Iterative development of a FOSS tool chain for collaborative annotation and semantic enrichment of 3D models

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Abstract

3D models within disciplines such as architecture, art, archaeology, and 3D reconstruction are particularly heterogeneous in formats and structure, and pose unique challenges to rendering software in terms of geometric complexity, memory and bandwidth requirements. Existing tools that tackle these challenges, often do so at the expense of other access priorities – such as rich linked open data (LOD) relations across digital artifacts and related metadata, collaborative environments for annotation or user-friendly interfaces. To address this knowledge gap, a FOSS (free and open source software) toolchain and associated workflow for semantic annotation of 3D cultural artefacts is being developed across several partner organisations led by the Open Science lab[1] at TIB – Leibniz Information Centre for Science and Technology and University Library, Hannover. Project context is NFDI4Culture, a German consortium of research- and cultural heritage institutions working towards a shared infrastructure for research data that meets the needs of 21st century data creators, maintainers and end users across the broad spectrum of the digital libraries and archives field, and the digital humanities, see Altenhöner (2020).

Our toolchain follows FAIR principles, and adopts common standards like PIDs and the W3C annotation model, but also expands on existing models where needed in order to bridge the gap between traditional data management schemas and 3D rendering environments. It facilitates linking 3D objects and annotations, and their cultural context (including historical people and places, geolocation and 3D-capture-technology metadata), to the broader semantic web and various national and international authority records (GND, Getty's AAT, VIAF and more). The toolchain is envisioned as a collaborative environment with different levels of read/write access, wherein groups of

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[1] https://www.tib.eu/en/research-development/research-groups-and-labs/open-science

researchers can use graphical user interfaces to perform data upload and annotation with clear data provenance.

Operating within NFDI4Culture's Task area 1: Data capture and enrichment, the integrated toolchain connects:

1) OpenRefine – for data cleaning, reconciliation and batch upload;

2) Wikibase – an open knowledge graph environment for LOD storage and management, including collaboration features and version control: 3D objects' metadata and related annotations can be linked to various resources, part of the semantic web and all data is searchable via a public SPARQL endpoint; and

3) Kompakkt – for rendering and annotating 3D models.

By connecting Kompakkt's existing architecture with the semantic environment of Wikibase, we are able to infer more complex relations between media items and their contextual metadata than previously possible. 3D reconstructions of rooms can be linked to their precise location within a building's flat plan, or to handscanned media representations of objects in the room, such as sculptures, for example. The latter (i.e. the media representations) can be described with rich historical data about the physical objects themselves, beyond the narrow technical metadata for the 3D file. The toolchain is created in an agile process openly with the community (in this case art history and architecture[2]) in a relatively short time. We currently optimise the toolchain within the current use case, already roadmapping the next iteration and refinement through added features other data and contexts in the field of architecture, art and digital reconstruction as well. The toolchain is planned to be combined with other toolsets for enriching and searching 3D models, e.g. in the context of Fachinformationsdienst (FID, specialized information service) BAUdigital[3].

Figure 1 shows a 3D model in Kompakkt including an annotation with a 2D image and metadata. These data connections are made visible via the Kompakkt interface, with custom queries to the Wikibase SPARQL endpoint. For a more comprehensive visualisation and quick intro to those features described we refer to a resource compiled by Rossenova (2022): The video shows the core steps in the media file upload and annotation workflow facilitated by the toolchain.

The presentation at CHNT is aimed at librarians, digital curators and data managers interested in learning how to manage research datasets containing 3D media, and how to make them available within an open data environment with 3D-rendering and collaborative annotation features. During the session we further want to discuss how to foster easy upload processes, enrichment and searchability, as users actually have little time to enter information when providing 3D models. Furthermore we want to broaden and rethink the concept of annotations: how do media files themselves become annotations, how can AI usefully support, and how can the user be involved in the process of generating training data when annotating?

