1 Binding letter of intent as advance notification or non-binding letter of intent

	Binding letter of intent (required as advance notification for proposals in 2019)
X	Non-binding letter of intent (anticipated submission in 2020)
	Non-binding letter of intent (anticipated submission in 2021)

2 Formal details

Planned name of the consortium

NFDI for Archaeology, Material Culture and Objects

Acronym of the planned consortium

NFDI4Objects

Applicant institution

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3   Objectives, work programme and research environment

Research area of the proposed consortium (according to the DFG classification system)

11 - Humanities

  with relation to

  21 - Biology

  23 - Agriculture, Forestry and Veterinary Medicine

  31 - Chemistry

  32 - Physics

  33 - Mathematics

  34 - Geosciences

  45 - Construction Engineering and Architecture

Concise summary of the planned consortium's main objectives and task areas

NFDI4Objects addresses the infrastructural needs of a well-defined group of researchers and practitioners with multiple disciplinary backgrounds, whose research foci and epistemological interests are in the **material legacy** of some three million years of human and environmental history. To accomplish this mission, the consortium pursues three main objectives:

1) The stimulation and improvement of **science-driven processes** within the community that systematically exploit **relevant research data**, guarantee **long term storage** and make the data **accessible internationally** in accordance with the **FAIR principles**.

2) Addressing the specific challenges of unlocking large and complex volumes of **existing data** in research processes, and at the same time providing access to the **digital results** of research projects according to the **user needs**.

3) The establishment of **structures** and an **operating model** that allows for a confederated portfolio of **trusted, easy-to-use and secure services** based on existing solutions in a network distributed over government agencies, universities, research institutes and infrastructure providers in close consultation with the community and other NFDI-consortia.

Representing the most fundamental source of knowledge on the cultural and biological evolution and diversity of humanity and its civilisations, this legacy consists of physical **objects**, their embedding **contexts** and their manifold properties and histories. It is largely contained in the "soil records" of our planet, as well as in each particular "object-biography", and it is meticulously unlocked by constantly advancing means of detection, recovery, reconstruction and interpretation. In this initiative, the term "object" applies to artefacts, architecture, archaeological features and anthropogenically shaped landscapes, as well as the biological or ecological remains associated with past human activity (for more detailed information see the extended abstract submitted in March).

With a scope that includes even the most minute of physical traces that past human activity has produced and that the environment has preserved, object-centric research combines methods

and traditions from the **humanities** and the **natural sciences**. This creates technological challenges that have, thus far, too often been addressed only partially and on a per-case basis. *NFDI4Objects* will bring together a dedicated **community** to create a user-oriented, needs-driven, internationally connected research data infrastructure for archaeology and numerous related disciplines. This includes not only the field of **archaeology** in the broadest sense (represented by eight diverse archaeological disciplines in Germany), but also **anthropology**, **architectural history** (Bauforschung), **ethnoarchaeology**, **geoarchaeology, paleobotany**, **archaeozoology**, **archaeogenetics, palaeopathology**, **geophysics**, archaeological **conservation** and various sub-disciplines in the field of **archaeometry**. It shares a methodological framework characterised by strong interdisciplinary links, and includes many approaches that generate extensive digital data. An important characteristic of the target community is the *a priori* existence of strong traditions and competencies in the field of digitisation methods and technologies among many of its members, as well as natively digital data acquisition (laser scanning, photogrammetry, Structure from Motion, remote sensing, etc.). The consortium is thus aimed at users who are organised in a variety of academic and professional associations and initiatives, including universities, non-university research institutions, museums and federal heritage authorities.

From this results a **diversity of data types** that gives rise to numerous concrete technical and conceptual requirements for this community- and user-based infrastructure. Data types and products central to the user community of *NFDI4Objects* are survey and field data, exploratory and survey records, sensor data, data from scientific analyses and laboratory protocols, image data, training/reference and signature data, 3D documentation data, spatially referenced data, databases, digital archives and data estates, and formally structured terminologies.

This leads to structural challenges for *NFDI4Objects* on several levels. The federal organisation of heritage management in Germany, as well as discipline-specific and institutional differences, create such a diverse general framework that currently requirements of findability, accessibility and interoperability of data services are mainly tailored towards individual needs. The NFDI initiative provides the unique opportunity of uniting all relevant groups in one project that will lead to more efficient preservation and recording of the material culture of humanity, as well as more methodically coherent and developed research and understanding. It is planned to structure the challenges and needs of the *NFDI4Objects* user community into five task areas:

1. NFDI4Objects **for Fieldwork** will cater for all needs originating from recording, exploration, and documentation of primary data sources (artefacts, sites and monuments, etc.) in the field, in depots and collections. The real-world requirements of field work (often under extreme conditions) can be taxing, including issues of reliable mobile data collection, offline data synchronisation and data safety. Therefore this task area will include a strong services and software innovations component.

2. NFDI4Objects **for Analysis** will cover platforms, standards and services for desktop-based research and laboratory-based analysis of objects, focussing on effective services and technologies for data standardisation, interfaces for retrieval (incl. machine-readability) and exchange.

