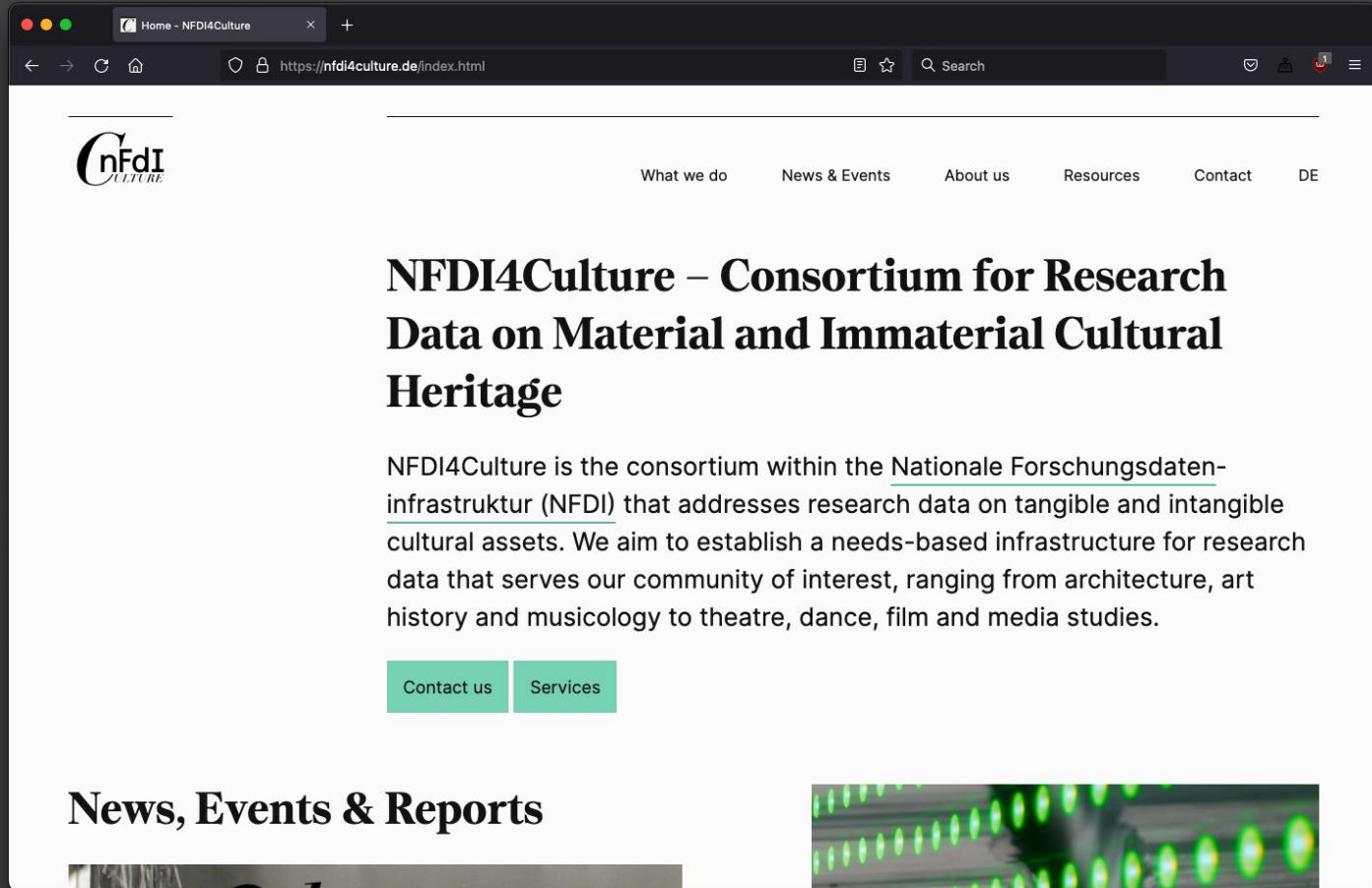


# Semantic annotation for 3D cultural artefacts: MVP

October, 2021

Prof. Dr. Ina Blümel, Dr. Lozana Rossenova,  
Lucia Sohmen, Richard Vock, and  
Zoe Schubert





The image shows a browser window displaying the homepage of NFDI4Culture. The browser's address bar shows the URL <https://nfdi4culture.de/index.html>. The website features a navigation menu with links for 'What we do', 'News & Events', 'About us', 'Resources', 'Contact', and 'DE'. The main heading is 'NFDI4Culture – Consortium for Research Data on Material and Immaterial Cultural Heritage'. Below this, a paragraph describes the consortium's mission: 'NFDI4Culture is the consortium within the Nationale Forschungsdateninfrastruktur (NFDI) that addresses research data on tangible and intangible cultural assets. We aim to establish a needs-based infrastructure for research data that serves our community of interest, ranging from architecture, art history and musicology to theatre, dance, film and media studies.' Two teal buttons labeled 'Contact us' and 'Services' are positioned below the text. At the bottom left, the section 'News, Events & Reports' is visible, accompanied by a blurred image of green lights.

Home - NFDI4Culture

https://nfdi4culture.de/index.html

Search

**CnFdi**  
CULTURE


What we do   News & Events   About us   Resources   Contact   DE

## NFDI4Culture – Consortium for Research Data on Material and Immaterial Cultural Heritage

NFDI4Culture is the consortium within the Nationale Forschungsdateninfrastruktur (NFDI) that addresses research data on tangible and intangible cultural assets. We aim to establish a needs-based infrastructure for research data that serves our community of interest, ranging from architecture, art history and musicology to theatre, dance, film and media studies.

Contact us   Services

### News, Events & Reports



# NFDI4Culture: Task Area 1

Task Area 1 - NFDI4Culture

https://nfdi4culture.de/what-we-do/task-areas/task-area-1.html

nfdi4culture

What we do News & Events About us Resources Contact DE

Capture & Enrichment

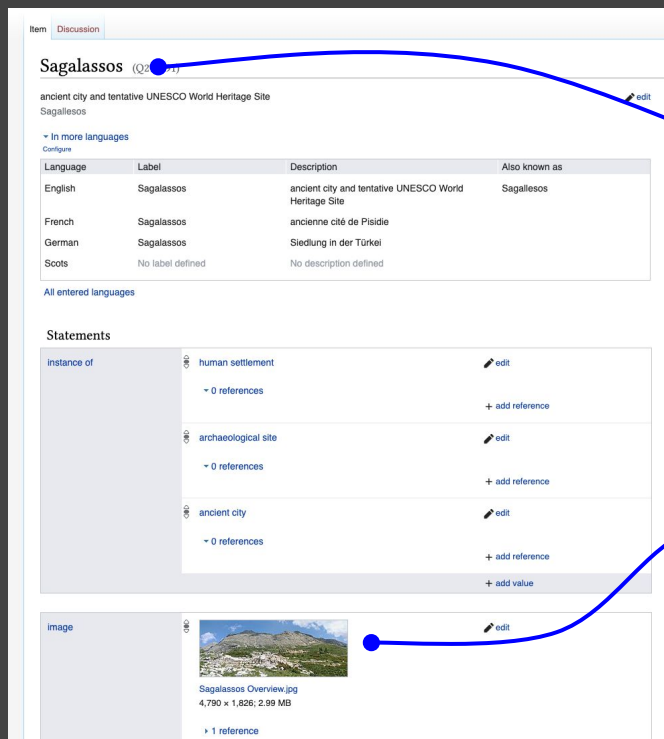
## Data capture and enrichment of digital cultural assets

Digital representations of tangible and intangible cultural assets provide an essential basis for research in the cultural heritage domain and are more and more present in the day-to-day work of scholars. Thereby, an ever-increasing variety of technologies and data types is being employed, such as 2D, 3D, audio, video, AR/VR, thermography or computer tomography.

