HELMHOLTZ
Open Science

On the Path to a Quality Indicator for Software and Data Publications for the Helmholtz Association

A Workshop Report

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Helmholtz-Association, Helmholtz Open Science Office

Spring Symposium 2024 of the Fachgruppe Database Systems (FG DB) "Beyond Silos: Next Steps in Research Data Management"

Jena, 11.-12.03.2024

Agenda

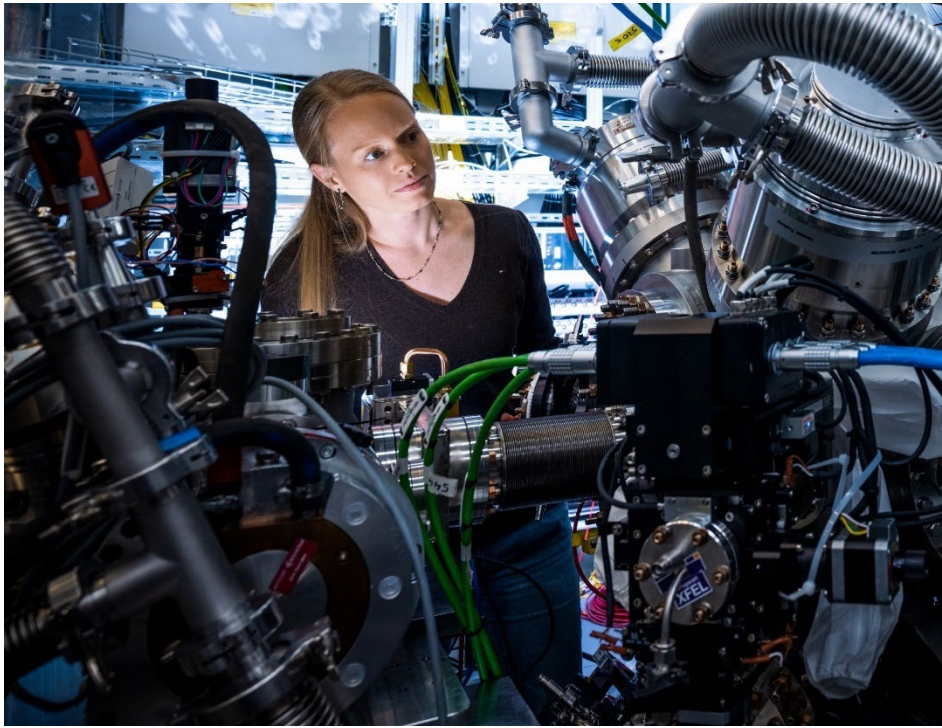
- Helmholtz
- Key Performance Indicators in the Program-Oriented Funding (PoF)
- Quality Indicator - Work in Progress
  - Software Publications (Overview)
  - Data Publications (Detail)
- Opportunities, Outlook, Challenges

Helmholtz

Helmholtz: Mission and Strategy

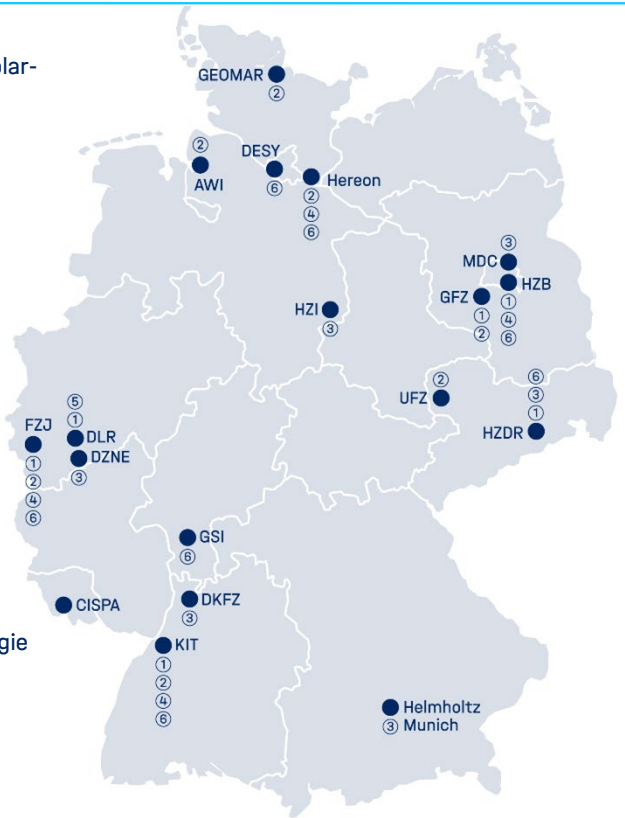
Research for Grand Challenges

- Systems solutions for grand challenges based on:
  - Scientific excellence
  - Interdisciplinarity and critical mass
  - long term research programs
- Helmholtz provides a highly attractive environment for talents and brilliant brains
- Profound expertise in large scale research infrastructure
- Helmholtz as a prime strategic partner at the local, national and international level
- Transfer of knowledge into economy and society



