Joint Chapter Meeting 2026 CAA Netherlands – Flanders and Germany

Book of Abstracts

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Session 1:
Semantic Web, Linked Open Data, and Data Infrastructure

SHARITAGE – Digitally enabled community-based European SHAred cultural heRITAGE engagement

Moving beyond the one-directional communication of archaeological fieldwork results, the Erasmus+ Cooperation Partnership project SHARITAGE develops and tests methods for the co-creative production of digital heritage narratives. The project brings together ten partners from six European countries. At its core, SHARITAGE advances the ArchaeoTrail system (www.archaeotrail.org), a platform that enables the creation and use of self-guided, smartphone-based tours through archaeological sites.

This paper presents the project's conceptual framework, which understands science communication as a participatory process in which archaeologists, students, heritage professionals, and local communities collaboratively develop site-specific content. This approach fosters mutual learning and shared authority in interpreting the past. Technically, the development of the ArchaeoTrail system in the SHARITAGE project focuses on inclusion. New features include adaptable narrative structures (branching) that allow different user pathways tailored to diverse audiences. In parallel, SHARITAGE develops modular university teaching materials and practical guidelines to embed co-creative digital heritage communication into university curricula across Europe.

By combining digital innovation and community engagement, SHARITAGE proposes a transferable model for participatory science communication in archaeology that strengthens both academic training and public engagement with archaeological heritage.

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Why and How: WikiKult's Living Toolkit for Open Cultural Data

"WikiKult – Offene Kulturdaten" is an independent, German-speaking community of practice for open cultural data, founded in 2024 within the Wikimedia Deutschland ecosystem. Its members from GLAM institutions, such as librarians, archivists, museum staff, researchers, and unaffiliated volunteers and citizen scientists, collaborate to create and expand, e.g., Linked Open Data via Wikidata from the cultural heritage domain through the Wikimedia projects, guided by FAIR, CARE, and open science principles.

This talk presents how the network organises itself and invites the CAA community to take part. Collaboration runs through two complementary settings: a monthly online Jour Flex offering a low-threshold space for exchange and incremental work, and in-person meetings (hosted in Berlin) that combine, for instance, World Café formats with challenge-driven barcamps, hands-on workshops, and Wikidata edit-a-thons. Resources are not commissioned but produced collectively in a wiki-style manner, drafted, revised, and openly versioned, so that the making of each output is itself an instance of the open practice the community promotes.

Two deliberately layered products have emerged and are still being further developed. A concise, visually designed handout, addressed to decision-makers, argues why institutions should contribute to an open knowledge base. A continuously maintained Living Handbook answers how, supporting first-time users and technically advanced practitioners alike, with worked examples such as the semantic modelling of Ireland's ogham stones, a Minimum Record–Wikidata crosswalk, and the description of research software.

We show where newcomers can help, from editing to documentation, and warmly invite colleagues to join, contribute, and help grow the network.

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TalkingTablets Projekt

Cuneiform tablets represent one of the earliest written traditions, yet their interpretation remains challenging due to sign ambiguity, uncertain readings, and high context dependence. This project extends the MaiCuBeDaHT infrastructure, which provides 3D tablet scans, annotations, and metadata as a knowledge graph, toward semantic retrieval and knowledge discovery for cuneiform texts.

The workflow begins by linking annotated sign names to Unicode cuneiform code points while preserving match uncertainty. For each position in each line, candidate signs are scored using probabilities, the confidence estimate for each line is calculated as a combination of these scores. For signs known to represent numbers, determinatives or logograms, the sets of their possible meanings is fetched from Wikidata, associated with the respective indices in the line, and a new certainty score for the translation is calculated. This association between a tablet and possible meanings is used as a sanity check for the next steps.

Further, we aim to generate complete translations using AKK_300m, which will enable us to create embeddings and evaluate semantic retrieval strategies. Once established, this will be the base of a RAG system, allowing users to directly "talk" to the tablets.

By propagating confidence scores, provenance, and FAIR-compliant documentation, the framework supports transparent, explainable, and reproducible research on cuneiform corpora.

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Crossy's Crosswalks – A Chameleon's Guide for Adapting Ontologies and Metadata in the Federated Archaeological Knowledge Graph Ecosystem

Meet Crossy, a chameleon native to the NFDI ecosystem and especially fond of the NFDI4Objects habitat. Like every chameleon, Crossy survives by changing colour – except Crossy's colours are metadata standards, ontologies and terminologies. Excavation data, museum collections, laboratory measurements, and research software each speak their own dialect (e.g., LIDO, CIDOC CRM, CodeMeta, CFF, DCAT, DataCite, schema.org, GeoSPARQL, Wikidata, OpenStreetMap), and they must all blend together to keep the Federated Knowledge Graph Ecosystem alive.

We present Crossy's two main camouflage strategies, both work in progress: the Object Core Metadata Profile (A: OCMDP), a Wikibase-curated SKOS crosswalk aligning, e.g., object and software metadata with the emerging NFDI Core Metadata Profile; and the Material Cultural Heritage Crosswalk Ontology (B: MaCHeCO), an OWL crosswalk aligning archaeological, archeo-natural, archaeo-geoscientific and community models with CIDOC CRM as semantic backbone reference to feed the NFDI4Objects Knowledge Graph, which needs CIDOC CRM or LIDO to survive.

