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Open Science

Helmholtz Open Science Briefing

Good (Digital) Research Practice and Open Science

Support and Best Practices for Implementing the DFG Code of Conduct “Guidelines for Safeguarding Good Research Practice”

Version 2.0

Imprint

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Abstract

The German Research Foundation's (DFG) Code of Conduct "Guidelines for Safeguarding Good Research Practice" has been in force since August 1, 2019. Open science aspects are of relevance to many of the guidelines contained in the Code. The Helmholtz Open Science office provides the present guide for these aspects. Based on selected recommendations in the DFG Code, it describes in a practical way the rele-vance of open science when implementing the Code at the Helmholtz Centers. With this guide, the Helmholtz Open Science Office aims to provide an impetus for embedding open science in good (digital) research practice.

Foreword

Ladies and gentleman,

Good (digital) research practice comprises many aspects, whose characteristics and weighting vary by research field. The interest in rules and points of reference that are intended to apply across disciplinary boundaries stands on an equal footing with this diversity. In Germany, the German Research Foundation's (DFG) Code of Conduct "Guidelines for Safeguarding Good Research Practice" explains this consensus. Adopted in July 2019 by the DFG's General Assembly, the Code must be implemented in a legally binding manner by all higher education institutions (HEIs) and non-HEI research institutions by July 2022 [extended by DFG until July 2023] as a prerequisite for receiving DFG funding. The revision of the preceding white paper was prompted in particular by the digital turn and its impact on research, as well as by new developments in publishing (e.g., open access).

The independent ombudspersons deployed at the Helmholtz Centers, and the Association's independent central ombudsperson, who has been appointed by the Assembly of Members since April 2022, are together responsible for good research practice at the Helmholtz Association.

The "Rahmenleitlinie zur Sicherung Guter Wissenschaftlicher Praxis und Verfahren bei wissenschaftlichem Fehlverhalten" [Framework Policy on Safeguarding Good Research Practice and Procedures in the Case of Scientific Misconduct] (GWP), which defines issues relating to overarching responsibility for compliance with the GWP at the Helmholtz Association, as well as common objectives and key tasks, was approved by the DFG in June 2021. The Helmholtz Association's Assembly of Members is expected to vote on the draft in September 2021.

The detailed implementation of the DFG Code and the fleshing out of the Framework Policy will take place by means of regulations at the Centers, taking into account the discipline-specific particularities of the research areas.

The present Helmholtz Open Science Office guide, "Good (Digital) Research Practice and Open Science," focuses on the aspects of good research practice of relevance to open science. It is intended to serve as an impetus to and as guidance for taking open science into account when implementing the Code at the Centers. In the guide, guidelines from the DFG Code are elucidated in detail from an open science perspective, and practical workflows and tools are presented.

This guide is a valuable complement to the Helmholtz Association's official regulations.

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Introduction

The German Research Foundation's (DFG) Code of Conduct "Guidelines for Safeguarding Good Research Practice"[1] came into effect on August 1, 2019. It comprises 19 guidelines, and constitutes a significant expansion of the DFG's white paper "Safeguarding Good Research Practice" (2013). The Code includes six guidelines that formulate general principles; a further 11 guidelines specify key steps in good research practice throughout the research process; they are followed by two guidelines on dealing with non-compliance with good research practice.

As of July 31, 2023, legally binding implementation of the DFG Code will be a prerequisite for applying for DFG funding. Initially, the deadline for implementation was June 31, 2021. However, it was extended in view of the COVID-19 pandemic.[2] Other research funding organizations (e.g., the German Federal Ministry of Education and Research [BMBF]) also require compliance with the Code.

The DFG Code is multidimensionally structured: The Code guidelines are on Level 1; explanations of these guidelines are provided on Level 2; and the online portal "Research Integrity,"[3] a dynamic document providing further information, is on Level 3. The latter portal comments on the individual guidelines and their respective explanations and provides in-depth and also subject-specific contributions, which are moderated by the DFG. (The English-language version of the portal went online in July 2021.[4]) In addition, the German Research Ombudsman[5] provides help with questions and support in cases of conflict relating to good research practice.

Open science aspects are of relevance to many of the guidelines in the DFG Code. The present guide relates the DFG guidelines to the respective relevant open science practices. It shows in a practical way how the topic of open science can be taken into account when implementing the DFG Code on good (digital) research practice. Individual guidelines from the DFG Code that are closely related to open science are explained. These explanations are supplemented in each case with recommendations and references to best practices in the open science context and ways in which the Helmholtz Open Science Office can offer support. The Helmholtz Open Science Office gives 19 recommendations in total, which are listed in full at the end of this publication (from p. 17 onward).

[1] German Research Foundation (DFG). (2019). *Guidelines for Safeguarding Good Research Practice – Code of Conduct*. Available online at: https://doi.org/10.5281/zenodo.3923602 (in English and German)

[2] See https://www.dfg.de/service/presse/pressemitteilungen/2020/pressemitteilung_nr_55/index.html [German-language press release announcing that the online portal had gone online. Accessed on June 8, 2021.]

[3] https://wissenschaftliche-integritaet.de/en/ [Accessed on September 16, 2022.]

[4] See https://www.dfg.de/service/presse/pressemitteilungen/2020/pressemitteilung_nr_55/index.html [German-language press release. Accessed on June 8, 2021.]

[5] https://ombudsman-fuer-die-wissenschaft.de/?lang=en [Accessed on June 8, 2021.]