Our overarching goal is to match the production and continuous enrichment of digital cultural heritage with the demands of researchers, GLAM experts and various other audiences. In close collaboration with the digitisation community, we seek to establish a strong network in order to facilitate a regular exchange between producers and users of digital materials. This will be complemented by open and modular services and tools for the capture and enrichment process of cultural heritage objects.

# Task area 1: Data Capture and Enrichment

MVP (minimum viable product): Connecting a Wikibase instance for LOD management with the Kompakkt viewer for 3D image preview and annotation; Data upload pipeline via OpenRefine;



Item Discussion

## Sagalassos (Q22019)

ancient city and tentative UNESCO World Heritage Site  
Sagalassos

In more languages

Language	Label	Description	Also known as
English	Sagalassos	ancient city and tentative UNESCO World Heritage Site	Sagalassos
French	Sagalassos	ancienne cité de Pisidie	
German	Sagalassos	Siedlung in der Türkei	
Scots	No label defined	No description defined	


All entered languages

### Statements

instance of

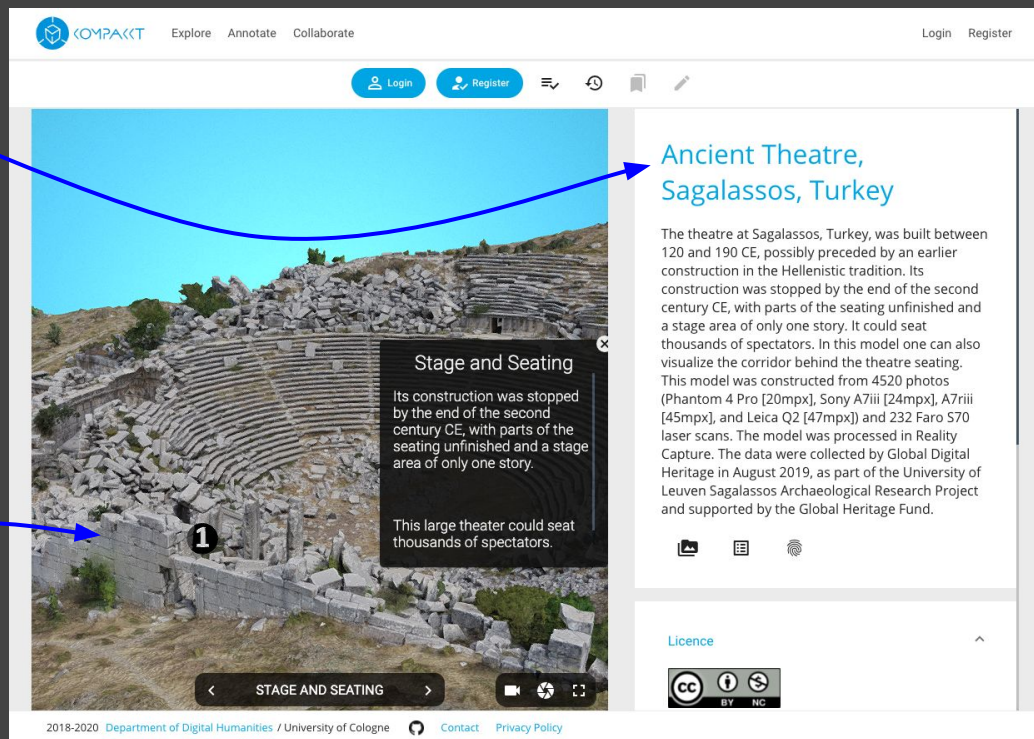
- human settlement
- archaeological site
- ancient city

image



Sagalassos Overview.jpg  
4,790 x 1,826; 2,99 MB

1 reference



COMPAKKT Explore Annotate Collaborate Login Register

## Ancient Theatre, Sagalassos, Turkey

The theatre at Sagalassos, Turkey, was built between 120 and 190 CE, possibly preceded by an earlier construction in the Hellenistic tradition. Its construction was stopped by the end of the second century CE, with parts of the seating unfinished and a stage area of only one story. It could seat thousands of spectators. In this model one can also visualize the corridor behind the theatre seating.

This model was constructed from 4520 photos (Phantom 4 Pro [20mpx], Sony A7iii [24mpx], A7riii [45mpx], and Leica Q2 [47mpx]) and 232 Faro S70 laser scans. The model was processed in Reality Capture. The data were collected by Global Digital Heritage in August 2019, as part of the University of Leuven Sagalassos Archaeological Research Project and supported by the Global Heritage Fund.



Stage and Seating

Its construction was stopped by the end of the second century CE, with parts of the seating unfinished and a stage area of only one story.

This large theater could seat thousands of spectators.

2018-2020 Department of Digital Humanities / University of Cologne Contact Privacy Policy