Five use cases illustrate Crossy at work: (A1) software as a FAIR Digital Object, modelled in CodeMeta/CFF and crosswalked to Wikidata; (A2) objects from museum collections expressed as flat tables, mapped to Wikidata via the WikiKult Living Handbook via the Minimum Record Recommendation (MDS v1.1) and harmonised with LIDO and CIDOC CRM; (B1) object biographies as CIDOC CRM lifecycles in a WissKI prototype; (B2) LIDO-to-CIDOC CRM mappings (X3ML); and (B3) community data from Wikidata, OpenStreetMap, FactGrid and the fuzzy-sl Wikibase integrated through semi-automated RDF pipelines.

Crossy reminds us that interoperability is not a finished data model but an ongoing process of alignment – and that crosswalks are scholarly contributions, not mere plumbing.

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Towards Smarter Terminology Alignment in Archaeological Knowledge Graphs: Embeddings, Neuro-Symbolic Reasoning and Gradual Mapping

Archaeological research relies on a wide landscape of heterogeneous terminologies that, despite Linked Open Data publication, remain largely disconnected. Platforms such as coli-conc (Balakrishnan, 2016) offer standard-based mapping infrastructure, yet archaeological vocabularies remain underrepresented and computational assistance for human mappers is largely limited to string-similarity-based reconciliation.

We operationalise this using an archaeological artifact taxonomy extracted from Wikidata via SPARQL CONSTRUCT, whose cross-vocabulary links to Getty AAT and GND serve as a silver-standard reference for evaluating mapping property recommendations.

This contribution explores computational approaches to terminology alignment in the archaeological domain. Using sentence embeddings (Reimers & Gurevych, 2019) as a richer similarity signal, we investigate whether a more distinguished set of SKOS mapping property recommendations (skos:exactMatch, skos:closeMatch, skos:relatedMatch) can be derived beyond binary string matching. We further experiment with non-Euclidean embedding geometries for suggesting hierarchical mappings (skos:broadMatch, skos:narrowMatch), where directionality matters and flat similarity metrics fall short.

Acknowledging that ML approaches are inherently statistical and produce imperfect or contradictory results, we additionally explore neuro-symbolic combinations: integrating embedding-derived similarity scores with the fuzzy-logical graph reasoning of the Academic Meta Tool (AMT) (Unold et al., 2019), newly developed as a Python module with an enhanced ontology (Thiery 2026b), and using the Gradual Semantic Alignment for SKOS (Thiery, 2026) to translate heterogeneous similarity signals into graded, qualitatively meaningful mapping recommendations.
This work is experimental and exploratory. We present initial findings and open questions, inviting discussion on where such hybrid approaches may realistically benefit human mappers working with archaeological terminologies.

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Code is Data, Too — Nuggets, Minions and Crows in a FAIR4RS Marketplace for Computational Archaeology

Research software is research data – yet in computational archaeology, the long tail of domain-specific scripts, Jupyter notebooks, Linked Open Data pipelines and small web apps remains largely invisible to generic registries. Treating these "software nuggets" as first-class FAIR objects requires a Research Software Engineering (RSE) perspective that the CAA community is well placed to drive forward.

This talk presents chublets.software, a Cultural Heritage Hub for little software nuggets, and reflects on what FAIR4RS means in practice for archaeological coding. Building on the CAA SIG SSLA Little Minions (since 2019), the Hungry Squirrels ontology and the open-archaeo catalogue, chublets.software harvests CITATION.cff and codemeta.json from Git repositories, reuses Wikidata Q-IDs, and curates the resulting metadata in a dedicated Wikibase whose property set is derived from a CodeMeta–CFF–Wikidata crosswalk. A SPARQL/rdflib export pipeline produces CodeMeta JSON-LD, DCAT and DataCite RDF, enabling chublets.software to act as a domain catalogue feeding into infrastructure services such as nfdi.software or find.software.

We argue that strengthening the F in FAIR4RS for archaeological software is as much a community task as a technical one: it links the Little Minions legacy to current infrastructure RSE work and offers a replicable pattern for other domain communities. We invite the CAA NL/FL/DE community to contribute their own minions and nuggets – and to discuss how the RSE perspective reshapes computational archaeology.

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Against Better Knowledge OR Better Knowledge-based: A Modest Proposal for Practical Multi-disciplinary Contextualisation

Over past decades, a new methodology of knowledge complements with a general reference implementation for consistent multi-disciplinary coherent conceptual knowledge was established and employed for a plethora of multi-disciplinary archaeological scenarios. For methodological implementation and realisation, a component reference implementation was created and employed for many realisations, e.g., advanced contextualisation and knowledge analysis.

The realisations enable multi-fold and many-fold method implementations and employment in scientific disciplines. Examples are multi-disciplinary coherent contextualisations of prehistoric and protohistoric object groups, associated knowledge analysis, creation of advanced measures, from artificial realia objects and relics to abstract objects and contexts, from archaeology, humanities, geophysical and geological contexts to remote sensing, for analysis, parallelisation, deployment of supercomputing resources, projection, visualisation, and animation.

Further new complex implementation scenarios for Europe, Prehistoric North European Plain including parts of Northern Germany and the Netherlands were conducted and are to be published. A short introduction on required information science fundamentals and an overview of new realisation scenario results will be given.

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FAIR and Open Pitfalls

This talk discusses three pitfalls when working with FAIR data and open-source software. The first topic examined is open controlled vocabularies, which are considered essential for ensuring that (archaeological) data are findable and reusable. However, these are subject to change. For instance, some of the terms in the German FAIR and open vocabulary Wortnetz Kultur (WNK) currently have no published definition, and definitions added later may not align with your understanding of the terms. Using WNK, Wikidata or the Arts and Architecture Thesaurus, it is neither easy to reconstruct the definition of a concept published five years ago nor to export the relevant data.