Helmholtz research centers
18 Centers in 6 Research Fields

- Alfred-Wegener-Institut Helmholtz-Zentrum für Polar- und Meeresforschung (AWI)
- CISPA - Helmholtz Center for Information Security
- Deutsches Elektronen-Synchrotron DESY
- Deutsches Krebsforschungszentrum (DKFZ)
- Deutsches Zentrum für Neurodegenerative Erkrankungen (DZNE)
- German Aerospace Center (DLR)
- Forschungszentrum Jülich (FZJ)
- GEOMAR Helmholtz-Zentrum für Ozeanforschung Kiel
- GSI Helmholtz Center for Heavy Ion Research
- Helmholtz Munich
- Helmholtz-Zentrum Berlin für Materialien und Energie (HZB)
- Helmholtz Center Dresden Rossendorf (HZDR)



- Helmholtz Center for Infection Research (HZI)
- Helmholtz Center for Environmental Research - UFZ
- Helmholtz-Zentrum Hereon
- GEOMAR Helmholtz Center for Ocean Research Kiel
- Helmholtz Center Potsdam - German Research Center for Geosciences GFZ
- Karlsruhe Institute of Technology (KIT)
- Max Delbrück Center for Molecular Medicine in the Helmholtz Association (MDC)

Research Fields:
(1) Energy, (2) Earth and Environment
(3) Health, (4) Information
(5) Aeronautics, Space and Tansport, (6) Matter

Helmholtz Open Science Office:
Core & Focus Topics 2023/2024

Core Topics:

Open Access

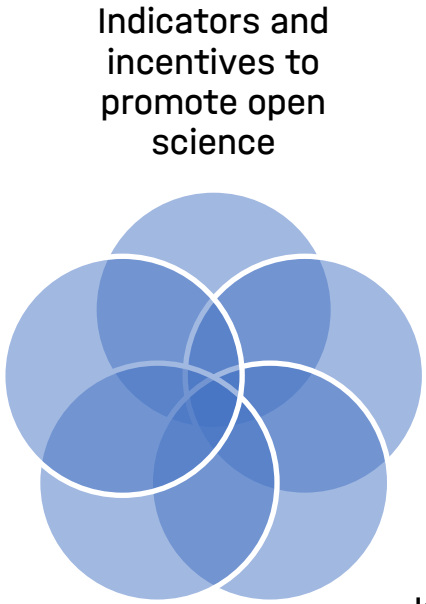
Open Research Data

Open Research Software

National and international Networking

HELMHOLTZ
Open Science

Focus Topics

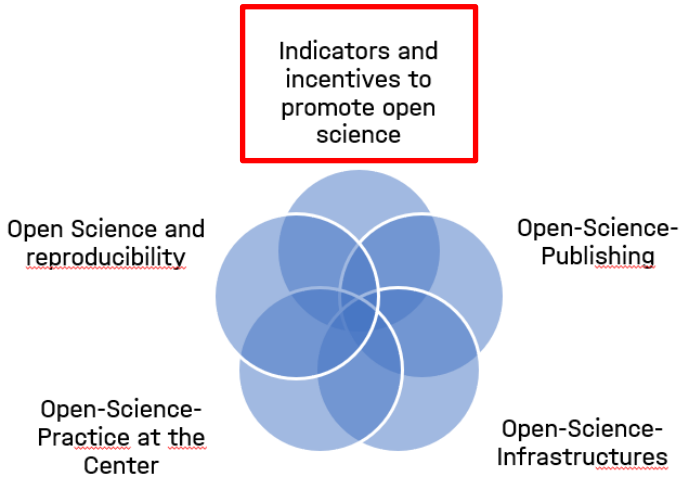


Key Performance Indicators in the Program-Oriented Funding (PoF)

Helmholtz
Program-Oriented Funding (PoF)

- Direction and structure for research at Helmholtz
- Strategic evaluation und scientific evaluation
  - at the level of the centers and the existing programs
- Central lever

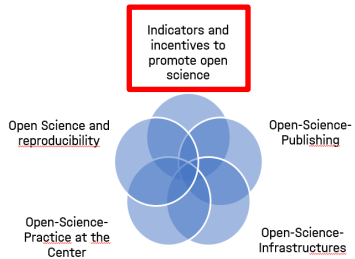
→ Among others:
Collection of key performance indicators



1: https://www.helmholtz.de/ueber-uns/struktur-und-governance/programmorientierte-foerderung/

Program-Oriented Funding – KPI "Status Quo"

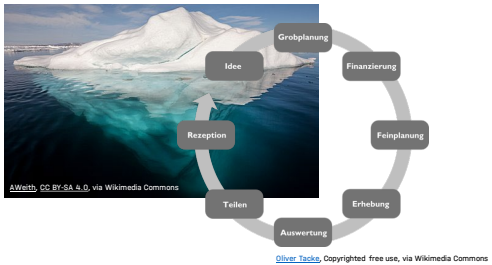
"The scientific evaluation is focused on scientific quality. The results serve to provide a review of the performance of both the Helmholtz Center and the individual, usually cross-center programs. Both aspects are equally important: The centers are the driving force behind the Association, since this is where research is carried out and where new insights are gained..."[1]



With regard to output (in the sense of published research artifacts) so far:

- Number of articles in peer-reviewed journals (indexed in Web of Science and/or Scopus or published by Open Research Europe ORE)
- Share of Open Access

