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Application Programming Interfaces (APIs) in Cultural Heritage Information Systems

Dotting the I in FAIR

In recent years, there has been a growing emphasis on developing digital resources that adhere to the FAIR principles (Findable, Accessible, Interoperable, Reusable), a shift that reflects a broader recognition of the importance of well-structured, sustainable, and open research data (Caravale *et al.* 2021, 161). The FAIR principles, in fact, «summon up the 'behavioral' guidelines evaluated over the years to maximize and ensure transparency, reproducibility and reusability of the research processes, allowing many different approaches to achieve the optimal discovery and reuse of data resources» (Piergrossi 2020). The implementation of these principles can be considered particularly relevant in disciplines such as Archaeology and Cultural Heritage (CH), where research data are inherently long-lasting and retain their value over time. This resilience makes it all the more important to ensure that archaeological digital resources remain accessible and reusable over time[1].

Ensuring the FAIRness of digital resources is not just a matter of good data management practices, but it also requires technical solutions that enable different systems to communicate effectively. One of the key mechanisms for achieving interoperability in digital infrastructures has become the use of Application Programming Interfaces (APIs). APIs define a structured way for software applications to exchange data and functionalities, allowing different platforms and applications to interact seamlessly. Within the CH domain, APIs are mostly used to facilitate integration across databases, digital repositories, and analytical tools, reducing silos and enhancing accessibility. By offering standardized access points to data or metadata, APIs support scalable and automated data exchange, eliminating the need for manual transfers or ad hoc solutions. In a metaphorical sense, APIs can be seen as the grammar that enables systems to communicate effectively. Although the configuration and implementation of APIs typically fall within the domain of software development, it has become increasingly important for humanists involved in the design and planning of digital infrastructures

[1] The push toward FAIR compliance has been driven not only by the scientific community but also by funding agencies and institutions, which increasingly require adherence to these principles as a condition for project support. For instance, the European Open Science Cloud (EOSC) explicitly promotes FAIR data management as a foundational principle of its infrastructure and funding strategies (Candela *et al.* 2021). A recent discussion of FAIR principles in the context of CH data practices can be found in Larsson *et al.* 2025.

to be aware of their role and their general functionality, since the understanding of their basic functions can foster better decisions about data accessibility, integration, and long-term sustainability.

Different forms of APIs

As with natural languages, different 'grammars' govern how systems interact; APIs take different forms, each suited to particular needs and infrastructures. Among these, the three main categories most commonly used outside strictly commercial or high-performance environments are REST, GraphQL, and SOAP. In the context of digital archaeological and CH, APIs typically operate over the web, following a client-server model and relying on HTTP as the underlying protocol. This web-based architecture enables systems to interact across networks, making APIs especially suited for exposing and consuming data in distributed environments. REST (Representational State Transfer) APIs are based on standard HTTP methods (such as GET, POST, PUT, DELETE) and use simple URL structures to access and manipulate resources, typically returning data in JSON or XML formats. REST APIs are appreciated for their simplicity, scalability, and compatibility with web technologies, making them a popular choice in digital platforms. For instance, the Sistema Informativo Territoriale Archeologico di Roma (SITAR) provides REST APIs that allow users to interact with archaeological datasets in JSON format, enhancing data interoperability and accessibility (Serlorenzi *et al.* 2023). Similarly, Europeana, the European platform for CH, offers REST APIs to access its extensive digital archives, facilitating the integration of cultural data into various applications and research environments (Lorenzini 2016).

In the CH domain, GET remains the most commonly implemented method, as APIs seems to be primarily used to expose curated datasets for public access and reuse. However, the full REST model also supports operations for creating (POST), updating (PUT or PATCH), and deleting (DELETE) resources, which open possibilities for collaborative annotation systems, administrative back-ends, or community-driven content enrichment. For instance, the popular repository Zenodo can be mentioned as an example of a system that provides RESTful API that support POST request for depositing and publishing research outputs programmatically (https://developers.zenodo.org).

The widespread adoption of REST as a standard for data exchange is also reflected in the growing number of digital humanities platforms that include built-in REST APIs. This architectural feature, increasingly common even in content management systems and archival tools, enables programmatic access to content, metadata, and services without the need for custom integration. It also shows how REST APIs have become not only a mechanism for large-scale interoperability, but also a baseline feature in the design of software infrastructures for research, publication, and collection management[2].