The second issue concerns airborne laser scanning (ALS) data, which is openly available in many parts of Germany and is widely used to detect and delimit archaeological features. The drawbacks of relying on a hillshade visualisation with a specific sun azimuth are well-known. Less known is the fact that even with a dense ALS point cloud the provider selected ground points may include large gaps where coniferous trees block the laser beams. Furthermore, the selected ground points do not include points on walls and bridges which could also be relevant

The third issue focuses on least-cost path calculations in QGIS. There is an open plugin with a user-friendly interface that performs this function. However, the documentation is limited, and tests show that this plugin produces less accurate results than the GRASS functions, which are also included in QGIS but are more cumbersome to use.

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Session 2:
Data Mining, Deep Learning and Large Language Models

Van Data naar Duiding: Developing a Domain-Specific Large Language Model for Dutch Archaeology

The Dutch archaeological sector faces a growing challenge: the vast and rapidly expanding volume of digital reports (4,000 to 6,000 annually) remains underutilised due to limited discoverability, poor integration, and insufficient synthesis. This "grey literature" often contains critical insights that are overlooked, hindering knowledge development and increasing the risk of redundant research. To address this, we present Van Data naar Duiding, a project aimed at developing a domain-specific Large Language Model (LLM) tailored to Dutch archaeological practice.

Our model uses Retrieval Augmented Generation (RAG) to provide contextually grounded answers, ensuring traceability to source documents and minimising confabulations. By integrating with AGNES, a pre-existing indexed search engine for archaeological reports, the system enables users to efficiently search, summarise, compare, and interpret information from these reports, while maintaining transparency and reproducibility.

The project emphasises collaborative innovation, combining technical expertise from the Jheronimus Academy of Data Science (JADS) with domain knowledge from commercial and academic archaeologists. A diverse user group (including professionals, students, and volunteers) will iteratively test and refine the model, ensuring practical applicability. By fostering AI literacy and addressing ethical and legal considerations (e.g., copyright, bias), we aim to create a tool that enhances research quality, supports decision-making, and democratises access to archaeological knowledge.

This presentation will outline the project's goals, methodology, and preliminary insights, inviting discussion on the role of AI in archaeology's digital future. As this project is in it's starting phase, your feedback is welcome and can be integrated into the project plan!

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Context Before Pixels: A Data-Driven Human-in-the-Loop LLM Workflow for LiDAR-Based Archaeological Prospection

This paper presents a methodologically inverted approach to LiDAR-based archaeological prospection, in which systematic contextual knowledge aggregation precedes — rather than follows — visual filter analysis. Developed through digital product engineering practice and subsequently applied to remote sensing, the workflow was tested on DGM025 data (0.25 m resolution, LGL Baden-Württemberg) and immediately yielded previously unrecorded structural anomalies in the Main-Tauber region.

The workflow proceeds in four stages. First, all publicly available contextual data for the target area — historical maps, documentary sources, Flurnamen, monument register entries (ADAB), and excavation records — is compiled into a structured knowledge base. Second, raw LiDAR point cloud data (LAZ/LAS) is used to generate custom DGM products, enabling greater control over resolution and filter parametrization; twenty-two filters are produced following EAC Guidelines 10. Third, the analyst and LLM iteratively examine filter outputs tile by tile, searching for geometrically unnatural structures. Fourth, each anomaly is cross-referenced against the knowledge base, and the LLM produces a probabilistic classification as a percentage-weighted hypothesis.

This context-first architecture distinguishes the approach from conventional workflows, in which literature review typically follows rather than informs visual interpretation, reducing confirmation bias and improving classification precision.

Applied to a 60 km corridor in the Main-Tauber region, the method identified a previously unrecorded multi-period landscape. Celtic Iron Age occupation — fortifications, mining and smelting complexes — forms the dominant and chronologically primary layer; Roman infrastructure was subsequently established within this landscape and demonstrably overlies existing Celtic features. Three formal monument notifications (§20 DSchG BW) and physical artefact recovery provide material corroboration.

The paper further addresses the automation frontier: fully automated runs produce useful but inferior results compared to the manual iterative process. The implications of full automation — including systematic re-evaluation of the German national LiDAR dataset within two to five years — will be assessed against current capability constraints.

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Geoglyphs in Peru – find them all with visual Large Language Models

Geoglyphs in Peru, and most notably the famous Nasca lines, are a peculiar anthropogenetic feature between the Pacific Ocean and the Andes mountain range. Dating to prehispanic times, especially the Early Intermediate Period (1 – 650 AD), these ground drawings cover hundreds of square kilometers of one of the driest deserts in the world. However, only a mi-nority of geoglyphs have been suitably recorded so far, and a large number is endangered by neglect, modern land use, and environmental change.

In this talk we examine the detectability of Peruvian Geoglyphs by modern AI workflows, based on a novel type of Neural Networks, often called Large Language Models (LLM). Orig-inally designed for pure textual transformations, newer generations are multimodal, that is, they can also process visual data such as images as input. With the QGIS plugin LandTalk providing easy access, the benefit of these LLMs for archaeological prospection is that they do not need any training of other types of preparation.

We show that general-purpose models such as ChatGPT (by OpenAI) and Gemini (by Google) can detect geoglyphs in satellite imagery with suitable accuracy if certain criteria are met. Using detailed geoglyph maps from previous small-scale research as benchmarks, we evaluate the performance of the LLMs in qualitative and quantitative terms. Besides, we discuss the pros and cons of this nov-el workflow for future archaeological prospection.