Focus on the „Final Product" of science



1: https://www.helmholtz.de/en/about-us/structure-and-governance/program-oriented-funding/

Program-Oriented Funding – KPI "Status Quo"

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Focus on the „Final Product" of science

- give value to all relevant research activities and scientific outputs including high-quality FAIR data and metadata, well-documented and reusable software, protocols and workflows, machine-readable summaries of findings, and teaching, outreach and engagement of societal actors;

Program-Oriented Funding – Quality Indicator

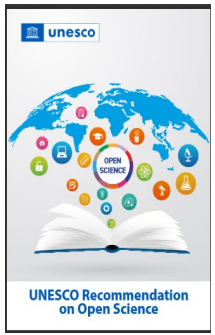
Mandate of the Helmholtz General Assembly (2022):

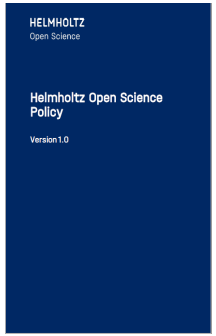
- Development of a multidimensional quality indicator for data products

Goals:

- Broadening / Improvement of the evaluation of science within Helmholtz
- Improving the quality of published research data
- Promotion of Open Science Practices

Expansion of the mandate to include the aspect of research software





Open Research Data

All Centers will establish detailed procedures for managing research data in publicly available policies,[6] and will regularly examine and if necessary adapt these procedures.

In 2023, a basic indicator for the presentation of citable research data publications will be established as an incentive within the framework of the PoF.

By 2024, a Helmholtz quality indicator for research data publications will be developed and established, which will be deployed within the framework of the PoF and will replace the aforementioned basic indicator.

Open Research Software

All Centers will aim to establish detailed research software management procedures in publicly available policies by 2025.[7]

A basic indicator for the presentation of citable research software publications will be established in 2023 as an incentive within the framework of the PoF together with research data publications.

By 2024, a Helmholtz quality indicator for research software publications will be developed and established, which will be deployed within the framework of the PoF and will replace the aforementioned basic indicator.

Task Group
Helmholtz Quality Indicators for Data and Software Products

- Since March 2022, ongoing
- Inclusive approach: Representatives of all Helmholtz Centers
- Work in 3 groups:
    1. Whole group
    2. Sub-group research data
    3. Sub-group research software
- Relevant products and events
    - Report on Helmholtz Open Science Forum „Indikatoren für Open Science": https://doi.org/10.48440/os.helmholtz.024
    - Report on Helmholtz Open Science Forum "Research Evaluation, Reputation Systems, and Openness" https://doi.org/10.48440/os.helmholtz.065

https://os.helmholtz.de/open-science-in-helmholtz/arbeitskreis-open-science/task-group-helmholtz-qualitaetsindikatoren-fuer-daten-und-softwareprodukte/

Quality Indicators - Work in Progress

Quality Indicators – Work in Progress

Basic Indicator, Lessons Learned, Challenges

Reporting year 2022: initially basic indicator (internal test collection)

Zitierbar publizierte Forschungs-daten- und Forschungs-software-Publikationen

[Anzahl]

Helmholtz Definition
Anzahl von zitierbar publizierten Forschungsdaten-Publikationen und Forschungssoftware-Publikationen sind je separat zu erfassen.
Die zitierbar publizierten Forschungsdaten- und Forschungssoftware-Publikationen müssen in einem Repositorium mit Metadaten gespeichert und mit einem persistenten Identifikator (insb. Digital Object Identifier – DOI) versehen sein.
Erlaubte Repositorien sind solche, die entweder a) unter Beteiligung eines Helmholtz-Zentrums betrieben werden oder b) extern sind und in re3data.org gelistet oder zertifiziert sind. c) Für die Publikation von Forschungssoftware können etablierte Software-Repositorien genutzt werden.
Bei Softwarepublikationen wird jeder Release als Publikation gezählt.

Challenges for all Centers

→ Infrastructures for publication of RD/RSW

→ Processes for collecting information on RD/RSW-publications

→ Instruments for collection of (records on) RD/RSW-publications

Quality Indicators – Work in Progress

Challenges

- Text publications

→ established mechanisms of quality assurance

→ established formats (articles, monographs, proceedings,...)

= more or less "comparable units"

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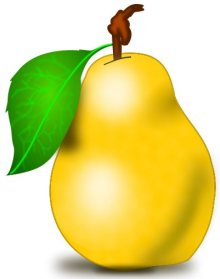


Alda Rizky Nur Afida, CC BY-SA 4.0, via Wikimedia Common

- Research Data/ Research Software

→ Missing "Quality" framework

→ Comparability

→ Granularity, versions, data types

→ Heterogeneity of centers, data and software (research areas)

→ Quantification

Quality Indicators – Work in Progress

Approach

Multidimensional Indicator

→ Mapping several quality dimensions to one value

Questions

- → Which dimensions of quality do we define for data and software publications?
- → Which attributes define the quality dimensions?
- → How can the attributes/dimensions be quantified?
- → How to get a single value via the attributes/dimensions?