Guidelines and Best Practices in the Context of Open Science

Guideline 5: Dimensions of performance and assessment criteria

To assess the performance of researchers, a multidimensional approach is called for; in addition to academic and scientific achievements, other aspects may be taken into consideration. Performance is assessed primarily on the basis of qualitative measures, while quantitative indicators may be incorporated into the overall assessment only with appropriate differentiation and reflection. Where provided voluntarily, individual circumstances stated in curricula vitae – as well as categories specified in the German General Equal Treatment Act (Allgemeines Gleichbehandlungsgesetz) – are taken into account when forming a judgement (DFG Code of Conduct, p. 11).

Relation to Open Science

- Actors who are guided by the principles of open science strive for openness and transparency – also in the context of criteria for assessing research performance. Open science in particular enables a broad perspective on research performance because, in addition to articles and other types of textual publication, research data, research software, and other research outputs are also considered. This perspectival expansion should be taken into account when assessing research performance. In addition, open science includes testing new methods of quality assurance, for example, in the form of open peer review.[6]
- At Helmholtz Centers, quality-assured publications are taken into consideration when assessing research performance; see the parameters for "program-oriented funding."[7] The accessibility of (open access) publications is also ascertained. In addition, accessibility is determined within the framework of the annual Open Access Report.
- The "San Francisco Declaration on Research Assessment" (DORA)[8] outlines numerous sustainable, balanced, and transparent mechanisms for assessing research performance. The aim of this initiative is to bring open science aspects more strongly into focus in performance dimensions and assessment criteria. Signatories of DORA from the Helmholtz Association are the Karlsruhe Institute of Technology (KIT) and the Max Delbrück Center for Molecular Medicine (MDC).
- With the "Helmholtz Guideline on Diversity and Inclusion,"[9] aspects related to open science, such as participation and openness, are also embedded in recruitment procedures and employee assessment.

[6] https://ag-openscience.de/open-peer-review/ [Accessed on June 8, 2021.]
[7] https://www.helmholtz.de/en/about-us/structure-and-governance/program-oriented-funding/ [Accessed on June 08, 2021.]
[8] https://sfdora.org [Accessed on June 8, 2021.]
[9] Helmholtz Association (2020). Helmholtz Guideline on Diversity and Inclusion. Available online at: https://www.helmholtz.de/system/beispieldaten/dokumente/Helmholtz_Guideline_on_Diversity_and_Inclusion.pdf [Accessed on June 8, 2021.]

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 1: To take greater account of open science in relation to performance dimensions and assessment criteria, it is recommended that the "San Francisco Declaration on Research Assessment" (DORA)[10] be signed and actively implemented.
- Recommendation No. 2: The application of the 10 guiding principles for research evaluation set out in the "Leiden Manifesto for research metrics" (CWTS)[11] is recommended in order to diversify the assessment approach, thereby making it more sustainable and comprehensive.
- Recommendation No. 3: Active participation in the further development of research evaluation at Helmholtz, inter alia within the framework of the Helmholtz Open Access Fora, is recommended.[12]

Guideline 7: Cross-phase quality assurance

> Researchers carry out each step of the research process lege artis. When research findings are made publicly available (in the narrower sense of publications, but also in a broader sense through other communication channels), the quality assurance mechanisms used are always explained. This applies especially when new methods are developed (DFG Code of Conduct, p. 13).

Relation to Open Science

- Quality assurance is an important basis for research. This is of course also true in the context of open science, where new needs and measures for quality assurance arise, especially with regard to digital working and publishing (i.e., scientific text, data, or software publications).
- Useful tools for the quality assurance of digitalized research include, for example, the FAIR criteria [13] for digital research data (i.e., research data should be findable, accessible, interoperable, and reusable); and persistent identifiers [14] (PIDs), for example, digital object identifiers (DOIs) and the ORCID iD,[15] to uniquely identify research results and researchers, respectively.
- The explanations with regard to Guideline 7 in the DFG Code explicitly state that "the source code of publicly available software must be persistent, citable, and documented" (p. 14). In keeping with the principle of open methodology, not only research data but increasingly also the software used for analysis is extremely relevant for the reproducibility of research results and, for example, their reuse in other, comparable contexts.
- The discussion about open peer review[16] is also gaining in importance. The aim of this approach is to make traditional peer review procedures more open and transparent.

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[10] https://sfdora.org [Accessed on June 8, 2021.]
[11] Hicks, D. et al. (2015). Bibliometrics: The Leiden Manifesto for research metrics. *Nature*, 520(7548), 429-431. DOI: https://doi.org/10.1038/520429a.
[12] See the web page of the Helmholtz Open Science Forum "Indikatoren für Open Science" [Indicators for Open Science]: https://os.helmholtz.de/veranstaltungen/foren/indikatoren-open-science/ [accessed on September 22, 2021] and the Forum report: https://doi.org/10.48440/os.helmholtz.024
[13] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18
[14] The website Forschungsdaten.info provides further information: https://www.forschungsdaten.info [accessed on June 8, 2021].
[15] https://orcid.org [Accessed on June 8, 2021.]
[16] Ross-Hellauer, T. (2017). What is open peer review? A systematic review. *F1000Research*, 6, 588. DOI: https://doi.org/10.12688/f1000research.11369.2