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From PDF to DataFrame, Part II: Finetuning the Workflow for Extracting Roman-Era Archaeological Data from Legacy Reports

A substantial corpus of data on Roman provincial archaeology is documented in serial publications and excavation reports. While fundamental for research, their conventional text format, often only accessible as PDFs, presents a significant challenge for modern, large-scale spatial analysis. At last year's CAA-NLFL, we introduced a pragmatic computational workflow, designed for implementation in Python environments, to systematically extract and structure this information. In this paper, we focus on the further development of this workflow to finetune the output to different types of text and multiple languages.

The approach consists of two phases. Initially, a structure-aware text extraction preserves the document's layout, which is crucial for identifying geographically distinct sections. These sections are demarcated by parsing location headers (municipalities, districts) via regular expressions cross-referenced with a custom gazetteer. Within each section, the system processes the text to identify and classify archaeological entities. Recognizing the telegraphic style and domain-specific terminology of these reports, the methodology relies on a powerful combination of pattern matching and targeted Named Entity Recognition. At the core of this process is a user-curated, hierarchical vocabulary specifically tailored for Roman-era material culture and features and developed bilingually (German/Dutch). The final output is a structured, georeferenced dataset where each entry corresponds to a findspot, attributed with its complete, normalized data (ID, location, classification). While this approach delivered promising first results, it was also clear that it needed a more tightly controlled workflow than could be offered by using standard PDF extraction tools in combination with LLMs and a user-curated vocabulary.

In this paper, we will present how we improved the workflow results by 1) finetuning the document extraction and section identification to support different document layouts, and 2) improving the Named Entity Recognition using a pretrained 'small language model' (specifically ArcheoBERTje for Dutch language reports: https://huggingface.co/alexbrandsen/ArcheoBERTje). The performance of the new workflow was tested by comparing it to human-interpreted output.

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Developing a Reproducible Workflow for AI-Assisted Chronological Data Extraction: A Case Study from Roman Villas in South Limburg

This study discusses the development of a reproducible AI-assisted workflow for extracting, normalizing, and structuring chronological information from archaeological texts. It is situated in relation to the broader PDF-to-DataFrame work presented by Tobias Verwoert and colleagues, but addresses a more specific and methodologically distinct problem: chronological extraction and normalization using a separate Python-based workflow with local LLM support through Ollama. The workflow combines PDF text extraction (OCR, PDFPlumber, and PyMuPDF), text cleaning, chunking, controlled vocabularies, and rule-based detection.

Chronological data can appear in varied forms, including numerical ranges (e.g., 70–150 CE), Roman-period labels (e.g., ROM), century-based expressions (e.g., 2nd century), and pottery typologies (e.g., Dragendorff 37, Dr. 37). Further variation is introduced by the nature of the source material, which ranges from nineteenth-century bulletins to recent development-led archaeological reports, highlighting a broader challenge for archaeologists. Taking this into account, the objective is to convert dispersed and inconsistent chronological information into structured, reusable data that can support interpretation and further analysis.

The case study focuses on Roman villa settlements in South Limburg and their pottery assemblages. It also assesses the challenges of using AI for archaeological interpretation, emphasizing the importance of carefully validating extracted data to prevent inconsistencies and reduce the risk of hallucinations. Overall, the preliminary results show that the workflow can extract with high accuracy, convert it into structured outputs, and support other studies that depend on chronological data, such as analyses of settlement development or site occupation phases.

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Whaling, Hunting, and Trapping in Hornsund, Svalbard: A Multi-Scalar Approach Integrating Zooarchaeology, Legacy Data, and Digital Documentation at Gåshamna-West

Gåshamna-West, Hornsund, Svalbard, preserves a vulnerable palimpsest of seventeenth-century shore-based whaling, later Pomor hunting, and Norwegian trapping on an actively eroding gravel plain. This study combines an extensive zooarchaeological survey, osteometric analysis of whale bone remains, and radiocarbon dating to reconstruct the exploitation and processing of marine mammals. We recorded 628 osteological remains, including 49 bowhead whale skulls, alongside beluga, walrus, and Arctic fox. Sawing, chopping, and age indicators show intensive bowhead processing dominated by adults but including juveniles, revealing valuable information regarding past whaling practices.

To contextualize these remains within a long-term research framework, the study integrates legacy archaeological fieldwork records from the 1990s, harmonizing historical excavation and survey data with modern documentation. This synthesis is supported by a multi-scalar remote sensing approach, utilizing UAV-based multispectral imagery and ne+6ar-field-photogrammetry to generate a high-resolution 3D Digital Elevation Model (DEM).

The integration of these datasets was facilitated by a computational spatial analysis workflow developed in Python. By implementing hexagonal binning (Hexbin analysis), we normalized point densities and mapped the spatial distribution of bone dimensions across identified clusters. This allowed for a robust comparison between legacy find spots and modern surveys, correlating bone fragmentation and size gradients with proximity to 17th-century processing ovens. Vertical discrepancies were mitigated through relative vertical calibration, ensuring the taphonomic analysis is accurately anchored to the local topography. This integrated approach aids in reconstructing early modern logistics while providing a digital baseline for monitoring coastal erosion.

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Unlocking the WMS Bottleneck: A Hybrid Deep Learning Pipeline for Extracting Pre-Modern Infrastructure and Urban Micro-Structures from Early 19th-Century Maps

Historical cartography offers crucial baseline data for landscape archaeology. The Tranchot map (1801–1814) and the Sächsische Meilenblätter (1780–1821) provide pre-industrial records of landscapes before land consolidation, river straightening, and industrialization reshaped topography. Yet their archaeological use is constrained because many sheets remain accessible only as compressed WMS rasters, while hand-drawn hatching, irregular symbols, and curved typography limit conventional computer vision and OCR.