Approach: Multidimensional Indicators

Iterative and inclusive process with all involved people

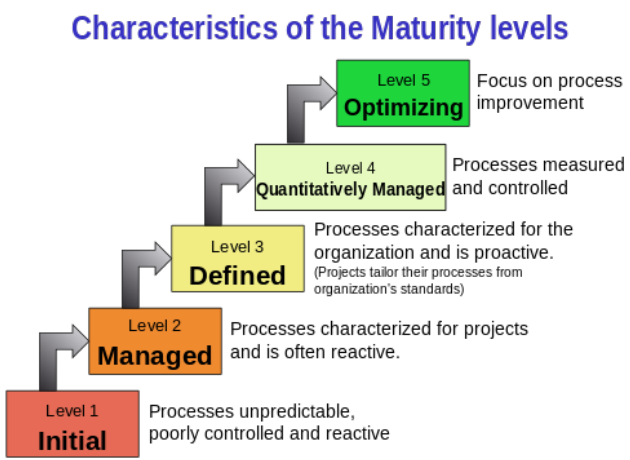
1. Definition of suitable dimensions for assessing the quality of RD- & RSW-publications
2. Collection of specific attributes for each dimension
3. Application of a generic maturity model to the attributes and assignment of numerical values for maturity levels in attribute
4. Determination of maturity level per dimension based on weighted average values of the attributes of each dimension
5. Summarized quality assessment (visualization using radar plot)

Quality Indicators – Work in Progress

Approach: Maturity model

3. Application of a generic maturity model to the attributes and assignment of numerical values for maturity levels in attribute

Concept after COBIT Maturity Model



Sally Godfrey, Public domain, via Wikimedia Commons (beispielhaft)

Research Data
(0) Non-existent: no information available or not applied
(1) Most necessary information provided or measure taken
(2) Basic information provided or measure taken (sensible level of information/measures)
(3) Advanced information provided or measure taken, allowing to generally understand and (re)use the published data
(4) Complete and accurate information provided or measure taken, to an extend that allows maximal understanding and usage of data

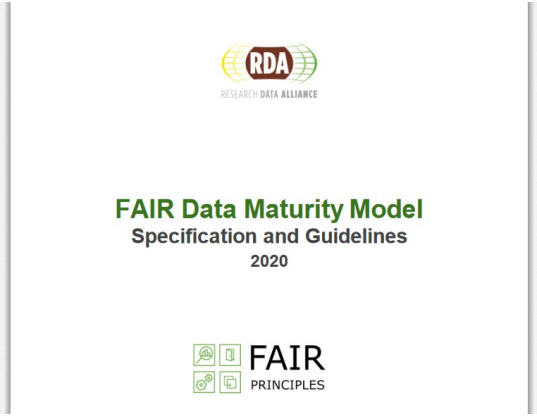
Research Software
(0) Non-existent: no information available
(1) Initial: initial information available being obtained in an ad-hoc, unorganized manner
(2) Repeatable: the information is complete, being produced in a repeatable, yet intuitive manner
(3) Defined: a process is established guaranteeing the complete compilation of the required Information
(4) Managed: the process being established is managed, i.e. monitoring/measuring is included
(5) Optimized: practices are put in place optimizing the way the process is operated, leading to improved quality over time

Quality Indicators – Work in Progress

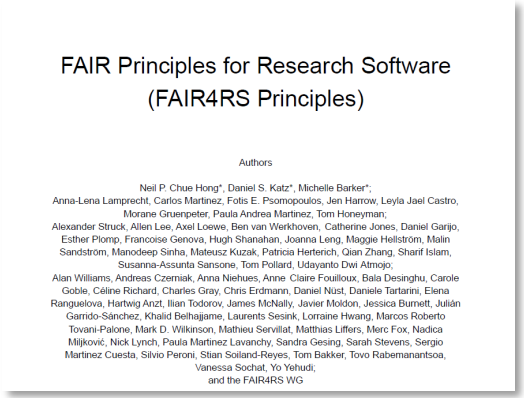
Approach: In general applying FAIR-Principles

1. Definition of suitable dimensions for assessing the quality of RD- & RSW-publications
2. Collection of specific attributes for each dimension

Wilkinson, M. et al. (2016). https://doi.org/10.1038/sdata.2016.18



RDA FAIR Data Maturity Mod el Working Group (2020). https://doi.org/10.15497/rda00050



Chue Hong, N. P. et al. (2021). FAIR Principles for Research Software (FAIR4RS Principles). Research Data Alliance. https://doi.org/10.15497/RDA00065

Quality Indicators – Work in Progress

Approach: Software – Dimensions (Overview)

FAIR-ST Framework

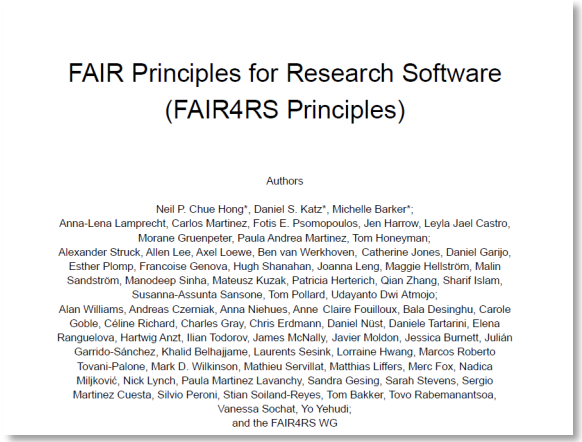
Findable – Accessible – Interoperable – Reusable

Scientific basis

Research software is an integral part of the research process. It therefore has to also follow community/organization specified common standards in performing research. While the contribution of software to a certain scientific achievement must be evaluated by dedicated experts in the field, some aspects of scientific quality can also be considered in wider generality.