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 4: To identify predatory publishing offerings, it is recommended to use the "FAQs on Predatory Publishing" produced by the Helmholtz Open Science Office.[17] In addition, to identify trustworthy journals, the following resources can be consulted:
    - the Directory of Open Access Journals (DOAJ),[18]
    - the checklist "Think. Check. Submit.,"[19] which provides useful tips for assessing the trustworthiness of a publication medium.
- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[20] which contains relevant tips on quality assurance when publishing research software, especially in the section "Quality Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][21] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.
- Recommendation No. 6: In the context of research data, in particular the section "Quality in the Context of Good Scientific Practice" in the "Recommendations for Policies of the Helmholtz Centers on Research Data Management"[22] should be taken into account.
- Recommendation No. 7: The Helmholtz Centers' open access repositories[23] are suitable for the quality-assured dissemination of research, and should be used as needed; further information can be obtained at the libraries of the respective Centers.
- Recommendation No. 8: In order to promote the preprint culture, and thus the early discussion of research projects and ideas, it is recommended to use suitable preprint servers for the respective disciplines (e.g., arXiv.org[24]).
- Recommendation No. 9: To identify research data repositories suitable for publishing research data, it is recommended to use the Registry of Research Data Repositories (re3data).[25]
- Recommendation No. 10: To ensure in addition to the long-term accessibility of research data also the reproducibility and reuse of the results, the corresponding research processes should be documented. Continuously updated data management plans (DMPs) are suitable for this purpose. Here, the required steps and workflows can be documented in standard operating procedures (SOPs)[26] – also for data that are regularly collected.

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[17] https://os.helmholtz.de/en/open-access/open-access-gold/predatory-publishing-faqs/ [Accessed on June 08, 2021.]

[18] https://doaj.org/ [Accessed on June 8, 2021.]

[19] https://thinkchecksubmit.org [Accessed on June 8, 2021.]

[20] Helmholtz Association (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007; the Web version is available at https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]

[21] Ad-hoc-Arbeitsgruppe Research Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to Research Software Management]. DOI: https://doi.org/10.5281/zenodo.1172970

[22] Helmholtz Association (2017). Empfehlungen für Richtlinien der Helmholtz-Zentren zum Umgang mit Forschungsdaten [Recommendations for Policies of the Helmholtz Centers on Research Data Management]. DOI: https://doi.org/10.2312/os.helmholtz.002. [The English-language version is available at: https://doi.org/10.2312/os.helmholtz.004]

[23] https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/open-access-der-gruene-weg/ [Accessed on June 8, 2021.].

[24] https://arxiv.org [Accessed on June 8, 2021.]

[25] https://www.re3data.org/ [Accessed on June 8, 2021.] The Registry of Research Data Repositories re3data is continuously developed with the participation of Helmholtz Centers. This further development is currently being pushed forward by the DFG-funded project re3data COREF. See: https://os.helmholtz.de/projekte/re3data-coref/ [accessed on June 8, 2021].

[26] See, for example: Hollmann S, Frohme M, Endrullat C, Kremer A, D'Elia D, Regierer B, et al. (2020) Ten simple rules on how to write a standard operating procedure. *PLoS Computational Biology* 16(9): e1008095. https://doi.org/10.1371/journal.pcbi.1008095 [accessed on June 8, 2021].

Guideline 10: Legal and ethical framework, usage rights

> Researchers adopt a responsible approach to the constitutionally guaranteed freedom of research. They comply with rights and obligations, particularly those arising from legal requirements and contracts with third parties, and where necessary seek approvals and ethic statements, and present these when required. With regard to research projects, the potential consequences should be evaluated in detail and the ethical aspects should be assessed. The legal framework of a research project includes documented agreements on usage rights relating to data and results generated by the project (DFG Code of Conduct, p. 15).

Relation to Open Science

- The aim of open science is the free reuse of research outputs (i.e., scientific text, data, and software publications). This aim does not apply absolutely, but rather must be weighed against other goods worthy of protection, respect for which may also be prescribed by law. This results in the principle of "intelligent openness,"[27] that is, "as open as possible and as closed as necessary," so that, for example, personality rights or security risks, as well as legitimate economic interests, are taken into account.

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 11: To enable the successful reuse of research outputs, it is recommended to use free and standardized licenses, for example, Creative Commons licenses.[28] There are various types of Creative Commons licenses, which differ in the scope of the rights of use granted to the licensees. The Helmholtz Open Science Office recommends that the most liberal Creative Commons attribution license, CC BY 4.0,[29] be used. Granting a license presupposes ownership of the rights granted under the license. Patentability must always be assessed before publication. Because experience has shown that the need for advice in connection with licensing is extensive, corresponding offerings should be available.
- Recommendation No. 12: It is recommended to make use of the individual consultations on copyright in the context of scholarly publishing offered by the libraries of the Helmholtz Centers.

Guideline 11: Methods and standards

> To answer research questions, researchers use scientifically sound and appropriate methods. When developing and applying new methods, they attach particular importance to quality assurance and the establishment of standards (DFG Code of Conduct, p. 16).

Relation to Open Science

- One of the fundamental goals of open science is to make research more transparent and clear. The use of uniform methods and standards makes a vital contribution in this context.

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[27] Boulton, G. et al. (2012). Science as an open enterprise. Royal Society. Available online at: http://royalsociety.org/policy/projects/science-public-enter [accessed on June 8, 2021].
[28] https://creativecommons.org/licenses/?lang=en [Accessed on June 8, 2021.]
[29] https://creativecommons.org/licenses/by/4.0/legalcode [Accessed on June 8, 2021.]