This paper presents a modular, open-source Python pipeline that converts WMS-based historical map images into a georeferenced, queryable, and topologically valid spatial database. Automated overlapping tile extraction preserves georeferencing and prepares consistent inputs for machine-learning workflows. The pipeline is demonstrated in three archaeological and historical applications: tracing Roman road remnants preserved as boundaries or rural paths, reconstructing pre-modern river systems and associated mills, weirs, and ponds, and analyzing urban micro-structures to quantify density and land use.

Feature extraction combines two deep-learning workflows. Structural elements are segmented with YOLOv8-seg and the Segment Anything Model; in urban contexts, multi-class instance segmentation distinguishes buildings, gardens, courtyards, and boundaries as closed semantic polygons, later simplified into valid vector geometries. Textual evidence is extracted with CRAFT (Character Region Awareness for Text) detection and TrOCR (Transformer-based Optical Character Recognition). To reduce OCR noise and AI hallucinations, recognized labels are linked spatially to historical gazetteers using buffered bounding boxes and Levenshtein distance-based similarity matching.

The resulting vector database enables complex topological queries and comparative analyses, including intersections with LiDAR data and regional comparisons of housing, garden plots, and land-use patterns. The workflow bridges web rasters and structured geographic knowledge, offering a scalable model for reconstructing historical landscapes.

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Session 3:
Reconstruction and explorations of space

Reconstructing Stratigraphic Surfaces and Layer Volumes of a Large Pit Feature using GIS-Based Interpolation

The DFG-funded project "Die Große Grube von Estenfeld, Kr. Würzburg – Abfallentsorgung oder strukturierte Deponierung?", led by Prof. em. Dr. Wolfram Schier and Dr. Kirsten Gebhard at the Institute for Prehistoric Archaeology, Freie Universität Berlin, analyses a large pit feature from a rescue excavation conducted in 2011 in Estenfeld (Lkr. Würzburg, Bavaria), requiring detailed spatial understanding of the stratigraphic sequence and formation processes.

Within my master's thesis, analogue profile drawings and digital excavation plans are used to reconstruct stratigraphic surfaces and calculate layer volumes across 33 quadrants. The quadrant profiles, surveyed in AutoCAD, are imported into GIS. Points are extracted along the profiles at regular intervals of 0.2 m and the corresponding Zcoordinates, representing the heights of stratigraphic boundaries, are derived from the analogue profile drawings and assigned to each point via the attribute table. This data is used to interpolate the surfaces of individual stratigraphic units. While this approach involves some loss of precision compared to on-site tachymetric 3D recording, it provides a viable method for the spatial analysis of excavation data.

By subtracting successive raster layers, volumetric values are calculated per quadrant and for the feature as a whole. Quadrant 17, containing the highest find density, exemplifies the results: layer 193 (2.4 m³), layer 194 (4.9 m³), layer 195 (1.4 m³), and layer 196 (4.0 m³). These volumes form the basis for subsequent find density analyses and taphonomic reconstructions of the depositional processes within the pit.

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The underground landscape of modern coal mines visualized

The southeastern region of the Netherlands hosted an extensive coal mining industry, with origins tracing back to the Roman period and operations continuing until the mid-1970s. From the mid-nineteenth century onwards, these mining systems were systematically surveyed and documented in considerable detail. The resulting cartographic records provide valuable insights into the spatial complexity of underground transport networks, extracted coal seams, logistical infrastructures, and the geological context of the region.

However, these historical maps are fragile and difficult to interpret. Moreover, the inherently three-dimensional structure of the mining systems is represented across multiple two-dimensional maps, making it challenging to comprehend the full spatial configuration from any single map. Only through the integration of numerous maps can the labyrinthine nature of this anthropogenic subterranean landscape be fully appreciated.

At present, access to these maps remains limited, and knowledge of the coal mining systems is rapidly declining among both the public and governmental institutions. Interest in these inaccessible underground features has diminished over time, despite occasional surface subsidence events that highlight their continued relevance.

Approximately fifty years after the closure of the mines, there is a renewed interest in their historical significance, as well as in the limited physical remnants. This study demonstrates the progressive vectorization of historical mining maps within a 3D GIS environment. The resulting visualizations reconstruct the underground landscape, revealing its structural complexity and beauty.

It is argued that 3D GIS provides a framework for representing and analyzing these industrial archaeological features, which have vanished from the visible landscape.

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From Ruin to System: Scientific Reconstruction and Hydraulic Functional Analysis of the Roman Baths of Tolbiacum (Zülpich) – A Work in Progress

Digital archaeology has moved past purely aesthetic visualizations toward scientifically valid models. The Roman baths of Tolbiacum (Zülpich) serve as a unique case study for this transition, evolving from a "static ruin" into a functional system. In my master's thesis, I focus on the reconstruction of the site and, furthermore, attempt to create a "digital twin" to conduct functional analyses through simulations.

The core methodology is the fusion of Terrestrial Laser Scanning (TLS) for metric precision and Structure-from-Motion (SfM) for high-resolution surface data. Grounded in surviving substructures, comparative analysis, and Roman engineering principles, the reconstruction initiates a new analytical phase rather than concluding research. By treating the watertight model as a simulation environment, Computational Fluid Dynamics (CFD) is used to test physical plausibility, such as canal gradients, basin filling times and energy consumption.

Currently in its initial phase, the project has established its theoretical framework and data fusion, while the simulation remains a work in progress. This study serves as a targeted "proof of concept," acknowledging the constraints of a master's thesis while demonstrating the potential of dynamic data reuse. Ultimately, this approach transforms the 3D model into a cognitive tool and digital laboratory for quantitatively evaluating Roman engineering.

