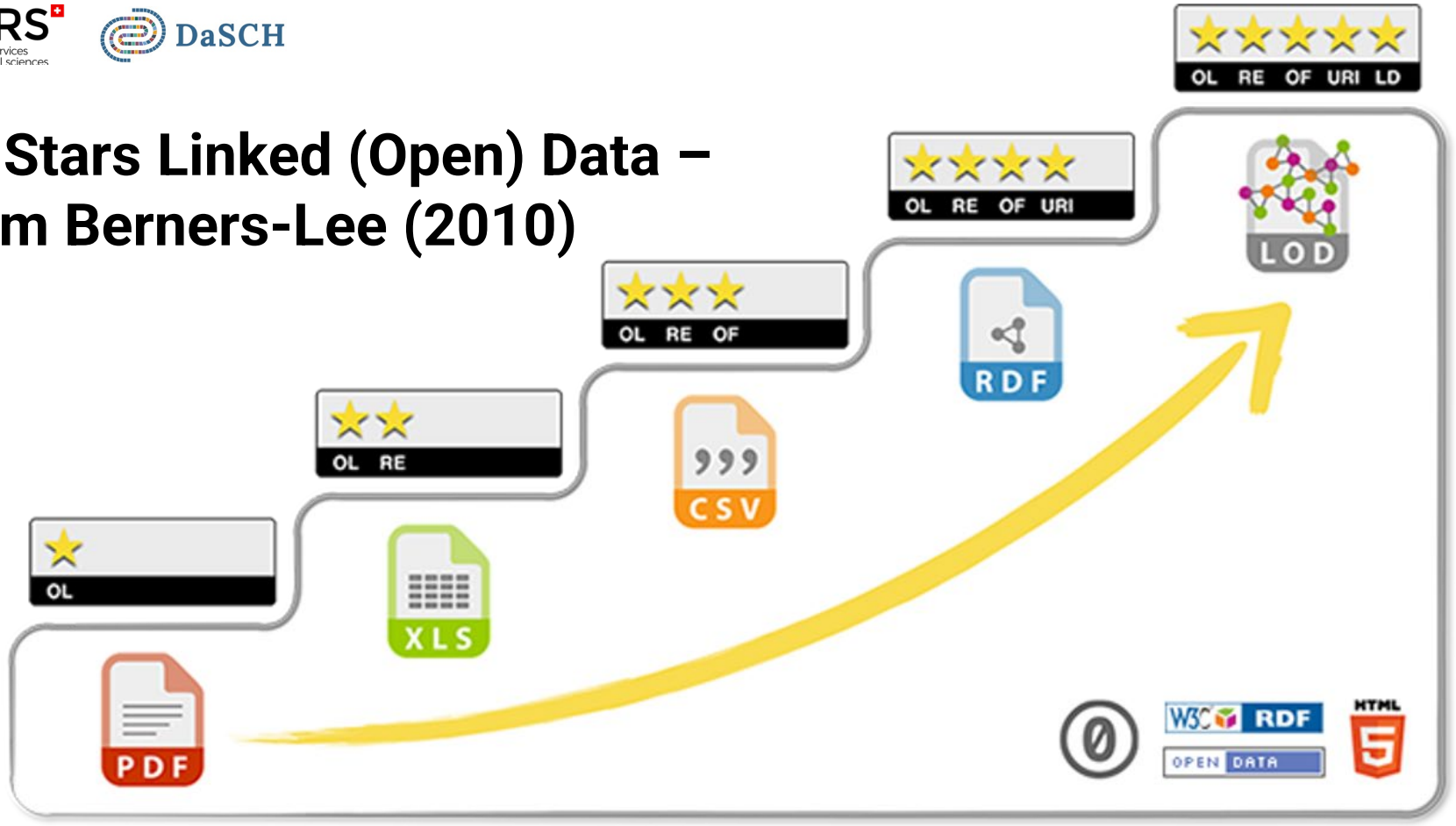
5-Stars Linked (Open) Data – Tim Berners-Lee (2010)



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Benefits

- Interoperability
- Discoverability
- Reuse
- Reproducibility

Applications

- Knowledge Graphs, Digital Humanities, Cultural Heritage

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Important Standards

Use of standards: TEI

Text Encoding Initiative (TEI)