Another interesting issue is that of provenance of information: Wikibase provides a visual interface for editing triples incl. version history. This is not only important in the context of research data. But

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[2] Lehrstuhl für Theorie und Geschichte von Architektur, Kunst und Design, https://www.arc.ed.tum.de/ltg/

[3] https://www.fid-bau.de/en/home/

what are the requirements of the broader cultural heritage community? Is it enough to interact with information via the 3D interface/tool or is there an interest to edit via Wikibase as well?
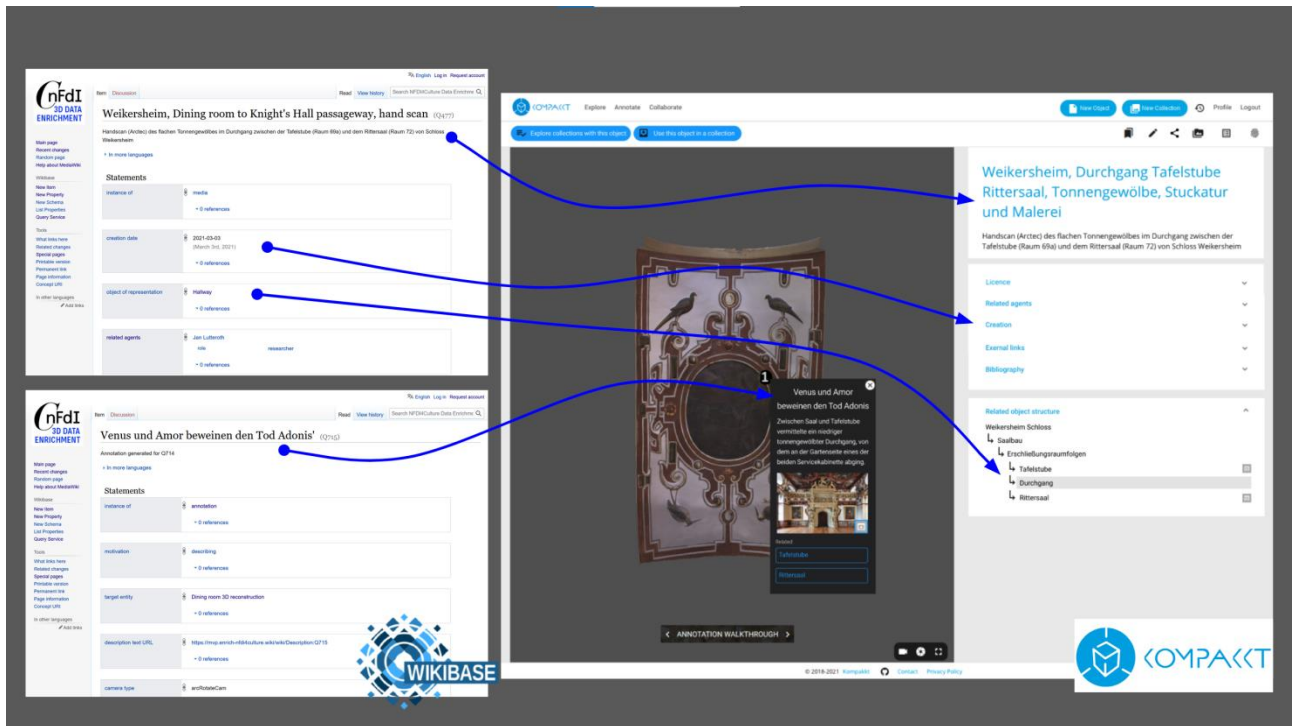

Fig. 1. 3D model visualisation in Kompakkt including annotation with a 2D image. Metadata describing 3D models and various kinds of annotations displayed in Kompakkt is instantly stored in Wikibase.

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Please list the contributions of the project participants here, according to the CRediT system. See specific descriptions of the role here: (http://credit.niso.org/). **Please omit non-applicable roles**.

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