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Exploring the use of Space Syntax Analysis on Waldgirmes

To gain an understanding of how the provincial Roman population used their environment, the Space Syntax Analysis (SSA) can be used on the archaeological findings. Although there are several difficulties for the use of SSA:

1. Modern cities like Mainz or Cologne developed on top of their famous Roman roots, leading to more uncertainties in describing specific points in the construction history of the city.
2. The SSA was developed for modern cities and societies, not for past ones.

To develop a useful workflow for the analysis, the roman settlement Waldgirmes was chosen as a case study which was excavated from 1993 to 2009 and published by Armin Becker, Gabriele Rasbach and Dietwulf Baatz in 2015. Waldgirmes is especially suitable for this study, as most parts of it weren't built over and it was only used for around 30 years by the Romans. Therefore, the city map is very well reconstructible. Hanna Stöger was one of the first to transfer the SSA from modern to Roman cities but mostly used it on Roman Ostia. Sean Tennant wrote his dissertation about the use of SSA in individual houses in the Roman West and was therefore the first one to use said method for this region. However, SSA has not previously been applied on cities of the Roman West, and this dissertation aims to close that research gap.

In the CAA Workshop, the current research results will be presented to-gether with the question of how to cope with the gaps in the reconstructed city map.

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Session 4:
It's about time — Chronology and Dating Methods

Dating Mesolithic Microlith Spectra by Inverting Canonical Correspondence Analysis

Microliths are disposable products in Mesolithic tool kits. They exhibit a wide range of outlines as well as types and techniques of retouch. For that reason they are the backbone for relative chronology of Mesolithic material culture. But this requires quite sophisticated typologies – and with C14 dates around one may wonder, „is that effort of checking each specimen's type really worth the time?"

Interestingly the combination of typologically classified microlith spectra and C14 dates for these assemblages allow for a new approach to estimate calendar age for assemblages which are classified by the same typology, but did not provide C14 dates.

The method applied is an extension of canonical correspondence analysis (CCA). It uses C14 dates as constraint and inverts the formula established by the CCA solution to solve for the ‚unknown constraints' of classified but yet undated assemblages. The talk explains the method and presents published results for the Early (9.0 to 7.7 ka BC) and new results for the Late (6.7 to 5.0 ka BC) Central European Mesolithic.

Typological classification and resulting data were provided by Birgit Gehlen, CCA was computed by Georg Roth. All analyses were conducted in R using package vegan. R code and data are published.

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bb-5kbc-sites as an example for modelling archaeological site information as Linked Open Data

One of the most abundant information archaeologists gather is data on archaeological sites: Name, geolocation, the administrative units in which the sites lie, cultural affiliation, dating and bibliographic sources are the most common attributes that are collected. In this paper we present how we transformed the data on 540 sites used in a PhD project into a Linked Open Data collection. The sites belong to Stroke Band Pottery Culture, Rössen Culture and Brześć-Kujawski Culture in Eastern Germany and Poland. As the sites were collected from several sources, the precision of the geolocation varies. To not loose this important information when sharing the dataset, precision was included into the collection by describing the method of collecting the coordinates, adding the source of this information and estimating the possible offset in meters.

Wikidata was used as a DataHub to enrich the gathered geographical information and include links to external databases and norm data (Getty TGN, iDAI.gazetteer, OSM). Also via Wikidata the bibliographic sources for the sites were added to the dataset. Perio.do-IDs refer to the chronologies used in the project.

The tabular csv-data had been modeled on the CIDOC CRM and this semantic information was transferred to the LADO ontology to prepare an RDF and Turtle publication. A SHACL validation insures the consistency with RDF-standards. The collection is now available on Github (https://github.com/Research-Squirrel-Engineers/bb-5kbc-sites), the technical documentation can be found under https://doi.org/10.5281/zenodo.19830969.

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Quantifying Quality in Archaeological Dating: Quality-Weighted Time Intervals for Transparent Samian Ware Dating

The online research database "Samian Research" records more than 250,000 Roman potters' stamps on terra sigillata from over 4,000 findspots across Europe. Although terra sigillata is regarded as dating material par excellence, the reasoning behind it should be transparent in a manner. In principle, sigillata dating is derived from dated find assemblages – through historical events, coin finds, or dendrochronology – yet many assemblages have themselves been dated by means of terra sigillata, threatening a circulus vitiosus. Moreover, date ranges are usually given without indicating which dates within the range are most likely.

A viable solution is to work with time intervals expressed as boxplots, in which both main intervals and peripheral variances are assigned quality values. Since start and end dates are independent, covariance is assumed to be zero. For each site, potters provide ranges defined by datemin and datemax; from these, we compute the mean, variance (var_samp), and standard deviation. A quality score derived from the coefficient of variation is normalised so that values near 1 indicate tightly clustered dates and values near 0 indicate high dispersion.

As proof of concept, the Roman military camp Inchtuthil, Scotland (AD 83–86; interval 74–86; n=3; q=0.7) and the Samian hoard at Pompeii (destroyed AD 79; interval 72–78; n=19; q=0.79) both yield high-quality values. By contrast, New Fresh Wharf (interval AD 162–196; n=159; q=0.39) shows medium quality. The boxes are centred around the mean dating interval, avoiding exaggerated ranges caused by single extreme outliers. Bespoke SQL queries compute these values directly from the PostgreSQL database, visualised via D3.js, applicable to both individual potters and find assemblages, allowing statements about the dating quality of the find material. The results can also be exported as RDF, laying the foundation for participation in the Federated Knowledge Graph Ecosystem.