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[30] which contains relevant tips on quality assurance when publishing research software, especially in the section "Quality Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][31] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.
- Recommendation No. 6: In the context of research data, in particular the section "Quality in the Context of Good Scientific Practice" in the "Recommendations for Policies of the Helmholtz Centers on Research Data Management"[32] should be taken into account.
- Recommendation No. 10: In order to ensure in addition to the long-term accessibility of research data also the reproducibility and reuse of the results, the corresponding research processes should be documented. Continuously updated data management plans (DMPs) are suitable for this purpose. Here, the required steps and workflows can be documented in standard operating procedures (SOPs)[33] – also for data that are regularly collected.
- Recommendation No. 13: In the context of research data management (RDM), the FAIR criteria[34] (research data should be findable, accessible, interoperable, reusable) must be complied with; see also the position paper on research data management "Making Information Resources More Usable."[35]

Guideline 12: Documentation

> Researchers document all information relevant to the production of a research result as clearly as is required by and is appropriate for the relevant subject area to allow the result to be reviewed and assessed. In general, this also includes documenting individual results that do not support the research hypothesis. The selection of results must be avoided. Where subject-specific recommendations exist for review and assessment, researchers create documentation in accordance with these guidelines. If the documentation does not satisfy these requirements, the constraints and the reasons for them are clearly explained. Documentation and research results must not be manipulated; they are protected as effectively as possible against manipulation (DFG Code of Conduct, p. 16).

Relation to Open Science

- The clear documentation of research results increases the transparency of research by

[30] Helmholtz Association (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Research Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007. The Web version is available at: https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]

[31] Ad-hoc-Arbeitsgruppe Wissenschaftliche Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to research software management]. DOI: https://doi.org/10.5281/zenodo.1172970

[32] Helmholtz Association (2017). Empfehlungen für Richtlinien der Helmholtz-Zentren zum Umgang mit Forschungsdaten [Recommendations for Policies of the Helmholtz Centers on Research Data Management]. DOI: https://doi.org/10.2312/os.helmholtz.002 . [The English-language version is available at: https://doi.org/10.2312/os.helmholtz.004]

[33] See, for example: Hollmann, S., Frohme, M., Endrullat, C., Kremer, A., D'Elia, D., Regierer, B., et al. (2020) Ten simple rules on how to write a standard operating procedure. *PLoS Computational Biology*, 16(9): e1008095. https://doi.org/10.1371/journal.pcbi.1008095

[34] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18

[35] Helmholtz Association. (2016). Making information resources more usable. Available online at: https://doi.org/10.48440/os.helmholtz.026

facilitating its reproducibility. Transparency and reproducibility are key aspects within the open science paradigm.

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[36] which contains relevant tips for quality assurance when publishing research software, especially in the section "Quality Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][37] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.
- Recommendation No. 7: The Helmholtz Centers' open access repositories[38] are suitable for the quality-assured dissemination of research and should be used as needed; further information can be obtained at the libraries of the respective Centers.
- Recommendation No. 9: To identify research data repositories suitable for publishing research data, it is recommended to use the Registry of Research Data Repositories (re3data).[39]
- Recommendation No. 10: In order to ensure in addition to the long-term accessibility of research data also the reproducibility and reuse of the results, the corresponding research processes should be documented. Continuously updated data management plans (DMPs) are suitable for this purpose. Here, the required steps and workflows can be documented in standard operating procedures (SOPs)[40] – also for data that are regularly collected.
- Recommendation No. 13: In the context of research data management (RDM), the FAIR criteria [41] (research data should be findable, accessible, interoperable, reusable) must be complied with; see also the position paper on research data management "Making Information Resources More Usable."[42]
- Recommendation No. 14: To promote the appropriate documentation and reproducibility of research, the Open Access Policy of the Helmholtz Association[43] in particular must be complied with.
- Recommendation No. 15: For further information on research documentation and the use of electronic lab books, the documentation of the Helmholtz Open Science Workshop

[36] Helmholtz Association. (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007. The Web version is available at: https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]

[37] Ad-hoc-Arbeitsgruppe Wissenschaftliche Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to Research Software Management]. DOI: https://doi.org/10.5281/zenodo.1172970

[38] https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/open-access-der-gruene-weg/ [Accessed on June 8, 2021.]

[39] https://www.re3data.org/ [Accessed on June 8, 2021.] The Registry of Research Data Repositories re3data is continuously developed with the participation of Helmholtz Centers. This further development is currently being pushed forward by the DFG-funded project re3data COREF. See: https://os.helmholtz.de/projekte/re3data-coref/ [accessed on June 8, 2021].

[40] See, for example: Hollmann S, Frohme M, Endrullat C, Kremer A, D'Elia D, Regierer B, et al. (2020). Ten simple rules on how to write a standard operating procedure. *PLoS Computational Biology* 16(9): e1008095. https://doi.org/10.1371/journal.pcbi.1008095

[41] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18

[42] Helmholtz Association (2016). Making information resources more usable. Available online at: https://doi.org/10.48440/os.helmholtz.026

[43] Helmholtz Association (2016). Open-Access-Richtlinie der Helmholtz-Gemeinschaft [Open Access Policy of the Helmholtz Association]. Available online at: https://doi.org/10.2312/os.helmholtz.017. [The English-language version is available at: https://os.helmholtz.de/en/open-access/open-access-policies/open-access-policy-of-the-helmholtz-association-2016/]

"Elektronische Laborbücher" [Electronic Lab Books][44] is recommended.