Other API models, such as GraphQL and SOAP (Simple Object Access Protocol), are less commonly used in digital humanities infrastructures, albeit for different reasons. GraphQL is a query language and runtime developed by Facebook in 2015

[2] A few examples of platforms offering built-in REST APIs include Omeka S, CollectiveAccess, DSpace 7+, Drupal with JSON:API, and ArchivesSpace.

that allows clients to request precisely the data they need from a strongly-typed schema. Unlike REST, which often requires multiple requests to different endpoints, GraphQL enables the retrieval of complex, related data in a single structured query. While popular in broader web development, its application in heritage-related systems remains largely undocumented. SOAP, introduced in the late 1990s, uses XML-based messaging for standardized remote procedure calls. It is typically adopted in enterprise environments requiring strict validation, security, and transactional integrity. In the context of digital humanities, however, SOAP's highly formalized structure has probably limited its adoption, in spite of more flexible and lightweight alternatives like REST.

While the current emphasis on APIs reflects the growing need for real-time, flexible data exchange, the pursuit of interoperability in the digital humanities has deeper roots[3]. Long before the widespread adoption of RESTful services, the Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH) was developed as a lightweight protocol for harvesting metadata between repositories. Introduced in the early 2000s, OAI-PMH allows external systems to retrieve structured metadata records via standard HTTP requests, typically in XML format. While not an API in the modern sense, OAI-PMH can be seen as an early protocol for structured machine-to-machine communication, designed specifically for metadata harvesting. Unlike general-purpose APIs such as REST, which support a wide range of data interactions, OAI-PMH is optimized for exporting standardized metadata in bulk, following a strict schema and limited set of operations. For example, a REST API might allow a user to request specific academic papers from a database, filtered by multiple metadata values (such as subjects and dates) in JSON format. An OAI-PMH endpoint, by contrast, would return an XML list of metadata records (e.g. Dublin Core) for all articles published in a journal since a given date, without supporting fine-grained content queries.

While REST APIs are designed for flexible and interactive access to structured data, OAI-PMH is intended primarily for the automated harvesting of metadata, often for inclusion in aggregators or institutional repositories. Widely adopted in the fields of digital libraries, archives, and CH, OAI-PMH has played (and still plays) a key role in enabling cross-institutional discovery and aggregation of digital resources. Its influence is still visible today; platforms such as Europeana (https://github.com/europeana/OAI-PMH) and the Archaeology Data Service (ADS - https://archaeologydataservice.ac.uk/help-guidance/data-reuse/fair-data/) continue to support OAI-PMH endpoints as part of their commitment to metadata accessibility and reuse. Notably «Archeologia e Calcolatori» has long promoted the use of OAI-PMH as part of its digital publishing infrastructure, underscoring the historical continuity between early interoperability protocols and today's API-driven ecosystems (Barchesi 2005; Paraciani 2024).

[3] Before the widespread adoption of web APIs, several protocols were developed to enable interoperability in the context of digital libraries and CH. Among these, Z39.50 (Lynch 1997) and SRU/SRW (Moreira 2008) are worth mentioning, allowing for the remote querying of bibliographic and archival databases using structured XML-based formats. While these standards are now mostly superseded, they represent important steps in the evolution of machine-to-machine communication and laid the groundwork for more flexible approaches such as OAI-PMH and, later, RESTful APIs.

APIs and interoperability

Ensuring true interoperability between systems is not only a matter of exposing data via APIs, but also of speaking a common language – adopting shared standards for data formats, protocols, and conceptual models. If APIs are the grammar that structures communication, standards define the vocabulary and script through which meaning is encoded and interpreted. In the context of digital archaeology and CH, standards serve as the backbone of machine-readable data exchange, enabling integration between heterogeneous platforms (Moscati 2021). These standards can operate at different levels. Some concern data structure and semantics, such as CIDOC CRM, which offers a rich and formal ontology for describing entities, events, and relationships in CH; and Dublin Core, a simpler and widely adopted metadata schema used to describe digital resources through a core set of elements. Other standards pertain to data formats and transport protocols, such as those developed by the Open Geospatial Consortium (OGC), including WMS (Web Map Service) and WFS (Web Feature Service), which are commonly used to share and visualize geospatial data (Danese *et al.* 2024). The adoption of such standards allows systems to align not only in how they transmit data, but in how they interpret and contextualize it. For example, many archaeological geoportals in Europe, including the Geoportale Nazionale per l'Archeologia in Italy, use OGC-compliant services to deliver interoperable map-based data layers (Acconcia *et al.* 2024). Similarly, ontologies and linked open data frameworks inspired by CIDOC CRM have been adopted in several archaeological projects to enable semantic interoperability at the level of concepts and relationships (Niccolucci, Richards 2019).