Technical basis

Quality of software also reflects general aspects of software engineering. At the end, software has to guarantee to actually produce what it has been aimed to do. Professional software development aims at producing software following state-of-the-art software engineering concepts. Thus, aspects of professional software engineering must also be considered as part of a quality assessment of research software development.


FAIR Principles for Research Software
(FAIR4RS Principles)

Authors

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and the FAIR4RS WG

Approach: Software – Dimensions (Overview)

FAIR-ST Framework

Findable – Accessible – Interoperable – Reusable

Attributes Findable:

- Open Publication Repository
- Versioning
- Persistent Identifier (PID)
- Rich Metadata

Approach: Software – Dimensions (Overview)

FAIR-ST Framework

Findable – Accessible – Interoperable – Reusable

Attributes Findable:

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Attributes Accessible:

- Access Conditions (organizational)
- Access Conditions (process)
- Technical Accessibility (run/start)

Approach: Software – Dimensions (Overview)

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Attributes Interoperable:
- Input/Output Formats
- Adaptability/Flexibility of Use

Approach: Software – Dimensions (Overview)

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Attributes Reusable:
- Reusability Conditions

Approach: Software – Dimensions (Overview)

FAIR-ST Framework

Scientific basis – Technical basis

Attributes Scientific basis:

- Community Standards
- Team Expertise
- Scientific Embedding

Approach: Software – Dimensions (Overview)

FAIR-ST Framework

Scientific basis – Technical basis

Attributes Scientific basis:

- Community Standards
- Team Expertise
- Scientific Embedding

Attributes Technical basis:

- Project Management
- Repository Structure
- Code Structure
- Reproducibility (Code)
- Code Change Process
- Security

Quality Indicators – Work in Progress

Approach: Data - Dimensions

POCME-Framework

Findable, **A**ccessible, **I**nteroperable, **R**eusable?

→ Regrouped and extended to

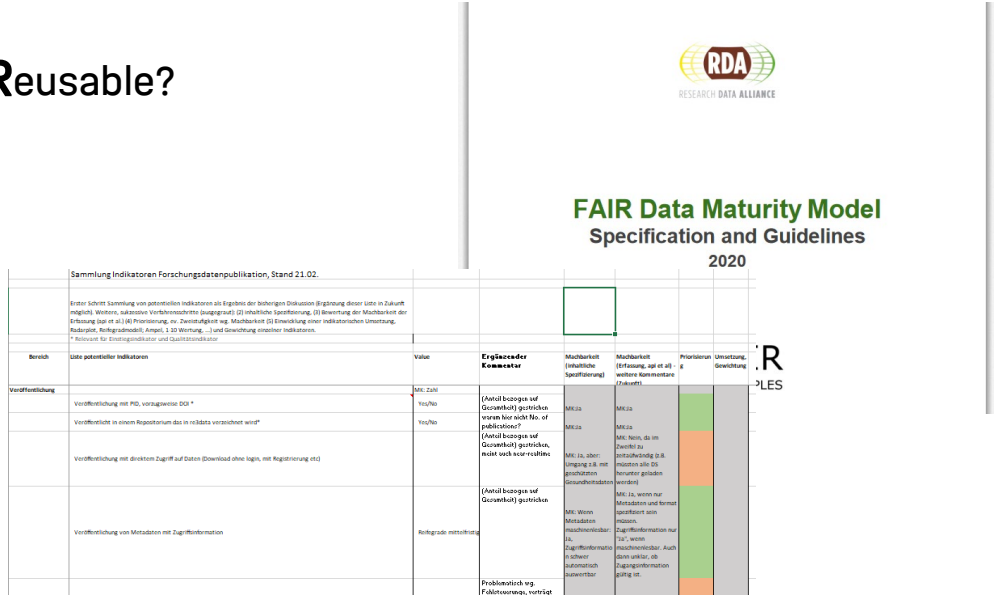
P-ublication

O-penness

C-uration

M-etadata

E-xternal View



Quality Indicators – Work in Progress

Approach: Data - Dimensions

POCME-Framework

Publication – Openness – Curation – Metadata – External View

- **Published with Identifier**

(0) No identifier (resource may only be found via personal communication)
(1) Basic Uniform Resource Identifier
(2) Dataset is identifiable via internal handle (does not resolve globally, generally no metadata)
(3) Dataset is basically identifiable via formalized, standardized, persistent identifier (resolves globally, general metadata provided)
(4) Dataset is identifiable via globally unique, formalized, standardized, persistent identifier supported by general metadata (e.g. DOI).