# Case study – Weikersheim (current web platform)


 Deckenmalerei  Karte  zum Projekt 

## Weikersheim, Residenzschloss

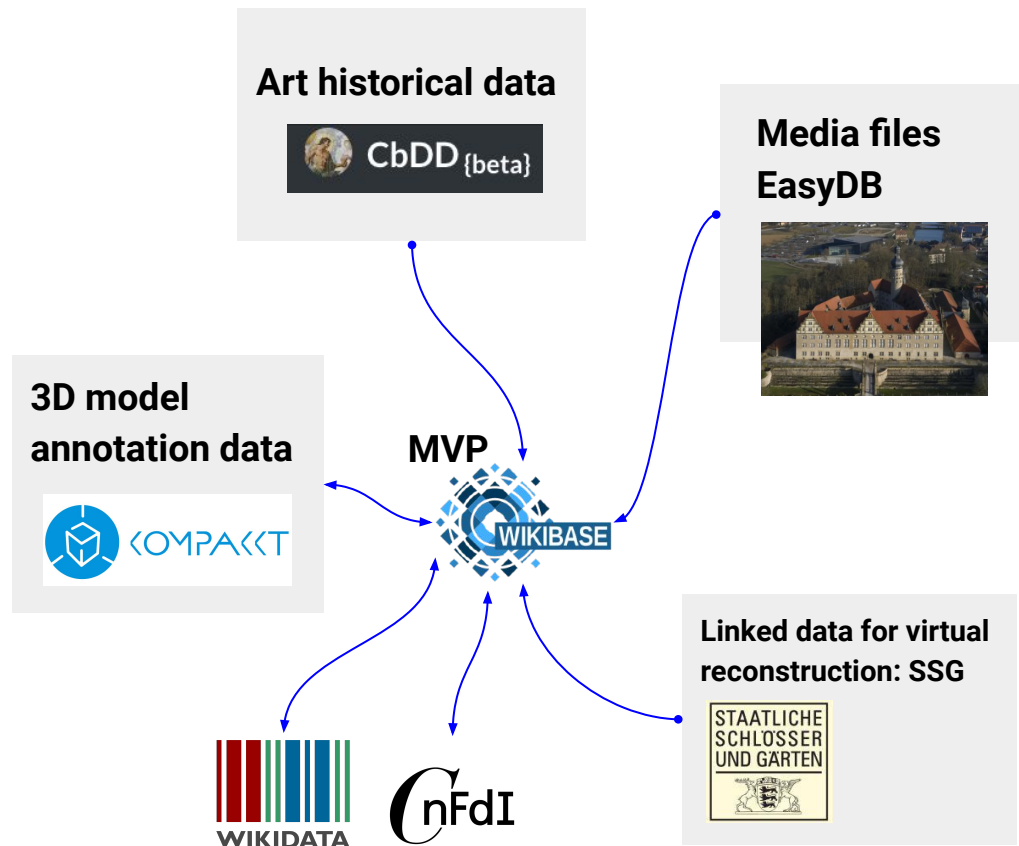
QR Code   
 Karte 



- Schatzkarte Weikersheim
  - Weikersheim
    - Die Säulenhalle
      - Die Säulenhalle der Residenz des Balthasar Königseger
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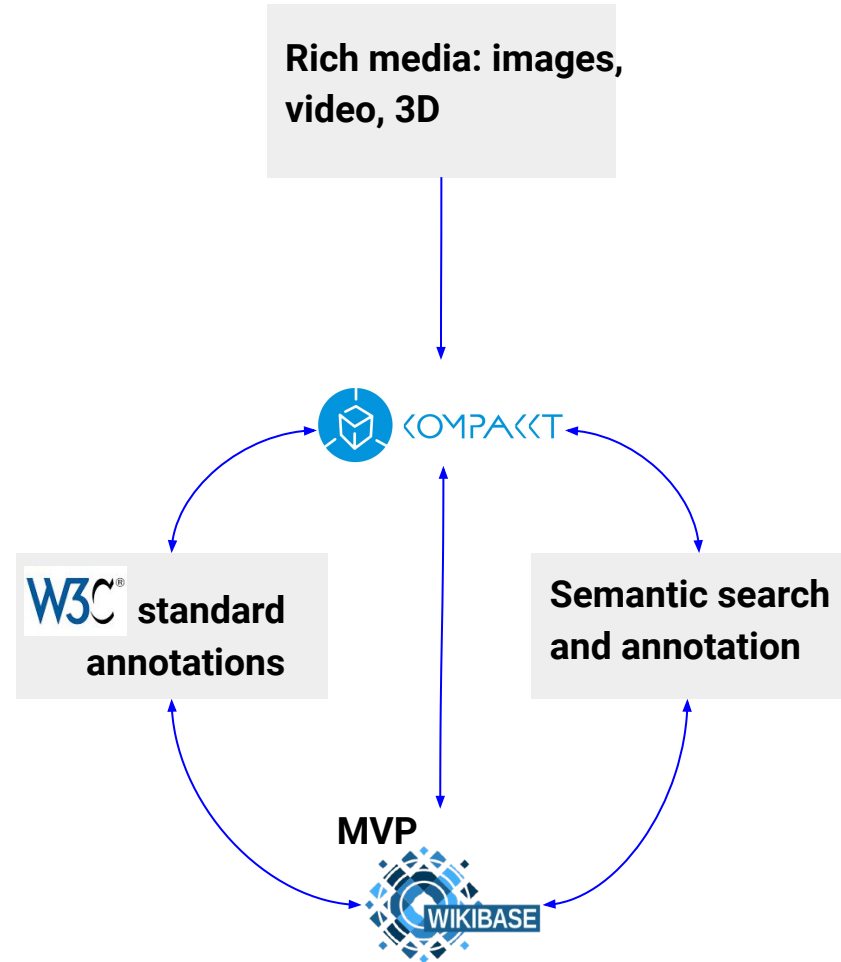
# Benefits of Linked Open Data & Wikibase

- Reduces siloing and redundancy of data
- Enables the enrichment of data from external repositories via federation
- Enables sophisticated advanced search for concepts, rather than keywords
- Data can be part of the NFDI4Culture knowledge graph

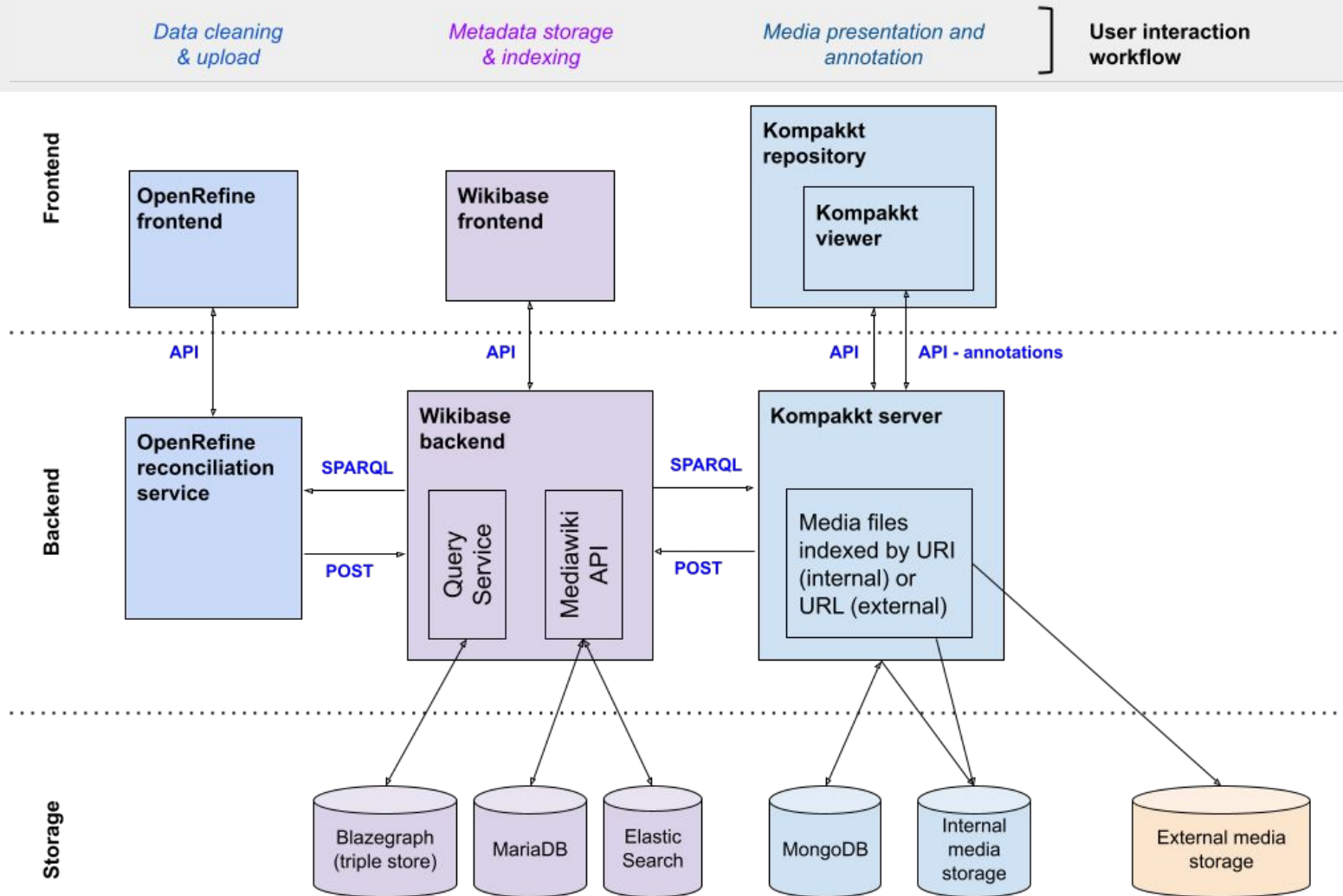


## Benefits of annotation via Kompakkt

- Can be used with a variety of rich media, soon also point clouds
- Enables collaborative annotation of media files
- Can also be used for bulk operations, with additional configuration
- Follows annotation standards which can be made interoperable with a linked open data platform like Wikibase