- standard for encoding texts in digital form, widely used in the humanities
- TEI is a set of guidelines for representing texts in Extensible Markup Language (XML)
- maintained by the TEI Consortium
- TEI enables generation of structured, machine-readable texts
- supports analysis, preservation, and reuse
- hierarchical and human-readable

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TEI

Use of standards: TEI

Applications

- Digital editions
- Manuscripts
- Corpora
- Cultural Heritage Data

- texts are encoded with tags that describe structure and meaning

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TEI

Use of standards: TEI

Main parts

- <teiHeader> (metadata)
  - title
  - author
  - source
- <text> (content)
  - marks structure (e.g. chapters, paragraphs)
  - marks entities (e.g. names, dates, places)

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TEI

TEI teiHeader fileDesc titleStmt

```xml
<?xml version="1.0" encoding="UTF-8"?>
<?xml-model href="http://www.tei-c.org/release/xml/tei/custom/schema/relaxng/tei_all.rng" type="application/xml" schematypens="http://relaxng.org/
<?xml-model href="http://www.tei-c.org/release/xml/tei/custom/schema/relaxng/tei_all.rng" type="application/xml"
   schematypens="http://purl.oclc.org/dsdl/schematron"?>
<TEI xmlns="http://www.tei-c.org/ns/1.0">
   <teiHeader>
      <fileDesc>
         <titleStmt>
            <title>Title</title>
         </titleStmt>
         <publicationStmt>
            <p>Publication Information</p>
         </publicationStmt>
         <sourceDesc>
            <p>Information about the source</p>
         </sourceDesc>
      </fileDesc>
   </teiHeader>
   <text>
      <body>
         <p>Some text here.</p>
         <div>
            <p>A list:</p>
            <list type="bulleted">
               <item>First item</item>
               <item>Second item</item>
               <item>Third item</item>
            </list>
         </div>
         <div>
            <p>A table:</p>
            <table>
               <row>
                  <cell role="label">first column</cell>
                  <cell role="label">second column</cell>
               </row>
               <row>
                  <cell>value 1</cell>
                  <cell>value 2</cell>
               </row>
            </table>
         </div>
      </body>
   </text>
</TEI>
```


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International Image Interoperability Framework

Use of standards: IIIF

- International Image Interoperability Framework (IIIF)
- https://iiif.io/
- international open standards
- frequently used in the field of cultural heritage, particularly by museums, libraries, archives and research institutions
- several APIs that enable advanced image processing, presentation and data exchange

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International Image Interoperability Framework

Use of standards: IIIF

Image API

- provides standardised access to images hosted on web servers
- users can request images in various sizes, formats, orientations and regions

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International Image Interoperability Framework

Use of standards: IIIF

Examples:

- original image: https://iiif.dasch.swiss/0803/H2Kye390dOP-FJpCoZWaF9C.jp2/full/5451,7062/0/default.jpg
- A square image crop of 2000x2000px, rotated by 90°: https://iiif.dasch.swiss/0803/H2Kye390dOP-FJpCoZWaF9C.jp2/square/2000,2000/90/default.jpg

Dann all auch die Diener da zu kamen er auch sin
angeborner feind was Darumb er sie erste vnd für
für hielte Das er von allem seinem hoffgesind vnd
seinen freunden vnd gonnern geeret wart

Nun molest Do graff Emich nach siner ge
wanheit vff einem gerent was Da die
seinen Hyten ein wildes schwin vor den hunden
hin vnd zuch Das gantz gerent hin nach gen sich
Darumb der vorgenant graff Der gerent schnell
nochgillie vff seinem stedten vnd vergessen
vnd Illte sin Raymont gar schnell nach vmb Das
er seinen vettern nit verlür In dem walld Vnd
Dich Dis der walld von Colombier vnd es was
spot an tag Das sach dem monestryn Ritter,
In dem walld vnd Illte dem gerente nach Vnd

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International Image Interoperability Framework

Use of standards: IIIF

Presentation API

- describes the structure and metadata of digital objects such as images, books or manuscripts using JSON
- enables the creation of complex, multi-page objects