- Recommendation No. 16: Further tips for research data management:
  - Use of data management planning tools, for example, RDMO[45]
  - Free licenses, for example, the Creative Commons attribution license CC BY 4.0[46] for textual publication types; for software, the GNU [General Public License],[47] the MIT License,[48] the Apache License 2.0[49]

Guideline 13: Providing public access to research results

> As a rule, researchers make all results available as part of scientific/academic discourse. In specific cases, however, there may be reasons not to make results publicly available (in the narrower sense of publication, but also in a broader sense through other communication channels); this decision must not depend on third parties. Researchers decide autonomously – with due regard for the conventions of the relevant subject area – whether, how and where to disseminate their results. If it has been decided to make results available in the public domain, researchers describe them clearly and in full. Where possible and reasonable, this includes making the research data, materials and information on which the results are based, as well as the methods and software used, available and fully explaining the work processes. Software programmed by the researchers themselves is made publicly available along with the source code. Researchers provide full and correct information about their own preliminary work and that of others (DFG Code of Conduct, p. 17).

Relation to Open Science

- In line with the principle of intelligent openness[53] described in the context of Guideline 10, in order to take account of personality rights or economic rights, "as open as possible and as closed as necessary" applies also to public access to research results. However, open science offers diverse potential for as full documentation as possible within these limits.
- Open methodology guarantees the reproducibility of research results through transparent research data management (e.g., documentation of data cleansing and data analysis). In addition, transparent documentation (open notebook science) enables more reflection on and transparency of all pathway decisions made during the research process.

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[50] which contains relevant tips for quality assurance when publishing research software, especially in the section "Quality

[44] Schultze-Motel, P. (2019). Helmholtz Open Science Workshop "Elektronische Laborbücher" [Electronic Lab Books]. DOI: https://doi.org/10.2312/os.helmholtz.001
[45] https://rdmorganiser.github.io [Accessed on June 8, 2021.]
[46] https://creativecommons.org/licenses/by/4.0/legalcode [Accessed on June 8, 2021.]
[47] https://www.gnu.org/licenses/gpl-3.0.de.html [Accessed on June 8, 2021.]
[48] https://opensource.org/licenses/MIT [Accessed on June 8, 2021.]
[49] http://www.apache.org/licenses/LICENSE-2.0.html [Accessed on June 8, 2021.]
[50] Helmholtz Association (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Research Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007. The Web version is available at: https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]

Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][51] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.

- Recommendation No. 7: The Helmholtz Centers' open access repositories [52] are suitable for the quality-assured dissemination of research, and should be used as needed; further information can be obtained at the libraries of the respective Centers.
- Recommendation No. 10: To ensure in addition to the long-term accessibility of research data also the reproducibility and reuse of the results, the corresponding research processes should be documented. Continuously updated data management plans (DMPs) are suitable for this purpose. Here, the required steps and workflows can be documented in standard operating procedures (SOPs)[53] – also for data that are regularly collected.
- Recommendation No. 12: It is recommended to make use of the individual consultations on copyright in the context of scholarly publishing offered by the libraries of the Helmholtz Centers.
- Recommendation No. 13: In the context of research data management (RDM), the FAIR criteria [54] (research data should be findable, accessible, interoperable, reusable) must be complied with; see also the position paper on research data management "Making Information Resources More Usable."[55]
- Recommendation No. 14: To promote the appropriate documentation and reproducibility of research, the Open Access Policy of the Helmholtz Association[56] in particular must be complied with.
- Recommendation No. 16: Further tips for research data management:
    - Use of data management planning tools, for example, RDMO [57]
    - Free licenses, for example, the Creative Commons attribution license CC BY 4.0[58] for textual publication types; for software, the GNU [General Public License],[59] the MIT License,[60] the Apache License 2.0[61]

[51] Ad-hoc-Arbeitsgruppe Wissenschaftliche Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to Research Data Management]. DOI: https://doi.org/10.5281/zenodo.1172970
[52] https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/open-access-der-gruene-weg/ [Accessed on June 8, 2021.]
[53] See, for example, Hollmann, S., Frohme, M., Endrullat, C., Kremer, A., D'Elia, D., Regierer, B., et al. (2020) Ten simple rules on how to write a standard operating procedure. *PLoS Computational Biology*, 16(9): e1008095. https://doi.org/10.1371/journal.pcbi.1008095
[54] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18
[55] Helmholtz Association (2016). Making information resources more usable. Available online at: https://doi.org/10.48440/os.helmholtz.026
[56] Helmholtz Association (2016). Open-Access-Richtlinie der Helmholtz-Gemeinschaft [Open Access Policy of the Helmholtz Association]. Available online at: https://doi.org/10.2312/os.helmholtz.017. [The English-language version is available at: https://os.helmholtz.de/en/open-access/open-access-policies/open-access-policy-of-the-helmholtz-association-2016/]
[57] https://rdmorganiser.github.io [Accessed on June 8, 2021.]
[58] https://creativecommons.org/licenses/by/4.0/legalcode [Accessed on June 8, 2021.]
[59] https://www.gnu.org/licenses/gpl-3.0.de.html [Accessed on June 8, 2021.]
[60] https://opensource.org/licenses/MIT [Accessed on June 8, 2021.]
[61] http://www.apache.org/licenses/LICENSE-2.0.html [Accessed on June 8, 2021.]