# MVP architecture





# Wikibase instance

The screenshot shows a web browser window displaying a Wikibase instance page. The browser's address bar shows the URL: [https://enrich-nfdi4culture.wiki.opencura.com/wiki/Main\\_Page](https://enrich-nfdi4culture.wiki.opencura.com/wiki/Main_Page). The page features a navigation bar with options like 'Main page', 'Discussion', 'Read', 'View source', and 'View history'. A search bar is also present. The main content area is titled 'Main Page' and includes a 'Contents' table of contents with seven items. The first item, 'Semantic annotation for 3D cultural artefacts: About our MVP', is expanded to show a paragraph of text and a bulleted list of tools. The text describes the project's goals and the tools used, including OpenRefine, Wikibase, and Kompakt. The list of tools includes: OpenRefine (data cleaning), Wikibase (the tool behind the interface), and Kompakt (a browser-based viewer). Below the text, there are sections for 'About our case study' and 'Adding new data in the archive', each with a bulleted list of actions like 'Create new item' and 'Create new property'. A left sidebar contains various navigation links such as 'Main page', 'Recent changes', and 'Tools'.

**CnFdI**  
3D DATA  
ENRICHMENT

Main page **Discussion** Read View source View history Search NFDI4Culture Data Enrichment

## Main Page

**Contents** [hide]

- 1 Semantic annotation for 3D cultural artefacts: About our MVP
- 2 About our case study
- 3 Adding new data in the archive
- 4 Example item pages for different types of data
- 5 Data model reference
- 6 Some example data queries
- 7 Indexes for quick reference

### Semantic annotation for 3D cultural artefacts: About our MVP

A suite of tools for semantic annotation of 3D cultural artefacts is being developed as part of the NFDI4Culture project across several partner organisations (led by the [Open Science lab at TIB, Hannover](#)). Operating within Task area 1: Data capture and enrichment, the proposed toolchain focuses on the annotation of 3D data within a knowledge graph environment, so that 3D objects' geometry, attendant metadata, as well as annotations remain searchable, while data interconnections are not lost. The project builds on several existing FOSS tools:

- [OpenRefine](#), a data cleaning, reconciliation and batch upload tool;
- [Wikibase](#) (the tool behind the interface you are viewing now), a suite of services developed by Wikimedia Germany; it combines the ability to handle large volumes of data points with sophisticated data querying and extraction services via a dedicated SPARQL endpoint;
- [Kompakt](#), a browser-based open-source 3D- and multimedia viewer Kompakt with built-in collaborative annotation features.

The integrated suite of tools follows FAIR principles and facilitates linking 3D-objects and annotations, and their cultural context (including historical people and places, geo-location and capture-technology metadata), to the broader semantic web and various national and international authority records (GND, VIAF and more).

By the end of 2021, the toolchain will be developed as an MVP (minimum viable product) to be tested and refined further with more data partnerships. It will allow a wide range of users to interact with 3D- and other types of multimedia objects and annotations, and ultimately open up new digital spaces for research, education and discourse around cultural stewardship and memory preservation without siloing knowledge.

### About our case study

This Wikibase instance contains sample data about Weikersheim Castle from the [Corpus der barocken Deckenmalerei in Deutschland](#), provided the MVP data partners at [The Institute of Art History](#) at Ludwig-Maximilians-Universität in Munich.

### Adding new data in the archive

- [Create new item](#)
- [Create new property](#)

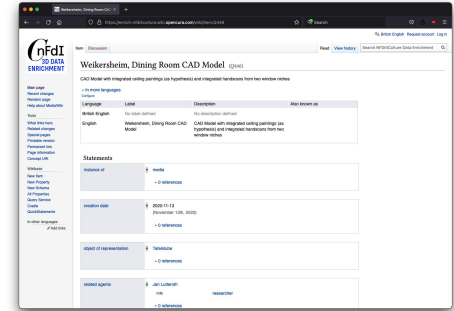
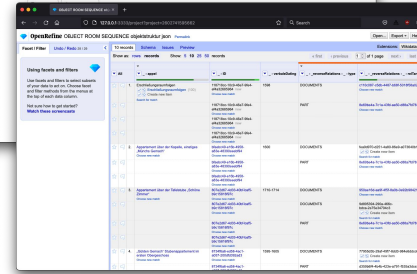
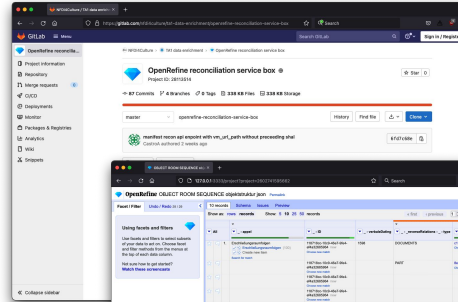
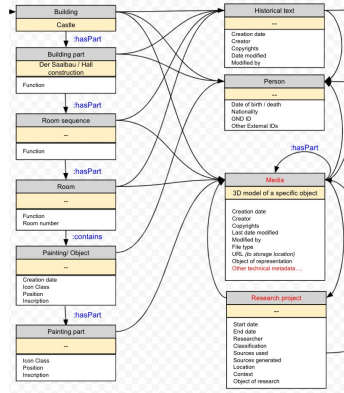
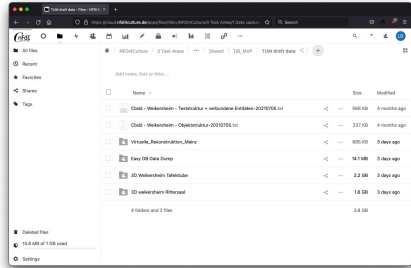
Wikibase

- New Item
- New Property
- New Schema
- All Properties
- Query Service
- Cradle
- QuickStatements

In other languages

[Add links](#)