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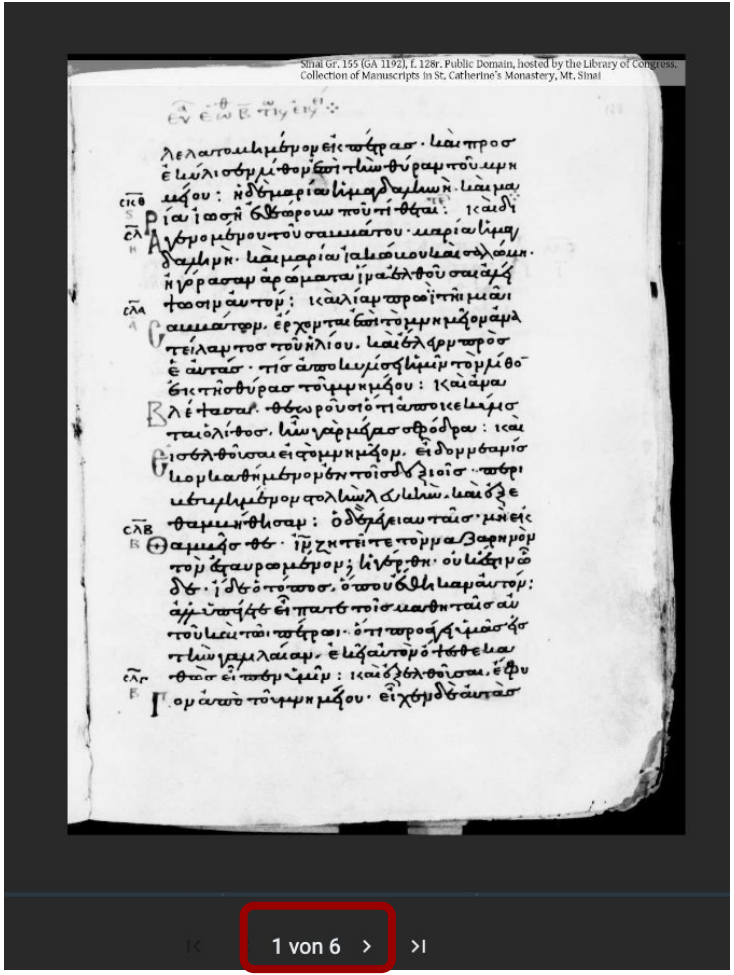
International Image Interoperability Framework

Use of standards: IIIF

Images

- detailed zooming, comparisons, structure and annotations are possible
- https://ark.dasch.swiss/ark:/72163/1/0838/rS2oEITHTbi8HTWwJz3QFA1
- https://ark.dasch.swiss/ark:/72163/1/0844/=Ws=lKGvT5ShPfIWTjK71wV

Annotation



Structure

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International Image Interoperability Framework

Use of standards: IIIF

Audios and videos

- several film reels, together with subtitles, transcripts, translations and notes
- Cookbook: https://iiif.io/api/cookbook/ (IIIF Manifest)
  - https://iiif.io/api/cookbook/recipe/0009-book-1/
  - https://iiif.io/api/cookbook/recipe/0017-transcription-av/
  - https://iiif.io/api/cookbook/recipe/0219-using-caption-file/

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Use of standards: IIIF

Other IIIF APIs

- Content Search API – to search annotations
- Authorization Flow API – to control access
- Change Discovery API – for aggregators to retrieve IIIF data
- Content State API – improvement to the method of transferring content from one viewer to another

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Use of standards: IIIF

Extensions

- Maps Extension – to link a geographical location to an IIIF object (georeferencing)

Examples:

- https://iiif.io/api/cookbook/recipe/0240-navPlace-on-canvases/
- https://iiif.io/api/cookbook/recipe/0154-geo-extension/

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Example of use: Getty Museum Collection

https://www.getty.edu/art/collection/object/103VQF#full-artwork-details

Respective IIIF Manifest:

https://media.getty.edu/iiif/manifest/ee9d8817-4a38-4d9a-94bd-08c028d32361

The file does not need to be stored locally for IIIF-compatible viewers (e.g. Mirador, Universal Viewer) – the URL of the IIIF Manifest is sufficient!

https://universalviewer.io/uv.html?manifest=

e.g.

https://universalviewer.io/uv.html?manifest=https://media.getty.edu/iiif/manifest/ee9d8817-4a38-4d9a-94bd-08c028d32361

85.AM.271

Finger Ring with the Ambush of Achilles

550–500 B.C.