Guideline 14: Authorship

> An author is an individual who has made a genuine, identifiable contribution to the content of a research publication of text, data or software. All authors agree on the final version of the work to be published. Unless explicitly stated otherwise, they share responsibility for the publication, Authors seek to ensure that, as far as possible, their contributions are identified by publishers or infrastructure providers such that they can be correctly cited by users (DFG Code of Conduct, p. 18).

Relation to Open Science

- In view of the great significance that publications in science and academia have for researchers and their institutions, unique linking of researchers to their research results plays an important role.
- In the context of the discussion of extended indicators for the documentation of research performance, the enhancement of the visibility of other persons who are (directly and indirectly) involved in research processes is also being discussed. In addition to the visibility of the direct authors, it is also a question of the visibility of data scientists, data managers, and technicians, for example. More and more journals now require that the nature of the contributions of the individuals involved be explicitly specified.[62]
- To identify and classify the relevant persons involved in the research process, the Contributor Roles Taxonomy (CRediT)[63] can be consulted. CRediT comprises 14 roles that can be used to represent the roles typically played by contributors to research outputs. The roles enable the specific contributions of those involved to be described appropriately.[64]
- Irrespective of the correct reporting of the authorship of publications, from an open science perspective, there is an interest in the unique identifiability of the authors named. This is achieved by linking the names of the authors to unique author identifiers.
- Internationally, the persistent identifier ORCID (Open Researcher and Contributor ID),[65] which has been in existence since 2012, has been developed for this purpose. With an ORCID iD, anyone who makes a contribution to the research process can uniquely link themselves with their publications, their research data, and other research outputs (e.g., research software). Thus, ORCID contributes to the findability and visibility of research outputs, ensures permanent accessibility, and thereby promotes the realization of open science. Some Helmholtz Centers have already successfully implemented ORCID.[66] The Helmholtz Open Science Office is involved in the project ORCID DE,[67] and is happy to provide support with questions about ORCID and other persistent identifiers.

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 17: The unique identification of researchers and their organizational

[62] See, for example, http://www.icmje.org/recommendations/browse/roles-and-responsibilities/defining-the-role-of-authors-and-contributors.html [accessed on June 8, 2021].
[63] https://casrai.org/credit/ [Accessed on June 8, 2021.]
[64] The University of Glasgow has explicitly incorporated CRediT into its "Code of Good Practice in Research," for example: https://www.gla.ac.uk/media/Media_490311_smxx.pdf [accessed on June 8, 2021].
[65] https://orcid.org [Accessed on June 8, 2021.]
[66] See under "Mitglieder des ORCID Deutschland Konsortiums …" [Members of the ORCID Germany Consortium] at: https://www.orcid-de.org/konsortium/ [accessed on June 8, 2021].
[67] https://os.helmholtz.de/projekte/orcid-de/ [Accessed on June 8, 2021.]

affiliations by means of an ORCID iD[68] is of great benefit; the use of ORCID iDs and the integration of ORCID at the Helmholtz Centers is recommended.

- Recommendation No. 18: To identify and classify the persons involved in the research process, it is recommended to consult the Contributor Roles Taxonomy (CRediT).[69,70]
- Recommendation No. 19: As full recognition of all those involved in the research process is not yet an established approach in all disciplines, researchers should promote in their own work and beyond – for example, when active on publishing committees – the improved recognition of all persons involved in the research system.

Guideline 15: Publication medium

> Authors select the publication medium carefully – with due regard for its quality and visibility in the relevant field of discourse. Researchers who assume the role of editor, carefully select where they will carry out this activity. The scientific/academic quality of a contribution does not depend on the medium in which it is published (DFG Code of Conduct, p. 21).

Relation to Open Science

- In the context of open access publishing, there are actors who try to convince researchers to publish in dubious journals against payment of a publication fee. This is known as predatory publishing. Predatory publishing damages the reputation of science in general and of the authors who publish in such formats in particular.

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 4: To identify predatory publishing offerings, it is recommended to use the "FAQs on Predatory Publishing" produced by the Helmholtz Open Science Office.[71] In addition, to identify trustworthy journals, the following resources can be consulted:
  - the Directory of Open Access Journals (DOAJ),[72]
  - the checklist "Think. Check. Submit.,"[73] which provides useful tips for assessing the trustworthiness of a publication medium.

[68] https://orcid.org [Accessed on June 8, 2021.]
[69] https://casrai.org/credit/ [Accessed on June 8, 2021.]
[70] The University of Glasgow has explicitly incorporated CRediT into its "Code of Good Practice in Research," for example: https://www.gla.ac.uk/media/Media_490311_smxx.pdf [Accessed on June 8, 2021.]
[71] https://os.helmholtz.de/en/open-access/open-access-gold/predatory-publishing-faqs/ [Accessed on June 8, 2021.]
[72] https://doaj.org/ [Accessed on June 8, 2021.]
[73] https://thinkchecksubmit.org/translations/german/ [Accessed on June 8, 2021.]

Guideline 17: Archiving

> Researchers back up research data and results made publicly available, as well as the central materials on which they are based and the software used, by adequate means according to the standards of the relevant subject area, and retain them for an appropriate period of time. Where justifiable reasons exist for not archiving particular data, researchers explain these reasons. HEIs and non-HEI research institutions ensure that the infrastructure necessary to enable archiving is in place (DFG Code of Conduct, p. 21).

Relation to Open Science

- An important element of open-science-appropriate archiving is compliance with the FAIR criteria[75] (research data should be findable, accessible, interoperable, and reusable).