# Data upload pipeline



1. data collection



2. data modeling

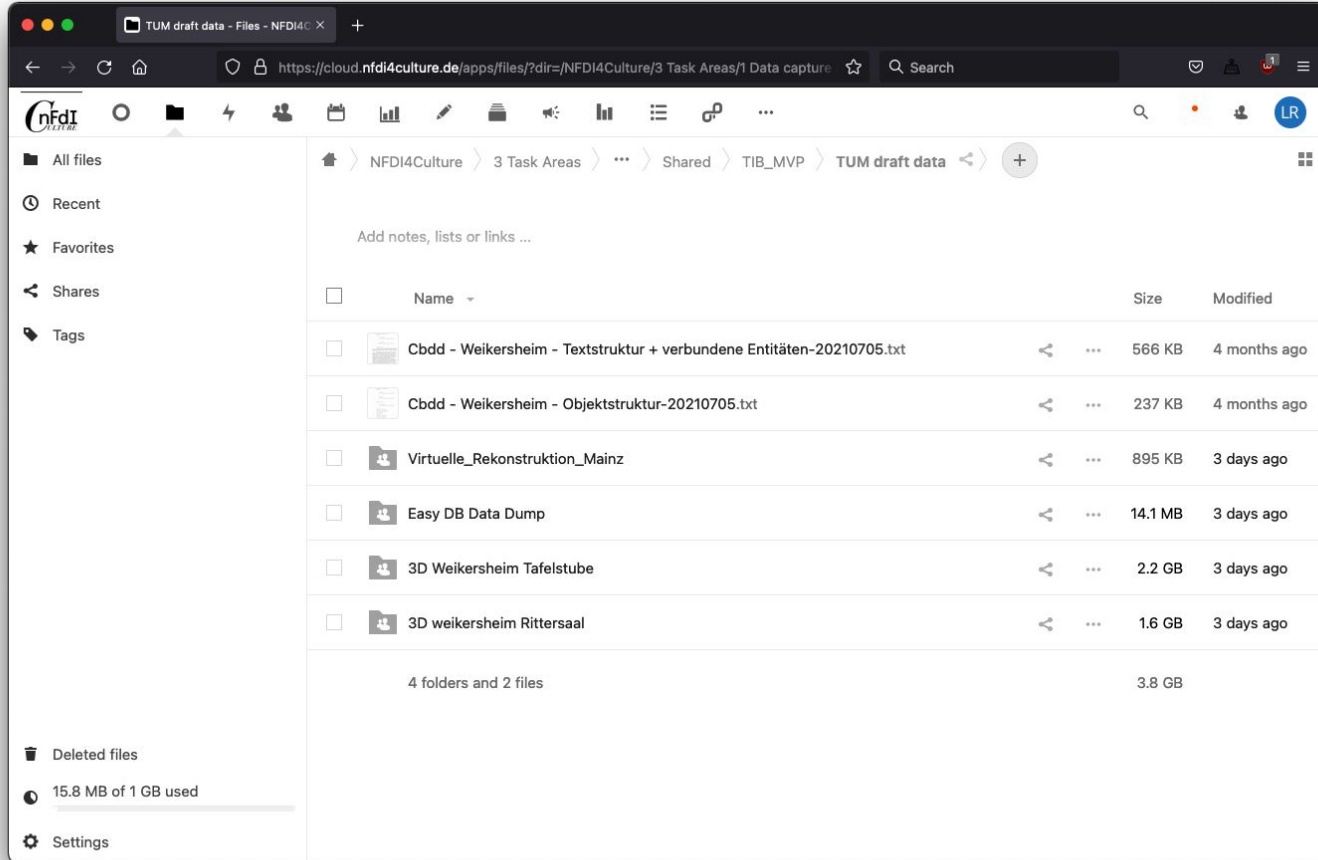


3. data transformation + reconciliation









4. data upload

# 1. Collecting a wide range of data from our data partners



The screenshot displays a web-based file manager interface for 'nfdi4culture'. The browser address bar shows the URL: [https://cloud.nfdi4culture.de/apps/files/?dir=/NFDI4Culture/3 Task Areas/1 Data capture](https://cloud.nfdi4culture.de/apps/files/?dir=/NFDI4Culture/3%20Task%20Areas/1%20Data%20capture). The left sidebar contains navigation options: All files, Recent, Favorites, Shares, Tags, Deleted files, and Settings. The main content area shows a breadcrumb path: NFDI4Culture > 3 Task Areas > ... > Shared > TIB\_MVP > TUM draft data. Below the path, there is a table of files and folders:

Name	Size	Modified
<input type="checkbox"/>  Cbdd - Weikersheim - Textstruktur + verbundene Entitäten-20210705.txt	566 KB	4 months ago
<input type="checkbox"/>  Cbdd - Weikersheim - Objektstruktur-20210705.txt	237 KB	4 months ago
<input type="checkbox"/>  Virtuelle_Rekonstruktion_Mainz	895 KB	3 days ago
<input type="checkbox"/>  Easy DB Data Dump	14.1 MB	3 days ago
<input type="checkbox"/>  3D Weikersheim Tafelstube	2.2 GB	3 days ago
<input type="checkbox"/>  3D weikersheim Rittersaal	1.6 GB	3 days ago
4 folders and 2 files		3.8 GB

At the bottom left, a storage usage indicator shows '15.8 MB of 1 GB used' with a progress bar. The 'Settings' gear icon is located at the bottom left of the sidebar.

## 2. Developing a data model based on established vocabularies

The screenshot shows a web browser window displaying the 'Data Model' page on the OpenCura platform. The page is titled 'Data Model' and is part of the 'NFDI4Culture Data Enrichment' project. The main content area features a table of Wikidata equivalent properties for 'Building item properties'.

**Contents [hide]**

- 1 Building item properties
- 2 Object item properties
- 3 Agent item properties
- 4 Descriptive text item properties
- 5 Media item properties
- 6 Annotation item properties

**Building item properties**

These items should be instances of [Building \(Q6\)](#) or one of its related items: [Building ensemble \(Q5\)](#), [Building part \(Q7\)](#), [Room sequence \(Q8\)](#), [Room \(Q9\)](#)

Title	ID	Wikidata equivalent property	Data type	Description	Examples	Inverse
instance of	P1	<a href="#">P31</a>	item	this item is a specific example and a member of that class	<a href="#">Weikersheim castle complex</a> <instance of> <a href="#">building ensemble</a>	
coordinate location	P12	<a href="#">P625</a>	geographic coordinates	location of an item, expressed in geographic coordinates	<a href="#">Weikersheim castle complex</a> <coordinate location> <span><span><span><span>9°53′45.02″N</span>, <span>49°28′49.98″E</span></span></span></span>	
administrative location	P17	<a href="#">P131</a>	item	the administrative entity this item is located in	<a href="#">Weikersheim castle complex</a> <administrative location> <a href="#">Weikersheim</a>	

### 3. Creating a reconciliation service for an OpenRefine instance to connect to Wikibase & transforming the data into the correct schema needed for upload

The image shows two overlapping browser windows. The background window is a GitLab repository page for 'OpenRefine reconciliation service box'. The foreground window is the OpenRefine interface displaying a table of records.