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Session 5:
Remote Sensing, GIS & Spatial Analysis

Settlements and mobility: a quantitative approach for the landscape of the Middle Neolithic (4500–3500 BC) of the Iberian peninsula

The Middle Neolithic in the north-east of the Iberian Peninsula (ca. 4500–3500 BCE) has been interpreted as a unitary cultural phenomenon, despite the existence of multiple cultural traditions, each with distinct funerary practices and pottery traditions. This paper revisits this issue by examining whether settlement patterns reflect a unitary phenomenon, as this question has not yet been thoroughly tested using a quantitative approach.

To address this, point pattern analysis and maximum entropy modelling are used to evaluate the environmental and spatial factors influencing site location. The analysis incorporates a wide range of covariates, including elevation, slope and agricultural suitability, as well as cost distances to important geographical features such as rivers, the coastline and areas of natural resources. Additionally, we incorporate several visibility-related variables to account for the perceptual dimension of the landscape. Particular emphasis is placed on mobility, modelled through natural movement corridors. To strengthen this component, we implement a quantitative framework that explicitly evaluates the impact of the number and spatial distribution of origin and destination points on corridor modelling outcomes. By conducting a structured sensitivity analysis, we can assess the stability of the resulting models and minimise biases associated with arbitrary point placement.

By refining the construction of mobility surfaces, the study provides a more robust basis for understanding movement potential and its role in determining settlement location. Ultimately, contributing to a more nuanced interpretation of Middle Neolithic landscapes.

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Mongol-period Settlements in the Gobi Desert: Integrating UAV and Satellite Remote Sensing in Mongolia

The Bonn Center for Digital Humanities (BCDH) contributes to the DFG-funded project Urban Impacts on the Mongolian Plateau: Entanglements of Economy, City, and Environment. Within this framework, the subproject Virtual Landscape and Multispectral Survey investigates the applicability of UAV-based remote sensing methods for archaeological research in Mongolia.

Between 2022 and 2026, several UAV surveys were conducted. The surveys produced digital surface models (DSMs) as well as RGB and multispectral orthomosaics.

As part of this work, the remote settlement complex of Takhilyn Us in the Gobi Desert was visited. Due to preservation conditions, archaeological mapping relied on the combined use of different remote sensing products, including false-colour imagery, soil indices, and DSM derivatives. To ensure reproducibility, a standardized mapping approach was applied.

The UAV surveys revealed that the site is significantly larger than previously assumed, consisting of at least four settlements covering approximately 67 hectares and accompanied by a large cemetery. Surface finds suggest a contemporaneous occupation during the Mongol Empire period (1206–1368).

To contextualize the settlement within its surrounding landscape, freely available satellite data, including JAXA DEMs, Sentinel-2 imagery, and satellite imagery provided by Google Earth, were used. Hydrological runoff simulations and land-cover classifications indicate that the settlements are located near stable vegetation islands likely caused by localized water retention.

Furthermore, historical maps may suggest a connection between the settlement complex and Mongol-period trade and communication networks.

The study highlights the strengths and limitations of UAV-based archaeological prospection in arid environments and provides new insights into a previously understudied Mongol-period settlement complex.

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Prehistoric settlement dynamics in Germany: A supra-regional meta-analysis

Geoarchaeological research has a long-standing tradition within German-speaking prehistoric archaeology. Since the early 20th century, natural factors—such as soil quality or the terrain position of archaeological sites—have been central to discussions about prehistoric settlement dynamics and human-environment relationships.

Several large-scale studies have been published, investigating changes in long-term settlement patterns across selected landscapes in Germany. Furthermore, since the 1980s, quantitative methods for chronologically and spatially evaluating settlement dynamics, as well as for source-critical analyses of site distributions, have greatly improved. The research potential of geoarchaeological studies has also expanded significantly with the increasing availability of digital geographical data and the integration of GIS.

These advancements suggest that a precise picture of supra-regional developments in prehistoric settlement dynamics could now be drawn—but this is not yet the case. At best, previous studies have only yielded vague tendencies in this regard. This lack of synthesis stems from the fact that individual researchers have handled the collection, processing, classification, selection, and evaluation of archaeological and geographical data differently in each study. Over the decades, this has resulted in a mosaic of isolated observations rather than a cohesive supra-regional picture.

To enable such a synthesis, we re-evaluated 13 regional catalogs and generated a standardized dataset comprising over 11,000 sites dating from the Neolithic through the end of the Iron Age. This presentation will demonstrate how this structured dataset can enhance geoarchaeological research. We will discuss methods for identifying supra-regional settlement patterns and present our initial findings.

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Beyond presence-absence: Uncertainty- and bias-aware modeling of human suitability landscapes

In archaeology, human suitability landscape (HSL) modelling is a widely used approach to investigate the habitability of different regions for specific prehistoric societies. The suitability of a region is influenced by a wide range of factors: on the one hand several environmental factors such as climate, vegetation, and resource availability, and on the other hand socio-cultural factors such as mobility, economy, and technology. Despite the number, importance and complexity of these factors, HSL models still mainly rely on simple evidence of human presence in the past, i.e. archaeological site locations.

Archaeological sites and their distribution are, however, inherently biased. Presence and absence data are for example shaped by uneven research intensity, accessibility constraints and individual data uncertainties. Still, most HSL models treat this data as binary input that is equally reliable.

This contribution presents a methodological framework for integrating archaeological biases into an established suitability landscape modelling approach, the Human Existence Potential (HEP) Model. To achieve this, archaeological input data is treated as non-binary with input weights through a weighted logistic regression approach. The framework introduces different bias functions that assign weights to archaeological input information. It is first explored in an idealized synthetic setup and then applied to a real-world case study from southern Africa during the Middle Stone Age.