- **Published with Information on Access to the Data**

(0) No metadata available
(1) Metadata available, but no data access-information available in the metadata
(2) Metadata available, data access-information available only in human-readable form
(3) Metadata available, data access-information available only in human readable form, including general license information
(4) Metadata available, data access-information available in human-readable and machine-readable form, including license information

- **Published via a Repository or Collection, that is indexed in a Meta-Repository**

(0) No information available, the data is not published via a repository/collection
(1) The data is published in a repository/ collection which is not listed in an eligible metarepository
(2) The repository/collection is listed in an eligible meta-repository, basic no. of quality indicators assigned by the meta-repository are achieved
(3) The repository/collection is listed in an eligible meta-repository, medium no. of quality indicators assigned by the meta-repository are achieved
(4) The repository/collection is listed in an eligible meta-repository, high no. of quality indicators assigned by the meta-repository are achieved

Quality Indicators – Work in Progress

Approach: Data - Dimensions

POCME-Framework

Publication – Openness – Curation – Metadata – External View

- General Degree of Openness

(0) No information on open accessibility/availability of the data at all
(1) Information available: no open accessibility/availability of the data. No justification, no information on possible contact or restrictions
(2) Like (1) + information on possible contact, restrictions or potential use cases on request available
(3) Like (2) + with justification AND/OR date of moratorium
(4) Open accessibility with corresponding license (no login or contact needed or otherwise with justification)

- Primary Data Formats

(0) No primary data available in digital form
(1) Primary data generally available
(2) Primary data stored in common proprietary data formats
(3) Primary data stored in open formats
(4) Primary data makes use of common, domain specific terminologies (e.g., codelists)

Quality Indicators – Work in Progress

Approach: Data - Dimensions

POCME-Framework

Publication – Openness – **Curation** – Metadata – External View

- **Level of Curation**

(0) Data is published in raw form without any curation or documentation (e.g. raw long-tail data)
(1) Data is published in raw form without curation but according to standard with basic documentation like readme (e.g. automatic generated sensor data, long-tail data following a basic scheme)
(2) Data is published in cleaned form with some curation (e.g. brief checking, documentation according to standard)
(3) Data is published in cleaned form with enhanced curation and/ or reprocessing (e.g. conversion to new formats, enhancement of documentation)
(4) Data is published after undergoing extensive curation and/or reprocessing according to discipline specific standards in order to enhance to max. quality (like (3) + additional editing of deposited data for accuracy)

- **Community Standards for Data**

(0) Data is prepared/ recorded in a non-standardized form, no documentation
(1) Data is prepared/ recorded in a non-standardized form, but there is documentation of the used format (e.g. readme, codebook)
(2) Data is prepared/recorded following an institutional Standard Operation Procedures (SOP) with traceable reference to the used SOP-scheme
(3) Data is prepared/recorded following a Standard Operation Procedures (SOP) or Community standard reflecting a general level of domain specific standards; with traceable reference to the used standard or scheme
(4) Data is prepared/recorded following an acknowledged and openly accessible Standard Operation Procedure (SOP) or Community standard reflecting a high level of domain specific standards; with traceable reference to the used standard or scheme

Quality Indicators – Work in Progress

Approach: Data - Dimensions

POCME-Framework

Publication – Openness – Curation – **Metadata** – External View

- Metadata to find/retrieve a Resource / Formal Metadata

(0) No metadata available
(1) Metadata available for/with the data publication that is not structured according to a commonly accepted scheme (i.e. no scheme applied)
(2) Metadata provided with the data publication that is structured in a basic way according to a commonly accepted scheme (e.g. completed DataCite mandatory-properties/discovery ; Dublin Core, etc.)
(3) Metadata provided with the data publication that is structured in an advanced way, according to a commonly accepted scheme (e.g., completed Datacite mandatory- and recommended-properties for discovery + discovery-supporting basic content metadata
according to DataCite scheme)
(4) Full Metadata provided with the data publication (complete DataCite mandatory- and recommended- and optional-properties for discovery + comprehensive discovery-supporting content metadata according to DataCite scheme)

- Content related Metadata

(0) No content related metadata available
(1) Some content related metadata available, following a (generic) scheme (e.g. DataCite)
(2) Complete content related metadata available following a (generic) scheme (e.g. DataCite)
(3) Some content related metadata available following standardized form or domain specific scheme
(4) Complete and curated content related metadata available following a standardized form and domain specific scheme (see 3)