**GitLab Repository Information:**

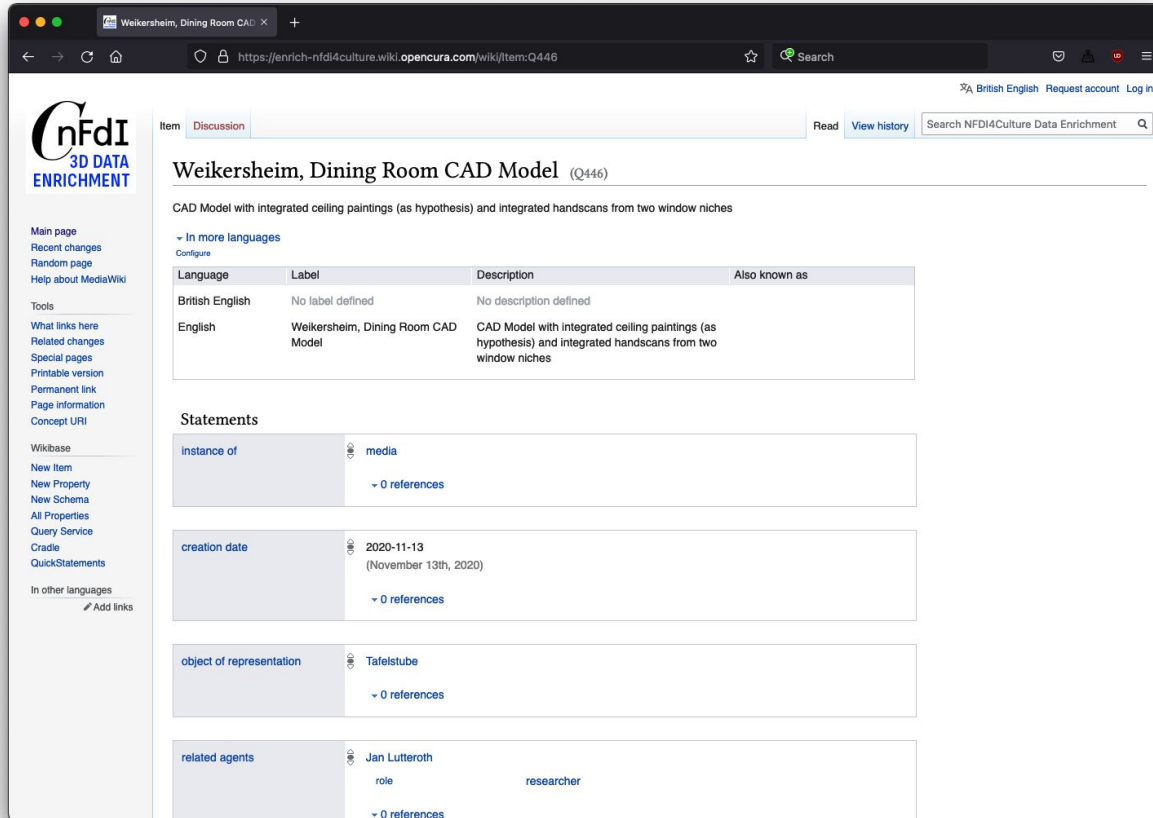
- Project: OpenRefine reconciliation service box
- Project ID: 28113514
- Commits: 87
- Branches: 4
- Tags: 0
- Files: 338 KB
- Storage: 338 KB
- Current branch: master
- Repository: openrefine-reconciliation-service-box
- License: GNU GPLv3
- Recent commits:
  - manifest recon api endpoint with vm\_url\_path without preceding shal (CastroA, 2 weeks ago)
  - README
  - GNU GPLv3

**OpenRefine Interface:**

- Table title: OBJECT ROOM SEQUENCE objektstruktur.json
- Records: 10 records
- Facets: - appellation, - ID, - verbaleDating, - \_reverseRelations - \_type, - \_reverseRelations - \_refTar
- Table columns: ID, appellation, count, type, \_reverseRelations - \_refTar

ID	appellation	count	type	_reverseRelations - _refTar
118718cc-10c9-46e7-9f64-e4a32689594	Erschließungsraumfolgen	1598	DOCUMENTS	c110c087-a5db-4487-b68f-5019f58a0293
118718cc-10c9-46e7-9f64-e4a32689594			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
118718cc-10c9-46e7-9f64-e4a32689594			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
118718cc-10c9-46e7-9f64-e4a32689594			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
bfaebc49-e16b-4955-a83e-48390eeebf94	Appartement über der Kapelle, einatiges „Münchs Gemach“	1600	DOCUMENTS	fe9d970-4251-4a80-86e9-a073640b188
bfaebc49-e16b-4955-a83e-48390eeebf94			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
bfaebc49-e16b-4955-a83e-48390eeebf94			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
807c2687-4c33-40bf-baf5-b0c1581697fc	Appartement über der Tafelstube „Schöne Zimmer“	1710-1714	DOCUMENTS	950ae16d-aa9f-491f-8af2-0e92b98421a1
807c2687-4c33-40bf-baf5-b0c1581697fc			DOCUMENTS	96895394-280a-466c-bdce-2a78a34704c3
807c2687-4c33-40bf-baf5-b0c1581697fc			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
807c2687-4c33-40bf-baf5-b0c1581697fc			PART	8e69be4a-7c1a-43fa-aa50-d88a76783ab
8734f5a6-ed58-4ac1-a057-20080329a5d3	„Gülden Gemach“ Stubenappartement im ersten Obergeschoss	1595-1605	DOCUMENTS	77955d3b-29af-49f7-8dd3-984e6ddcc627
8734f5a6-ed58-4ac1-a057-20080329a5d3			PART	d359e64-4b4b-423e-a791-4535a3dce3d9

## 4. Uploading data through a mix of OpenRefine actions and bot scripts. Sample Wikibase item – [CAD model item link](https://enrich-nfdi4culture.wiki.opencura.com/wiki/Item:Q446)



The screenshot shows a web browser window displaying a Wikibase item page. The browser's address bar shows the URL: <https://enrich-nfdi4culture.wiki.opencura.com/wiki/Item:Q446>. The page title is "Weikersheim, Dining Room CAD Model (Q446)".

The page content includes:

- Item:** Discussion, Read, View history, Search NFDI4Culture Data Enrichment
- Language:** British English, Request account, Log in
- Item Description:** CAD Model with integrated ceiling paintings (as hypothesis) and integrated handscans from two window niches
- In more languages:** Configure
- Table:** A table with columns: Language, Label, Description, Also known as. It lists the item in British English and English.
- Statements:** A list of statements including "instance of", "creation date", "object of representation", and "related agents".

**Table: Language, Label, Description, Also known as**

Language	Label	Description	Also known as
British English	No label defined	No description defined	
English	Weikersheim, Dining Room CAD Model	CAD Model with integrated ceiling paintings (as hypothesis) and integrated handscans from two window niches	