3. NFDI4Objects **for Cultural Heritage Management** will meet the complex requirements of protection, conservation, restoration and related areas of work and research (such as provenance research). In this task area, the primary challenge lies in the integration of policies, decision making processes and technological development.

4. NFDI4Objects **for Storage** will provide comprehensive technologies and standards for the long-term archiving of research data and all other aspects of FAIR principles. It will build on existing and proven components, with an iterative, strictly demand-driven approach to technological growth and investment. Measures required for this include the review and evaluation of existing regional or institutional solutions, the development of concepts for their integration, standardization, the adaptation to different user scenarios and the implementation of a discovery service for existing data and its long-term archiving.

5. NFDI4Objects **for Connection and Cross-linking** is a task area designed with connectivity of data, standards and concepts in mind; both internally (within *NFDI4Objects*) and externally (within NFDI and internationally). It will enable and promote networking (of both people and data) across disciplinary and institutional divides. This task area will also address the consortium resp. community-specific needs of data literacy and training.

Brief description of the proposed use of existing infrastructures, tools and services that are essential in order to fulfil the planned consortium's objectives

NFDI4Objects can build on extensive preparatory work, for example the results of the consortium-based DFG-Project IANUS. This project has developed a technical and organisational concept for the operation of a national research data centre, has developed a service for long-term preservation of data collections according to OAIS standards, provides IT recommendations regarding data management, formats, tools and documentation processes, as well as a register and the verification of qualification possibilities for digital data in research processes, and a catalogue of minimum IT-skills as a recommendation for higher education curricula. The IANUS project also included a stakeholder analysis for the long-term preservation of archaeological research data, carried out in 2014. In light of the intensive dynamics of change at the national, European and international levels, the present initiative will update the 2014 analysis in the coming months before submission of the proposal in 2020, with the aim of integrating new needs and newly developed data services.

NFDI4Objects will primarily build on existing infrastructural components, carefully extending capabilities, services and standards according to user needs. Archaeological research has always been data-intense, and therefore universities, heritage authorities and other research institutions either have their own computational resources, make use of state/regional computing centres, or both. Much work has already been invested by the community in

connecting these systems via standard protocols and services, including connections with "outside services" (see, for example, the tools of https://idai.world). Many of these implementations are technologically convergent in that they put into practice several key elements of open software technology evolution. This directly results in a high potential for the integration of several existing but not yet interoperable repositories for research data and service levels at universities, state heritage institutions and non-university research institutions within *NFDI4Objects*.

Within the framework of the NFDI, there is thus extensive infrastructure that is set to undergo iterative, evolutionary change, and where improvements to the nature of the design process (in the form of better user-based involvement and needs-driven development) is more acutely required than additional technological solutions. On the other hand, there are categories of research data, such as massive volumes of image-based 3D data, that are not adequately catered for, and where technological research and development are urgently needed to prevent users from further relying on private sector offerings of questionable FAIRness and sustainability. In addition, the strengthening of the service nature of existing infrastructural offers (this being a principal aim of *NFDI4Objects*) will require thorough analysis and resolution of technological *and* conceptual upscaling issues, resulting in a need for both strong development of the user-oriented decision-making and sustainable growth strategies.

Interfaces to other proposed NFDI consortia: brief description of existing agreements for collaboration and/or plans for future collaboration

Research on material objects and their contextualisation is essentially committed to methods and goals in the humanities. Nevertheless it relies on close cooperation with other disciplines, in particular biology, earth system sciences, medicine, chemistry and physics, as well as sociology and engineering. *NFDI4Objects* thus plans to serve the needs of a community that includes highly specialized interdisciplinary intersections with a broad group of disciplines.

Within the **humanities**, *NFDI4Objects* is involved in intensive processes to identify specific user needs, the results of which are documented in a Memorandum of Understanding[1] with the initiatives **NFDI4Text+**, **NFDI4Memory** and **NFDI4Culture**. *NFDI4Objects* plans to develop and implement all necessary measures to cover the needs of all humanities disciplines working with high demands on the contextualization of material objects.

A cooperation is planned with the **KonsortSWD** initiative in order to align the services of *NFDI4Objects* with the needs of the research fields of **cultural and social anthropology** methodically located in **sociology**. With regard to ethical and legal aspects, in particular for sensitive research data, *NFDI4Objects* plans to use the services developed within the framework of KonsortSWD and to feed in specific requirements for their enhancement.

NFDI4Objects sees a particular relationship with **NFDI4Earth, NFDI4Biodiversity and NFDI4Agri** among the science-oriented initiatives. We see common tasks in the promotion of

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1) Brünger-Weilandt, Sabine, K-C. Bruhn, A.W. Busch, E. Hinrichs, W. Horstmann, M. Grötschel, J. Paulmann, P. von Rummel, E. Schlotheuber, D. Schmidt, T. Schrade, H. Simon, Memorandum of Understanding by NFDI initiatives from the humanities and cultural studies (2019, July 2nd) http://doi.org/10.5281/zenodo.3265763

the acceptance of open specifications and architectures for (spatial) data infrastructures, the preparation and quality assurance of vocabularies and reference systems (ontologies), the harmonization of specific data models and exchange formats, the elaboration of transdisciplinary case studies, the inclusion of government data and services, and the opening of industry standards for reproducible research. *NFDI4Objects* can support these initiatives with already existing services for the profound spatial-temporal indexing of datasets (chrono- and geo-gazetteers).