Recommendations of the Helmholtz Open Science Office

- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[74] which contains relevant tips on quality assurance when publishing research software, especially in the section "Quality Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][75] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.
- Recommendation No. 7: The Helmholtz Centers' open access repositories[76] are suitable for the quality-assured dissemination of research, and should be used as needed; further information can be obtained at the libraries of the respective Centers.
- Recommendation No. 9: To identify research data repositories suitable for publishing research data, it is recommended to use the Registry of Research Data Repositories (re3data).[77]
- Recommendation No. 13: In the context of research data management (RDM), the FAIR criteria[78] (research data should be findable, accessible, interoperable, reusable) must be complied with; see also the position paper on research data management "Making Information Resources More Usable."[79]

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[74] Helmholtz Association (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007. The Web version is available at: https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]

[75] Ad-hoc-Arbeitsgruppe Wissenschaftliche Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to Research Software Management]. DOI: https://doi.org/10.5281/zenodo.1172970

[76] https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/open-access-der-gruene-weg/ [Accessed on June 8, 2021].

[77] https://www.re3data.org/ [Accessed on June 8, 2021]. The Registry of Research Data Repositories re3data is continuously developed with the participation of Helmholtz Centers. This further development is currently being pushed forward by the DFG-funded project re3data COREF. See: https://os.helmholtz.de/projekte/re3data-coref/ [accessed on June 8, 2021].

[78] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18

[79] Helmholtz Association (2016). Making information resources more usable. Available online at: https://doi.org/10.48440/os.helmholtz.026

Advice and Support

The Helmholtz Open Science Office is happy to answer any questions and to provide support, for example, in the context of information events.

Website: https://os.helmholtz.de/en/

Contact: open-science@helmholtz.de

Summarized Recommendations

- Recommendation No. 1: To take greater account of open science in relation to performance dimensions and assessment criteria, it is recommended to sign and actively implement the "San Francisco Declaration on Research Assessment" (DORA).[80]
- Recommendation No. 2: The application of the 10 guiding principles for research evaluation set out in the "Leiden Manifesto for research metrics" (CWTS)[81] is recommended in order to diversify the assessment approach, thereby making it more sustainable and comprehensive.
- Recommendation No. 3: Active participation in the further development of research evaluation at Helmholtz, inter alia within the framework of the Helmholtz Open Science Fora, is recommended.[82]
- Recommendation No. 4: To identify predatory publishing offerings, it is recommended to use the "FAQs on Predatory Publishing" produced by the Helmholtz Open Science Office.[83] In addition, to identify trustworthy journals, the following resources can be consulted:
    - the Directory of Open Access Journals (DOAJ),[84]
    - the checklist "Think. Check. Submit.,"[85] which provides useful tips for assessing the trustworthiness of a publication medium.
- Recommendation No. 5: It is recommended to take into consideration the "Model Policy on Sustainable Research Software at the Helmholtz Centers,"[86] which contains relevant tips on quality assurance when publishing research software, especially in the section "Quality Assurance and Archiving"; and the "Handreichung zum Umgang mit Forschungssoftware" [Guide to Research Software Management][87] produced by the Priority Initiative "Digital Information" of the Alliance of Science Organisations in Germany.
- Recommendation No. 6: In the context of research data, in particular the section "Quality in the Context of Good Scientific Practice" in the "Recommendations for Policies of the Helmholtz Centers on Research Data Management"[88] should be taken into account.
- Recommendation No. 7: The Helmholtz Centers' open access repositories[89] are suitable for the quality-assured dissemination of research, and should be used as needed; further information can be obtained at the libraries of the respective Centers.
- Recommendation No. 8: In order to promote the preprint culture, and thus the early

[80] https://sfdora.org [Accessed on June 8, 2021.]
[81] Hicks, D. et al. (2015). Bibliometrics: The Leiden manifesto for research metrics. *Nature*, 520(7548), 429–431. DOI: https://doi.org/10.1038/520429a
[82] See web page of the workshop: https://os.helmholtz.de/veranstaltungen/foren/indikatoren-open-science/ [accessed on June 8, 2021] and the workshop report: https://doi.org/10.48440/os.helmholtz.024
[83] https://os.helmholtz.de/en/open-access/open-access-gold/predatory-publishing-faqs/ [Accessed on June 8, 2021.]
[84] https://doaj.org/ [Accessed on June 8, 2021.]
[85] https://thinkchecksubmit.org/translations/german/ [Accessed on June 8, 2021.]
[86] Helmholtz Association (2019). Muster-Richtlinie Nachhaltige Forschungssoftware an den Helmholtz-Zentren [Model Policy on Sustainable Software at the Helmholtz Centers]. DOI: https://doi.org/10.2312/os.helmholtz.007. The Web version is available at: https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/akteure-und-ihre-rollen/arbeitskreis-open-science/muster-richtlinie-nachhaltige-forschungssoftware-an-den-helmholtz-zentren/ [accessed on June 8, 2021]. [The English-language version is available at: https://os.helmholtz.de/en/open-research-software/model-policy/]
[87] Ad-hoc-Arbeitsgruppe Wissenschaftliche Software (2018). Handreichung zum Umgang mit Forschungssoftware [Guide to Research Software Management]. DOI: https://doi.org/10.5281/zenodo.1172970
[88] Helmholtz Association (2017). Empfehlungen für Richtlinien der Helmholtz-Zentren zum Umgang mit Forschungsdaten [Recommendations for Policies of the Helmholtz Centers on Research Data Management]. DOI: https://doi.org/10.2312/os.helmholtz.002. [The English-language version is available at: https://doi.org/10.2312/os.helmholtz.004]
[89] https://os.helmholtz.de/open-science-in-der-helmholtz-gemeinschaft/open-access-der-gruene-weg/ [Accessed on June 8, 2021].

discussion of research projects and ideas, it is recommended to use suitable preprint servers for the respective disciplines (e.g., arXiv.org[90]).