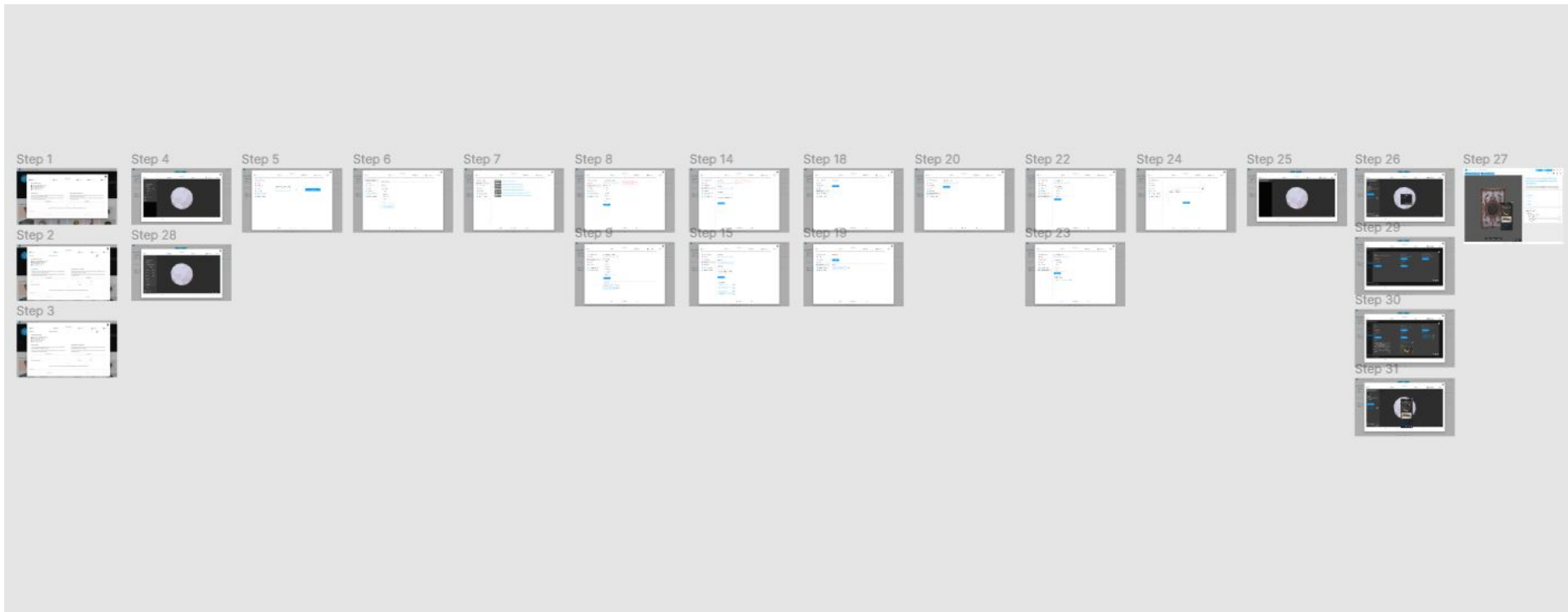
**Statements**

- instance of:** media (0 references)
- creation date:** 2020-11-13 (November 13th, 2020) (0 references)
- object of representation:** Tafelstube (0 references)
- related agents:** Jan Lutteroth (role: researcher) (0 references)

# Data entry workflow: high level diagramme

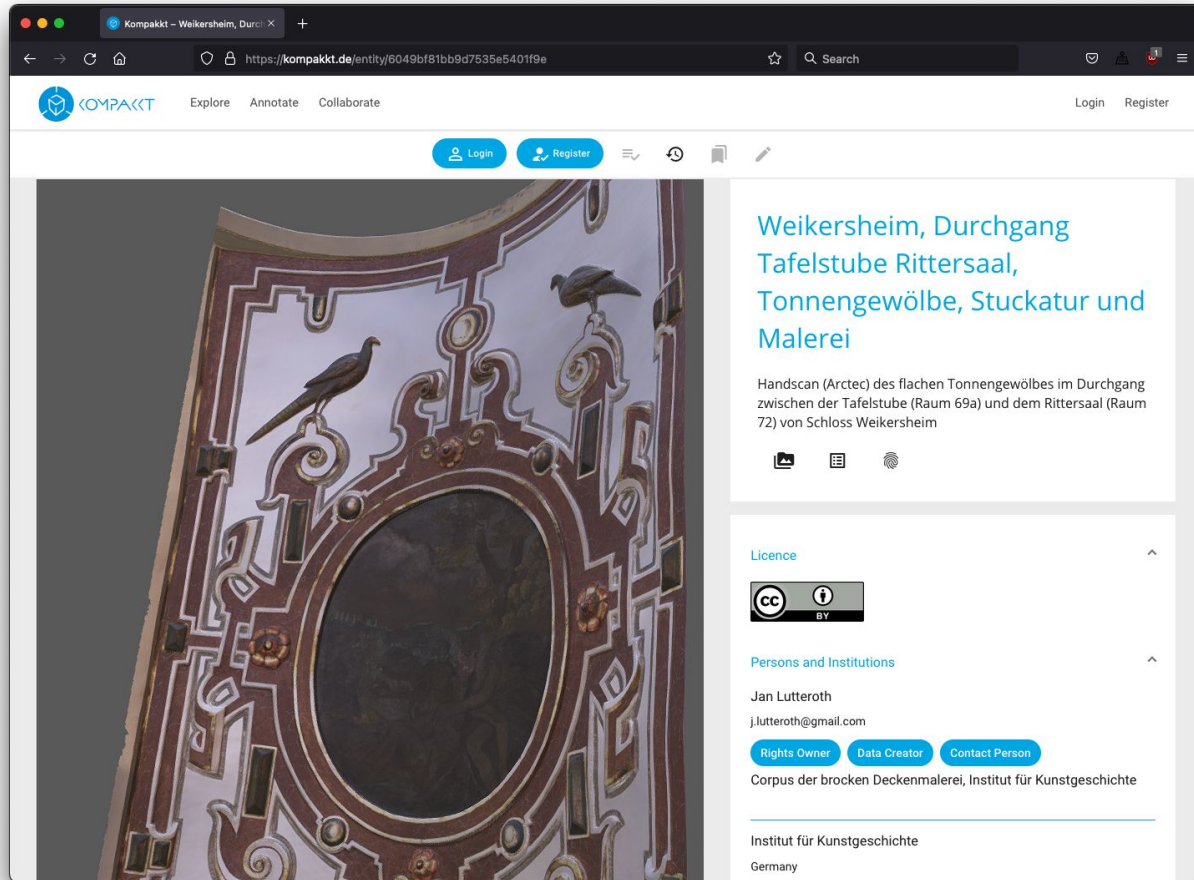


# Data entry workflow: Phase 1, focus on manual annotation





# Sample Kompakt item – Dining room passage handscan



Kompakt – Weikersheim, Durc... X +

https://kompakt.de/entity/6049bf81bb9d7535e5401f9e

EXPLORE Annotate Collaborate Login Register

Login Register

## Weikersheim, Durchgang Tafelstube Rittersaal, Tonnengewölbe, Stuckatur und Malerei

Handscan (Arctec) des flachen Tonnengewölbes im Durchgang zwischen der Tafelstube (Raum 69a) und dem Rittersaal (Raum 72) von Schloss Weikersheim

CC BY

Persons and Institutions

Jan Lutteroth  
j.lutteroth@gmail.com

Rights Owner Data Creator Contact Person

Corpus der brocken Deckenmalerei, Institut für Kunstgeschichte

Institut für Kunstgeschichte  
Germany

# Semantic annotation in our custom Kompakt instance:

The screenshot displays the Kompakt web application interface. At the top, there is a navigation bar with the Kompakt logo and links for 'Explore', 'Annotate', and 'Collaborate'. On the right side of the top bar, there are buttons for 'New Object', 'New Collection', 'Profile', and 'Logout'. Below the navigation bar, there are two blue buttons: 'Explore collections with this object' and 'Use this object in a collection'. The main content area is split into two columns. The left column features a large 3D model of a doorway with intricate carvings of birds and a central panel. A semantic annotation popup is overlaid on the model, containing the following text: '1 Venus und Amor beweinen den Tod Adonis. Zwischen Saal und Tafelstube vermittelte ein niedriger tonnengewölbter Durchgang, von dem an der Gartenseite eines der beiden Servicekabinette abging.' Below the text is a small image of the doorway and two buttons labeled 'Tafelstube' and 'Rittersaal'. At the bottom of the main area, there is a button labeled 'ANNOTATION WALKTHROUGH'. The right column contains a title 'Weikersheim, Durchgang Tafelstube Rittersaal, Tonnengewölbe, Stuckatur und Malerei' and a description: 'Handscan (Arctec) des flachen Tonnengewölbes im Durchgang zwischen der Tafelstube (Raum 69a) und dem Rittersaal (Raum 72) von Schloss Weikersheim'. Below the description are several expandable sections: 'Licence', 'Related agents', 'Creation', 'External links', and 'Bibliography'. The 'Related object structure' section shows a tree view: 'Weikersheim Schloss' -> 'Saalbau' -> 'Erschließungsraumfolgen' -> 'Tafelstube' -> 'Durchgang' -> 'Rittersaal'. At the bottom of the page, there is a footer with the text '© 2018-2021 Kompakt' and links for 'Contact' and 'Privacy Policy'.