Through the work package "NFDI4Objects for Connection and Cross-linking", the intensification of contacts to further initiatives is already being continuously expanded in the application phase. The focus here will be on scientific analytics (chemistry, physics) and medicine.

4 Cross-cutting topics

Comprehensive solutions for the following cross-cutting topics are relevant for NFDI4Objects and need to be designed and developed by several or all NFDI consortia:

- Data Quality
  - Identification of data domain specific challenges (raw data, processed data, metadata, norm data)
  - specifications of criteria addressing accuracy, precision, consistency and completeness for each domain
  - data quality management and user involvement
- Data Literacy, Training and Qualification
  - Eligible measures on all levels (students, postdocs, lecturers and scholars)
  - Adherence to state-of-the-art didactic principles
- Software Curation
  - Agreement on fundamentals of sustainable software development and open source principles
  - Managing the reuse of software
  - Internationally interconnected git-Repositories
- Online Applications and Collaboration
  - Single-sign-on solution
  - Concepts for federated search based on consortium specific retrieval systems
  - Common technical best practices for interfaces of online-services
  - Implementing UX/UI-Design principles
  - Platform(s) fostering digital scholarship
- Open Standards, Interoperability and use of existing Infrastructures
  - Development of focused, open and transparent processes for the definition of standards and specifications
  - Cooperation with international consortia already developing open specifications and standards
  - Support of the evolvement of interoperable data formats and service architectures
  - Development of measures for the legally permitted connection of existing

- infrastructures from state, private or scientific institutions
        - Recovery, backup and refurbishment of scattered legacy data from research projects completed over the last decades
    - Legal-ethical issues
        - Guidelines and both legally and technically verified solutions for handling sensitive data
        - Incorporation of administrative data and service infrastructures governed by different federal legal frameworks
        - Taking into account complex national legal regulations in multinational research projects
        - Awareness of data ownership issues, especially with regard to cultural heritage data
    - Knowledge formalisation
        - Not only the humanities, but also cultural and social sciences have high demands on the digital representation of the knowledge inherent in data for a machine-supported use of data resources. This applies in particular to the often essential inclusion of legacy data, in which outdated and in some cases highly problematic knowledge conceptualisations would be incorporated without reflection into the research data compendium provided by the NFDI.

NFDI4Objects combines experience and expertise in the following areas and can contribute to appropriate solutions within the NFDI to the following cross cutting topics:

- Data Quality
    - Disciplines engaged in material object studies, and archaeology in particular, have been engaged for decades with the digitisation of material remains of human history and cultural evolution. Due to the often destructive methods employed, data quality is of paramount importance for research processes. This applies in particular to data from scientific sampling and laboratory analyses (botany, zoology, genetics), surveying and 3D data, complex descriptive and technical metadata, data on semantic concepts referring to classifications, typologies and the spatio-temporal contextualisation of objects. In these data-quality related fields, NFDI4Objects can draw on an extensive scientific background and contribute significantly to the design of the NFDI as a whole.
- Data Literacy, Training and Qualification
    - NFDI4Objects can draw on a large number of existing qualification measures for many user levels. A proposal for a core curriculum and user-generated best practices in digitally handling material object data already exist, and can be used to derive concrete qualification content useful to many contiguous consortia.
    - Over two decades of experience in the transformative processes of the digitisation of object documentation support the development of appropriate measures for the continuous involvement of users, already during the establishment of the NFDI.
- Software Curation

- Several participants have long term experience in ensuring that software is specifically tailored to user needs and constantly up to date, and actively contribute to its further development.
- Online Applications
    - A wide range of online applications in different states of stability and technical maturity and of relevance for other consortia, currently serve research processes in the *NFDI4Objects* user domain. The consortium must agree on procedures to ensure the identification, selection and transformation of these services into distributed, institutionalised services that meet the needs of the NFDI. These processes can contribute to the development of generic procedures within the NFDI.
    - Several Members of the consortium have long experience in the field of the publication of data, in particular Heidelberg University and the specialized information service (FID) for the "Altertumswissenschaften" at Heidelberg that serves as a node for different consortia.
- Open Standards, Interoperability and use of existing Infrastructures
    - Sections of the community of *NFDI4Objects* are active and internationally networked advocates of open data, open source and open science, working collaboratively on corresponding projects. Open Data and Open Access policies and practices have been regularly discussed at an international level by scholars of *NFDI4Objects*-communities for more than a decade. As early adopters, these groups can contribute to initiatives to disseminate the above-mentioned principles.