Unknown artist/maker

Not currently on view

View full record details

Public Domain

3 images

Front

Impression

Profile

An intricate scene decorates the bezel of this Etruscan ring. Two men approach a fountain where water gushes into a vessel from a lion's head spout. Behind the fountain, a man squats as if hiding, holding a sword. These details identify the scene as a standard depiction of the ambush of Troilos, prince of Troy, by the Greek hero Achilles during the Trojan War. On this ring, however, a strange dog-headed creature, who is not part of the Troilos myth, sits atop the fountain. The creature may actually be jackal-headed and thus meant to recall the Egyptian god Anubis.

All Greek and Etruscan metal rings with engraved bezels ultimately derive from Egyptian and Phoenician cartouche-

Finger Ring with the Ambush of Achilles
Unknown artist/maker

APIs & other identifiers

The reference information listed below is intended for those who work with the Getty's data.

API URL:
object/4885977c-5bd4-49a9-a8b7-a658f93f1352 ↗
The entity identifier in the Museum Collection API

TMS ID:
13001
The identifier in the Museum's internal collection management system

DOR ID:
10997
The identifier in the Museum's legacy internal digital object repository

IIIF:
Manifest URL (v2) ↗
Manifest URL (v3) ↗
Open in comparison viewer ↗
The International Image Interoperability Framework, or IIIF, is an open standard for delivering high-quality, attributed digital objects online at scale. Visit iiif.io to learn more.

SPARQL API:
Open in Query Builder ↗
The SPARQL API provides an endpoint and interface for constructing graph queries of the Museum Collection Linked Open Data

Related IDs:
Internal Identifier Relationships ↗
The ID management system records relationships between identifiers across Getty's systems and resources

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Example of use: IIIF 3D

- IIIF standard for 3D is still under development
- Image and Presentation API 4.0 (release June 2026) include the first implementations

Example: IIIF Manifest

https://gautschr.github.io/3D-modelling/iiif-manifests/mitreo/mitreo.json

View via Universal Viewer:

https://uv-v4.netlify.app/#?manifest=https://gautschr.github.io/3D-modelling/iiif-manifests/mitreo/mitreo.json&c=&m=&cv=&xywh=

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Example of use: IIIF 3D

- Instructions on how to deploy a 3D model using GitHub Pages, create IIIF manifests, and display both: https://gautschr.github.io/3D-modelling/
- Test how it looks in different 3D viewers: https://morphosource.github.io/manifestival/
- Example IIIF 3D Manifests:
  - https://gautschr.github.io/3D-modelling/iiif-manifests/St._Gallus_Kirche/St._Gallus_Kirche.json
  - https://gautschr.github.io/3D-modelling/iiif-manifests/pharos/pharos.json
  - https://gautschr.github.io/3D-modelling/iiif-manifests/zytglogge/zytglogge.json

Viewer: Aleph + UV (MorphoSource)

Load Manifest Into Viewer

Mithraeum in the Baths of Mithras in Ostia

ATTRIBUTION

Provided by Rita Gautschy


```
items": [
{
 "id": "https://github.com/gautschr/3D-modelling/edit/main/iiif_manif
 "type": "Scene",
 "items": [
  {
   "id": "https://github.com/gautschr/3D-modelling/edit/main/iiif_ma
   "type": "AnnotationPage",
   "items": [
    {
     "id": "https://github.com/gautschr/3D-modelling/edit/main/iiif_m
     "type": "Annotation",
     "motivation": ["painting"],
     "body": {
      "id": "https://raw.githubusercontent.com/gautschr/3D-modellir
      "type": "Model",
      "format": "model/gltf-binary"
```


Select an Example Manifest

https://gautschr.github.io/3D-modelling/iiif-mar

Load

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Save the Date!

Eighth Webinar

Topic **Copyright, Authorship & Licenses**

When **September 29, 2026 at 2pm**

Where **Online**

Source: Freepik, Marsiholo

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Questions?

Source: Abscent84 / Getty Images