This work contributes towards an uncertainty integration strategy that is important for interdisciplinary research and modelling.

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Shedding Light on Viewsheds: How the Input Parameters Shape Output and Interpretation

In my bachelor thesis I dealt with the generation and interpretation of viewsheds. For only one (Alter Gleisberg) of the three Late Bronze Age hillforts (Johannisberg, Jenzig) around Jena a viewshed analysis was already conducted – but it was years ago, based just on a few terrain profiles and used in publications merely as an illustration. I wanted to raise awareness about the data, it's assumptions and interpretation, i.e. that there is more about viewsheds than a nice illustration for publications.

Calculation was done in Jupyter Notebooks by using the Python API of GRASS GIS. On the basis of a DEM with 2 m resolution hundreds of viewsheds were generated for the study area covering 414 km² thereby varying observer height, target height and DEM Error and comparing the influence of these parameters.

While also using a DSM for comparison I tried a new method to identify critical areas in the terrain, where vegetation would heavily impact the viewshed quantitatively. To revisit the popular interpretation of hillforts controlling traffic in the surroundings I relied on the concept of Individual Distance Viewsheds which strongly suggest the need of a more elaborate concept of ‚Controlling traffic' for the ‚Alter Gleisberg' than merely by sight.

Combining the viewsheds of the three hillforts led to a whole new bunch of questions, chiefly concerning the relative weights of the individual viewsheds and their implications for interpretation. Least-Cost-Path analyses, intertwined with viewsheds, could only briefly be covered, though some data was produced that shows ist potential.

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Same pots, different people? Exploring the dual burial custom of Westphalia's Funnelbeaker culture

In the Late Neolithic, the groups of the Funnelbeaker culture (TRB) were the first farming communities to populate the North European Plain where they erected thousands of megalithic tombs. The Westphalia region in western Germany is located on the southwestern periphery of the TRB-groups.

From the turn of the 4th and 3rd millennia, TRB burials in Westphalia also appeared in so-called flatgraves. This dual burial custom reflects the beginning of a cultural transformation: While the monumental megalithic tombs were used for collective burials, inhumations in flatgraves focused on the individual. Compared to more central TRB regions, Westphalia has a relatively high density of known flatgrave sites, while megalithic tombs only occur sporadically. This tendency towards spatial separation suggests that the flatgraves might be the expression of a separate group that made the transition to individual burials particularly early.

To date, no clear qualitative differences between the inventories of flat and megalithic graves have been identified. The aim of this PhD project is to investigate the extent to which cultural differentiation can be retraced behind the two burial phenomena. To do this, a comprehensive catalogue of all Westphalian flatgraves and their grave goods is created and analysed in an exploratory way, using multivariate methods and focusing especially on the pottery. Furthermore, the area is examined from a landscape archaeological perspective in order to uncover possible differences in site selection. Finally, an ethnological digression will offer insights into possible explanations for pottery distribution to contextualise the findings of the previous analyses.

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Towards Transparent Demographic Modelling: Accounting for Bias and Uncertainty in Archaeological Data

Any large-scale project in archaeology needs to deal with unevenly distributed data, due to differing preservation conditions, research histories, and available chronological precision. Thus, all proxies used to analyse landscape use, socio-economic developments and demography vary substantially between regions, which makes comparisons difficult.

The ERC ESTER project (ESTimation of the prehistoric population of Eurasia based on a large number of Records) aims to produce regionalised reconstructions of prehistoric demography across Europe and Western Asia using a multi-proxy Bayesian framework. By combining archaeological and environmental indicators, such as radiocarbon intensities, aoristic site sums, dendrochronological evidence, and land-use proxies, ESTER seeks to bridge the gap between local settlement studies and continental-scale syntheses. To deal with the aforementioned challenges regarding the availability of information, ESTER develops a systematic framework to identify, describe, and incorporate sources of uncertainty and biases into regional demographic models, to make proxy selection and weighting transparent, thus enabling more comparable and reproducible estimates of population change.

The talk will present first implementations that are currently being explored in selected case studies. They will illustrate how a structured consideration of bias can advance both the theoretical and methodological foundations of landscape-scale archaeodemography.

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The impact of soil pH on the preservational conditions of prehistoric pottery

Since 2023, our geoarchaeological project, funded by the German Research Foundation (DFG), has investigated prehistoric settlement dynamics across Germany, spanning from the Neolithic through the pre-Roman Iron Age. To facilitate these supra-regional comparisons, we have systematically recorded and standardized data from over 11,000 sites in 13 regions. This comprehensive dataset allows us to identify periods where settlement patterns were uniformly distributed across large areas versus those marked by distinct regional decisions.

A core element of this research is the critical evaluation of site distributions. In this presentation, we will use statistical analyses to demonstrate how local soil pH values affect the preservation of prehistoric pottery across different time periods.

Our key indicator is the density of sites containing pottery finds per square kilometer within our 13 study areas. We conduct this analysis for individual epochs—the Neolithic, Bronze Age, and Pre-Roman Iron Age—to draw specific conclusions about each period. The analysis operates on three levels: (I) all recorded sites; (II) only sites discovered on the surface; and (III) only buried sites.

Generally, we observe that the density of Neolithic pottery sites is particularly sensitive to pH values. This effect is present, albeit less pronounced, during the Bronze Age, but disappears entirely for Pre-Roman Iron Age sites. However, when we restrict our focus solely to surface sites, this pH influence reappears across all periods. Conversely, examining only buried sites suggests that pH has no discernible impact on the density of sites with pottery.

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