Yet, despite the availability of these standards, interoperability remains a moving target. The adoption of standards can be uneven, and their implementation often requires technical expertise and long-term institutional commitment. As such, APIs and standards should not be seen as purely technical components, but as instruments embedded within wider socio-technical ecosystems, where governance, documentation, sustainability, and community practices are equally crucial to achieving FAIR and interoperable infrastructures.

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REFERENCES

Acconcia V., Boi V., Falcone A., Di Cocco I., Serlorenzi M. 2024, *Dati aperti in archeologia: una riflessione sullo stato dell'arte nell'ambito del Ministero della Cultura*, in A.M. Marras, A. Palmisano, R. Leone, V. Messina (eds.), *ArcheoFOSS 2023. Proceedings of the 17th International Conference on Open Software, Hardware, Processes, Data and Formats in Archaeological Research (Turin 2023)*, «Archeologia e Calcolatori», 35.2, 29-38 (https://doi.org/10.19282/ac.35.2.2024.04).

Barchesi C. 2005, *"Archeologia e Calcolatori": nuove strategie per la diffusione di contenuti in rete sulla base dell'OAI-PMH,* «Archeologia e Calcolatori», 16, 225-241.

Caravale A., Piergrossi A., Rossi I. 2021, *Open Data, Open Knowledge, Open Science: The new research group at the Institute of Heritage Science (CNR)*, in J. Bogdani, R. Montalbano, P. Rosati (eds.), *ARCHEO.FOSS XIV 2020. Open software, hardware,* *processes, data and formats in archaeological research. Proceedings of the 14th International Conference 15-17 October 2020*, Oxford, Archaeopress, 158-167.

Danese M., Masini N., Biscione M. 2024, *Gli Open Data per il patrimonio culturale: aspetti teorici ed esperienze in Italia*, Roma, Cnr Edizioni.

Larsson Å.M., Bornsäter B., Hacke M. 2025, *Developing practices for FAIR and linked data in Heritage Science*, «npj Heritage Science», 13, 1, 53 (https://doi.org/10.1038/s40494-025-01598-x).

Lorenzini M. 2016, *Le API di Europeana come esempio di integrazione e rappresentazione delle risorse culturali,* «Archeologia e Calcolatori», Suppl. 8, 211-216.

Lynch C. 1997, *The Z39.50 Information Retrieval Standard*, «D-Lib», 3, 4.

Moreira W. 2008, *Introduction to the use of protocols SRU/SRW: Tools for coperative cataloging*, «Perspectivas em Ciência da Informação», 13, 3, 167-182 (http://dx.doi.org/10.1590/S1413-99362008000300011).

Moscati P. 2021, *Digital archaeology: From interdisciplinarity to the 'fusion' of core competences*, «magazén. International Journal for Digital and Public Humanities», 2, 2, 253-274 (https://doi.org/10.30687/mag/2724-3923/2021/04/004).

Niccolucci F., Richards J. 2019, *ARIADNE and ARIADNEplus*, in J. Richards, F. Niccolucci (eds.), *The Ariadne Impact*, Budapest, Prime Rate Kft., 7-26.

Paraciani N. 2024, *A new website for the journal "Archeologia e Calcolatori"*, «Archeologia e Calcolatori», 35.2, 471-482 (https://doi.org/10.19282/ac.35.2.2024.49).

Piergrossi A. 2020, *What is F.A.I.R.?,* «Archeologia e Calcolatori», 31.1, 253-256 (https://doi.org/10.19282/ac.31.1.2020.12).

Serlorenzi M., Cecchetti A., D'Andrea A., Lamonaca F., Leoni G., Montalbano R., Picciola S. 2023, *SITAR project. New approaches and methods for an open data archaeology of Rome*, in I. Haynes, T. Ravasi, S. Kay, S. Piro, P. Liverani (eds.), *Non-Intrusive Methodologies for Large Area Urban Research*, Oxford, Archaeopress, 114-116.

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Indexing science

The growth of academic publishing, both in the proliferation of journals and the emergence of commercial publishers often unaffiliated with universities or research institutions (Björk *et al.* 2008; Larivière *et al.* 2015), has created a pressing need for efficient search tools and reliable mechanisms to assess journal credibility. These demands have fueled the development of journal indexing and ranking systems, which now play a crucial role in shaping researchers' careers, institutional evaluations, and access to funding. While their impact has been particularly pronounced in STEM and Health disciplines, the growing emphasis on interdisciplinarity has extended their influence to the Social Sciences and Humanities as well.

1. *Main abstracting & Indexing services*

Journal indexes have a long history and an undeniable importance in the research process. They aid scholars in locating relevant literature, increasing the visibility