KOMPACT Explore Annotate Collaborate

New Object New Collection Profile Logout

Explore collections with this object Use this object in a collection

## Weikersheim, Durchgang Tafelstube Rittersaal, Tonnengewölbe, Stuckatur und Malerei

Handscan (Arctec) des flachen Tonnengewölbes im Durchgang zwischen der Tafelstube (Raum 69a) und dem Rittersaal (Raum 72) von Schloss Weikersheim

Licence

Related agents

Creation

External links

Bibliography

Related object structure

Weikersheim Schloss

- Saalbau
  - Erschließungsraumfolgen
    - Tafelstube
    - Durchgang
    - Rittersaal

1 Venus und Amor beweinen den Tod Adonis  
Zwischen Saal und Tafelstube vermittelte ein niedriger tonnengewölbter Durchgang, von dem an der Gartenseite eines der beiden Servicekabinette abging.

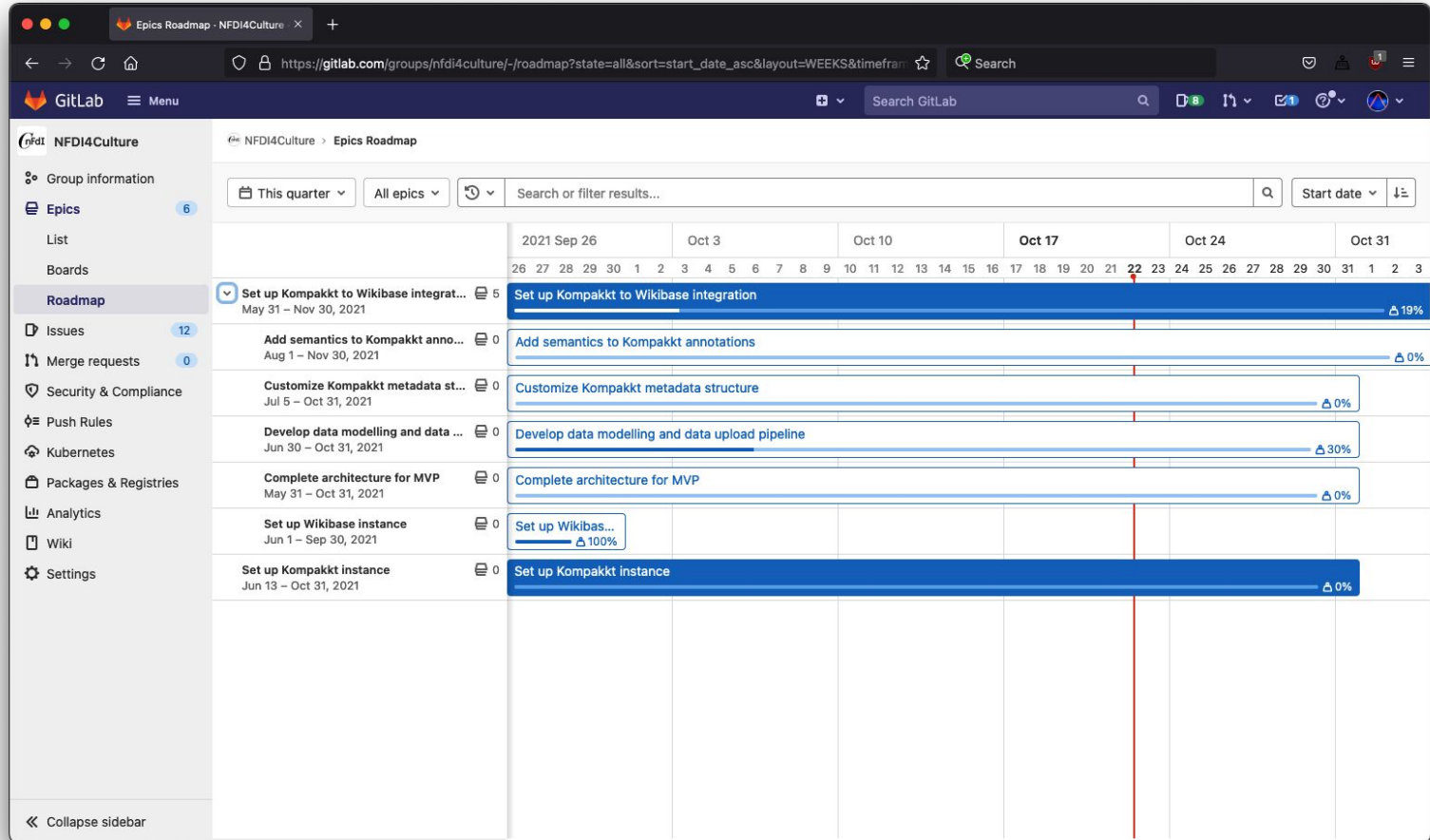
Tafelstube

Rittersaal

ANNOTATION WALKTHROUGH

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# Open development – GitLab



# Open requirements gathering – contribute

The screenshot displays the GitLab web interface for requirements management. The browser address bar shows the URL: `https://gitlab.com/nfdi4culture/ta1-data-enrichment/kompakt-wikibase-integration/-/requirements_manage`. The left sidebar contains a navigation menu with the following items: Project information, Repository, Issues (12), List, Boards, Service Desk, Milestones, Iterations, Requirements (selected), Merge requests (0), CI/CD, Security & Compliance, Deployments, Monitor, Infrastructure, Packages & Registries, Analytics, Wiki, Snippets, and Settings. The main content area is titled "Requirements" and shows a list of requirements. At the top, there are filters for "Open 4", "Archived 1", and "All 5", along with a "New requirement" button. A search bar contains the text "Search requirements". The list of requirements includes:

- REQ-5 **Viewing images inside annotations**  
created 3 months ago by Lozana Rossenova · updated 3 months ago
- REQ-4 **Automate annotation creation**  
created 3 months ago by Lozana Rossenova · updated 3 months ago
- REQ-3 **Exporting annotations**  
created 3 months ago by Lozana Rossenova · updated 3 months ago
- REQ-2 **Allow linking between derivatives of the same 3D model**  
created 3 months ago by Lozana Rossenova · updated 3 months ago

Each requirement entry has edit and delete icons to its right.

# Thank you!

Useful links:

<https://nfdi4culture.de/>

<https://enrich-nfdi4culture.wiki.opencura.com/>

<https://openrefine.org/>

<https://kompakkt.de>

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