Approach: Data - Dimensions

POCME-Framework

Publication – Openness – Curation – Metadata – External View

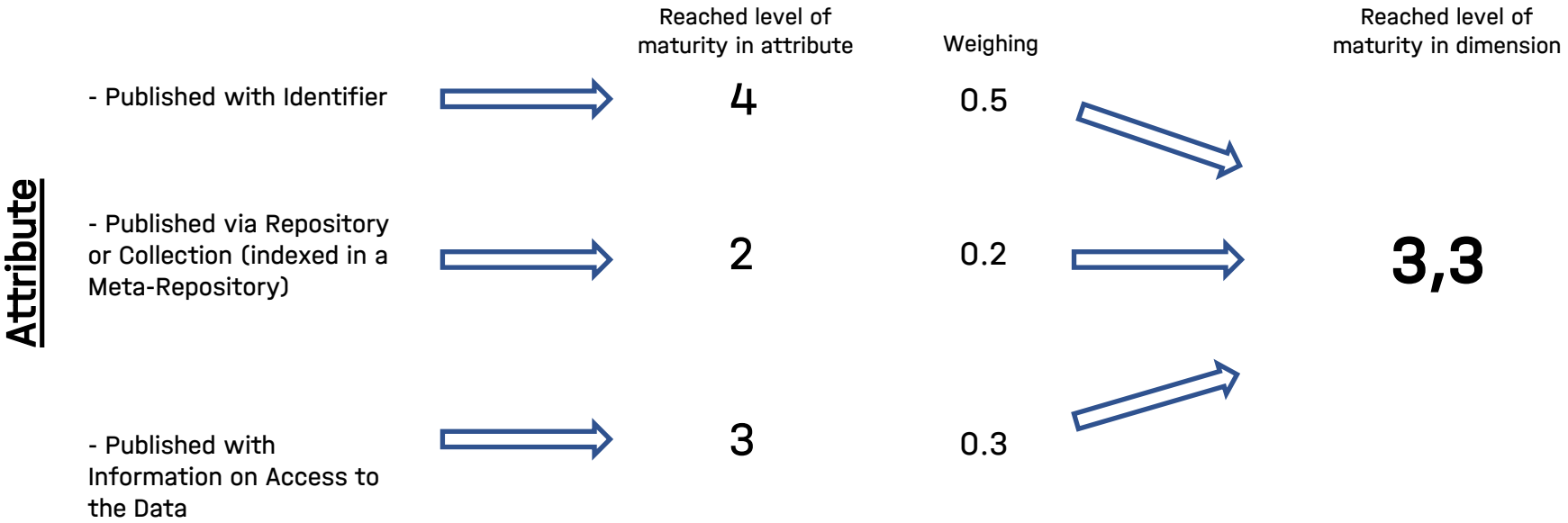
- Score from Domain Specific Fair Assessment Tool

(0) 0-20% Score reached
(1) 21-40% Score reached
(2) 41-60% Score reached
(3) 61-80% Score reached
(4) 81-100% Score reached

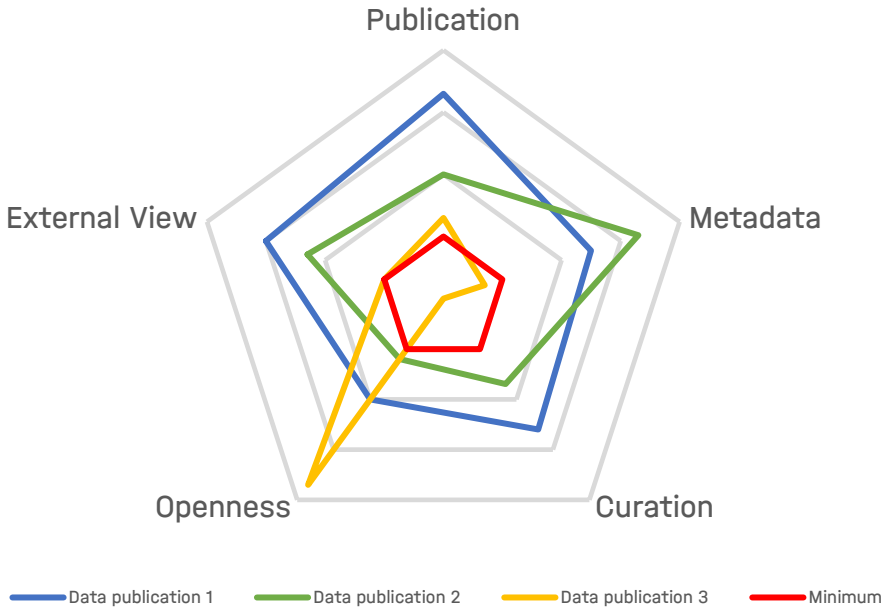
Quality Indicators – Work in Progress

Approach: Maturity model

Publication – Openness – Curation – Metadata – External View



Approach: Visualization and Aggregation



Aggregation (Considerations):

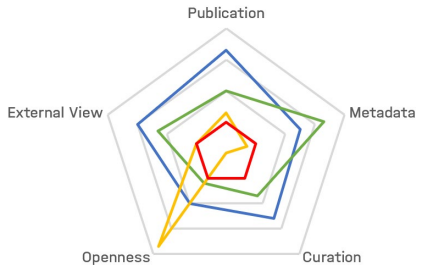
- Number of RD/RSW publications that fulfill a minimum value in each dimension?
- Number of RD/RSW with a minimum maturity (weighted across all dimensions)?
- ...?

Quality Indicators – Work in Progress

Opportunities

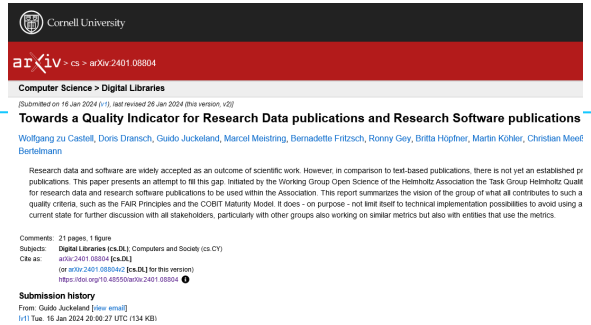
- more than just a simple number - reflects the quality of RD/RSW processes
- Different requirements and starting positions at institutional level can be mapped (radar plot)
- Radar plot delivers indications of potential for improvement at the level of the individual publication
- Incentive to improve internal processes