- Recommendation No. 9: To identify research data repositories suitable for publishing research data, it is recommended to use the Registry of Research Data Repositories (re3data).[91]
- Recommendation No. 10: To ensure in addition to the long-term accessibility of research data also the reproducibility and reuse of the results, the corresponding research processes should be documented. Continuously updated data management plans (DMPs) are suitable for this purpose. Here, the required steps and workflows can be documented in standard operating procedures (SOPs)[92] – also for data that are regularly collected.
- Recommendation No. 11: To enable the successful reuse of research outputs, it is recommended to use free and standardized licenses, for example, Creative Commons licenses.[93] There are various types of Creative Commons licenses, which differ in the scope of the rights of use granted to the licensees. The Helmholtz Open Science Office recommends that the most liberal Creative Commons attribution license, CC BY 4.0,[94] be used. Granting a license presupposes ownership of the rights granted under the license. Patentability must always be assessed before publication. Because experience has shown that the need for advice in connection with licensing is extensive, corresponding offerings should be available.
- Recommendation No. 12: It is recommended to make use of the individual consultations on copyright in the context of scholarly publishing offered by the libraries of the Helmholtz Centers.
- Recommendation No. 13: In the context of research data management (RDM), the FAIR criteria[95] (research data should be findable, accessible, interoperable, reusable) must be complied with; see also the position paper on research data management "Making Information Resources More Usable."[96]
- Recommendation No. 14: To promote the appropriate documentation and reproducibility of research, the Open Access Policy of the Helmholtz Association[97] in particular must be complied with.
- Recommendation No. 15: For further information on research documentation and the use of electronic lab books, the documentation of the Helmholtz Open Science Workshop "Elektronische Laborbücher" [Electronic Lab Books][98] is recommended.
- Recommendation No. 16: Further tips on research data management:
    - Use of data management planning tools, for example, RDMO[99]

[90] https://arxiv.org [Accessed on June 8, 2021].

[91] https://www.re3data.org/ [Accessed on June 8, 2021.] The Registry of Research Data Repositories re3data is continuously developed with the participation of Helmholtz Centers. This further development is currently being pushed forward by the DFG-funded project re3data COREF. See: https://os.helmholtz.de/projekte/re3data-coref/ [accessed on June 8, 2021].

[92] See, for example: Hollmann, S., Frohme, M., Endrullat, C., Kremer, A., D'Elia, D., Regierer, B., et al. (2020). Ten simple rules on how to write a standard operating procedure. *PLoS Computational Biology*, 16(9): e1008095. https://doi.org/10.1371/journal.pcbi.1008095

[93] https://creativecommons.org/licenses/?lang=de [Accessed on June 8, 2021.]

[94] https://creativecommons.org/licenses/by/4.0/legalcode [Accessed on June 8, 2021.]

[95] Wilkinson, M. D. et al. (2016). The FAIR Guiding Principles for scientific data management and stewardship. *Scientific Data*, 3(1), 1-9. DOI: https://doi.org/10.1038/sdata.2016.18

[96] Helmholtz Association. (2016). Making information resources more usable. Available online at: https://doi.org/10.48440/os.helmholtz.026

[97] Helmholtz Association (2016). Open-Access-Richtlinie der Helmholtz-Gemeinschaft [Open Access Policy of the Helmholtz Association]. Available online at: https://doi.org/10.2312/os.helmholtz.017. [The English-language version is available at: https://os.helmholtz.de/en/open-access/open-access-policies/open-access-policy-of-the-helmholtz-association-2016/]

[98] Schultze-Motel, P. (2019). Helmholtz Open Science Workshop "Elektronische Laborbücher" [Electronic Lab Books]. DOI: https://doi.org/10.2312/os.helmholtz.001

[99] https://rdmorganiser.github.io [Accessed on June 8, 2021.]

    - Free licenses, for example, the Creative Commons attribution license CC BY 4.0[100] for textual publication types; for software, the GNU [General Public License],[101] the MIT License,[102] the Apache License 2.0[103]

- Recommendation No. 17: The unique identification of researchers and their organizational affiliations by means of an ORCID iD[104] is of great benefit; the use of ORCID iDs and the integration of ORCID at the Helmholtz Centers is recommended.
- Recommendation No. 18: To identify and classify the persons involved in the research process, it is recommended to consult the Contributor Roles Taxonomy (CRediT).[105,106]
- Recommendation No. 19: As full recognition of all those involved in the research process is not yet an established approach in all disciplines, researchers should promote in their own work and beyond – for example, when active on publishing committees – the improved recognition of all persons involved in the research system.

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[102] https://opensource.org/licenses/MIT [Accessed on June 8, 2021.]
[103] http://www.apache.org/licenses/LICENSE-2.0.html [Accessed on June 8, 2021.]
[104] https://orcid.org [Accessed on June 8, 2021.]
[105] https://casrai.org/credit/ [Accessed on June 8, 2021.]
[106] The University of Glasgow has explicitly incorporated CRediT into its "Code of Good Practice in Research," for example: https://www.gla.ac.uk/media/Media_490311_smxx.pdf [accessed on June 8, 2021].

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