Research Fields:
(1) Energy, (2) Earth and Environment
(3) Health, (4) Information
(5) Aeronautics, Space and Tansport, (6) Matter



Quality Indicators – Work in Progress

Outlook and next steps


Cornell University

arXiv > cs > arXiv:2401.08804

Computer Science > Digital Libraries

[Submitted on 16 Jan 2024 (v1), last revised 26 Jan 2024 (this version, v2)]

Towards a Quality Indicator for Research Data publications and Research Software publications

Wolfgang zu Castell, Doris Dransch, Guido Juckeland, Marcel Meistring, Bernadette Fritzsch, Ronny Gey, Britta Höpfner, Martin Köhler, Christian Meeß Bertelmann

Research data and software are widely accepted as an outcome of scientific work. However, in comparison to text-based publications, there is not yet an established pr publications. This paper presents an attempt to fill this gap. Initiated by the Working Group Open Science of the Helmholtz Association the Task Group Helmholtz Qualit for research data and research software publications to be used within the Association. This report summarizes the vision of the group of what all contributes to such a quality criteria, such as the FAIR Principles and the COBIT Maturity Model. It does - on purpose - not limit itself to technical implementation possibilities to avoid using a current state for further discussion with all stakeholders, particularly with other groups also working on similar metrics but also with entities that use the metrics.

Comments: 21 pages, 1 figure

Subjects: Digital Libraries (cs.DL); Computers and Society (cs.CY)

Cite as: arXiv:2401.08804 [cs.DL]

(or arXiv:2401.08804v2 [cs.DL] for this version)

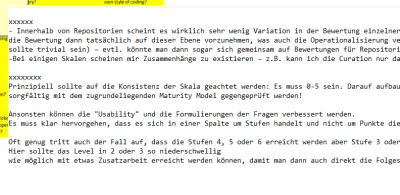
https://doi.org/10.48550/arXiv.2401.08804

Submission history

From: Guido Juckeland [view email]

[v1] Tue, 16 Jan 2024 20:00:27 UTC (134 KB)

- Concept has been published as white paper: https://doi.org/10.48550/arXiv.2401.08804
- Paper and Pencil-exercise with actual software and data publications
  - by groups from different research areas


xxxxxx
- Innerhalb von Repositorien scheint es wirklich sehr wenig Variation in der Bewertung einzelner
die Bewertung dann tatsächlich auf dieser Ebene vorzunehmen, was auch die Operationalisierung ve
sollte trivial sein) - evtl. könnte man dann sogar sich gemeinsam auf Bewertungen für Repositori
-Bei einigen Skalen scheinen mir Zusammenhänge zu existieren – z.B. kann ich die Curation nur da

xxxxxxxx
Prinzipiell sollte auf die Konsistenz der Skala geachtet werden: Es muss 0-5 sein. Darauf aufbau
sorgfältig mit dem zugrundeliegenden Maturity Model gegengeprüft werden!

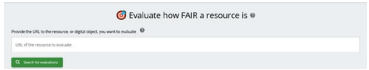
Ansonsten können die "Usability" und die Formulierungen der Fragen verbessert werden.
Es muss klar hervorgehen, dass es sich in einer Spalte um Stufen handelt und nicht um Punkte die

Oft genug tritt auch der Fall auf, dass die Stufen 4, 5 oder 6 erreicht werden aber Stufe 3 oder
Hier sollte das Level in 2 oder 3 so niederschwellig
wie möglich mit etwas Zusatzarbeit erreicht werden können, damit man dann auch direkt die Folges

Quality Indicators – Work in Progress

Outlook and next steps

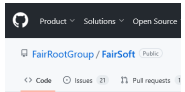
- On site workshop of the Task Group (20.&21.03.2024)
  - Evaluation / Analysis results Paper and Pencil-exercise
  - Consensus building on the feasibility of the attributes, Color coding (immediate, medium-term, long-term)
  - Tool market to identify a possible Helmholtz-Indicator-Toolbox
    Identify cooperations in automation



F-UJI Automated FAIR Data Assessment Tool

FAIRshake

HMC FAIR DATA DASHBOARD



- Transparent communication:
  a) to decision-makers what is currently possible/realistic to measure
  b) to the people who are supposed to collect the figures (create acceptance, addressing concerns

Challenges I

- Current status represents conceptual framework (what/how to measure in an ideal world)
- Difference between the centers in terms of the data/software generated/used
- Different starting positions and speeds of the centers
- Automation is challenging

Manual effort currently unavoidable

Quality Indicators – Work in Progress

Challenges II

Manual effort currently unavoidable - Discussions with regards to data publications

- Extension of the HMC FAIR Data Dashboard
- Creation of a Repository "White List" for Helmholtz Repositories; assessment process required based on defined Dimensions/ Attributes

- Data "in the wild" (aka in Repositories outside Helmholtz)?

→ re3data (~100 Repos with Helmholtz connection; scheme >40 attributes)

→ RDA Common Descriptive Attributes of Research Data Repositories
https://doi.org/10.15497/RDA00103

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Open Science

Thank you for your attention!

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- Mailing list for employees of Helmholtz: Helmholtz Open Science Professionals

- Helmholtz Open Science Newsletter
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