Heritage Science

REVIEW

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Models and tools for the digital organisation of knowledge: accessible and adaptive narratives for cultural heritage

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Abstract

The cultural heritage sector includes a significant variety and complexity of data and information. Making this accessible today represents one of the main aims of cultural institutes. The connections between digital archives and knowledge enable the extension of this wealth of information beyond the physical existence of cultural assets by fostering the creation of digital libraries based on the comparison and interaction of data and on sharing the most up-to-date scientific literature. To this purpose, the results of the analysis on the Italian system of cataloguing and dissemination of knowledge related to cultural heritage are first illustrated. These are indispensable for enhancing the experience of cultural heritage, starting from guidebooks and travel literature, which represent the first codified forms of description of cultural heritage addressed to an audience of visitors/users, and ending with the most recent ways of sharing knowledge related to cultural heritage. Among these, digital platforms for participatory storytelling and the drafting of innovative texts and narratives stand out. Particular attention is paid to the innovative models for the use and enjoyment of cultural heritage employed in some of the main institutes and museums, where examples are analysed to effectively illustrate the emergence of new forms and modes of knowledge and narrative of cultural heritage, between big data and digital devices. Through these analyses, this article provides an overall picture of the current models and methods for the digital organisation of cultural heritage knowledge in order to raise awareness of the main critical issues encountered and to activate targeted planning and design processes capable of responding adequately to the needs of an increasingly active and participative user base in the processes of learning and enjoyment of cultural heritage. The interactions between scientific and technological research characterise the field of cultural heritage knowledge and are both instrumental in facilitating established approaches and contribute to changing the very parameters of research by posing new epistemological questions.

Keywords Digital catalogues, Cultural ontologies, Information accessibility and inclusion, Sources for cultural heritage, Guidebooks, Online platforms and databases, Museum online collections

Introduction

This article describes activities prior to the development of interdisciplinary research aimed at the configuration of innovative systems for the personalised use and enjoyment of cultural heritage.

The article emphasises the Italian context both for the breadth, quality, and variety of the tangible and intangible cultural heritage and for its consolidated tradition of studies and research applied to the field of cultural heritage. These aspects make it one of the most advanced

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Table 1 Overview of digital systems of reference for sharing knowledge

Category	Name	Web link
Platforms	Digital Public Library of America	https://dp.la/
	Europeana	https://www.europeana.eu/it
	CulturaItalia	https://www.culturaitalia.it/
	Museiiditalia. Musei digitali	https://museid.culturaitalia.it/
	Memofonte	https://www.memofonte.it
	Memory of the World UNESCO	https://www.unesco.org/en/memory-world
	Gallica	https://gallica.bnf.fr/accueil/?mode=desktop
	Mediterranea	http://www.mediterraneaericerchestoriche.it/
	British History Online	https://www.british-history.ac.uk/
	Harry Ransom Center—Digital Collections	http://www.hrc.utexas.edu/collections/digital/
	CASPAR (Cultural, Artistic and Scientific knowledge for Preservation, Access and Retrieval)	https://www.casparpreserves.eu/
	INCEPTION (Inclusive Cultural Heritage in Europe through 3D semantic modelling)	https://www.inception-project.eu/en
	Library of Congress	https://www.loc.gov/collections/
Digital Storytelling Platforms	izi.TRAVEL the storytelling Platform	https://izi.travel/it
	Museum on Main Street (MoMS)	https://museumonmainstreet.org
Museums and exhibition digital collections	Paul Getty Museum	https://www.getty.edu/art/collection/
	British Museum	https://www.britishmuseum.org/collection
	Museo del Prado	https://www.museodelprado.es/en/the-collection/art-works
	Metropolitan Museum of Art	https://www.metmuseum.org/art/the-collection
	Rijksmuseum—Closer to Johannes Vermeer	https://www.rijksmuseum.nl/en/johannes-vermeer
	Vatican Museums (Musei Vaticani)	https://www.museivaticani.va/
	Museum of Modern Art MoMA	https://www.moma.org/collection/works/78386
Databases	Census	https://database.census.de/
	HistAntArtSI Project	http://histantartsi.eu/
	ARIADNE PLUS—Ariadne Infrastructure	https://ariadne-infrastructure.eu/
Digital Archives and Libraries	Naples Digital Archive	https://www.biblhertz.it/it/dept-michalsky/naples-digital
	Belgica	http://belgica.kbr.be/fr/coll/coll_fr.html
	Fondo Antonio Cervi	http://badigit.comune.bologna.it/cervi/index.asp
	Istituto e Museo di Storia della Scienza	http://www.museogalileo.it/en/index.html
	Biblioteca Nacional de España	https://www.bne.es/es
	Aboca Museum	http://www.abocamuseum.it/en/
	Early European Books	https://www.proquest.com/eeb/index
	Revolution 1848—Digitales Archiv	https://filosofiastoria.wordpress.com/
	Cefael	https://cefael.efa.gr/site.php
	ZERI & LODe project	http://data.fondazionezeri.unibo.it/
	Smithsonian Digital Library	http://www.sil.si.edu/DigitalLibrary.cfm

nations in the sector. Also, Italy has a significant role within the European Union where it has given rise to important international projects on sharing and networking knowledge and data related to cultural heritage.

Themes related to the valorisation, enjoyment and use of cultural heritage are not, nor can they be limited to a specific territorial field.[1] Aware of this fact, the last section of the paper addresses the topic from a wider viewpoint, which is in some ways "eccentric" (but complementary) compared to the field of investigation advanced in the first two sections. In fact, the last part highlights the need to constantly and attentively observe the global scenario and the initiatives adopted by the main international cultural heritage institutes, drawing the appropriate lessons and references from them (Table 1).

[1] As eloquently testifies the very institution of the World Heritage Lists adopted by UNESCO since 1972, which have endorsed the need to look at cultural heritage of assets and knowledge from a global, supranational and transdisciplinary perspective.

More specifically, the article is divided into three parts. The first part ("Models and methods for building an integrated knowledge system around cultural heritage" section) is dedicated to the study and analysis of the systems of construction and sharing of catalogues and ontologies related to cultural heritage, drawn up in Italy following a common European consultation. Specific reference is appointed to the Italian Ministry of Culture (MiC) and its Central Institutes, first and foremost the Central Institute for Cataloguing and Documentation-ICCD. This includes the files of the General Catalogue of Cultural Heritage relating to the assets preserved in the institutions, archives, libraries, and state research centres belonging to the Ministry.

After a general overview at European level (*Europeana*, *Ariadne Plus*, etc.), the research focuses on the Italian case. In this direction, the state of the art and ongoing activities are analysed in depth. Particular attention is given to the configuration of reference platforms and ontologies for sharing and comparing the sources and the conspicuous documentation inherent to cultural heritage. An organic and multilevel information and regulatory framework is thus outlined.

The second part of the paper ("Sources for rewriting cultural heritage in the Digital Age. The guides" section) is strongly related to the first. It identifies and critically selects some of the main reference sources on knowledge for the valorisation of cultural heritage, without any claim to exhaustiveness. The aim is to introduce a comparative critical analysis of the state of the art regarding the use of primary and secondary sources in guides (and audio guides) and explanatory-descriptive texts dedicated to the narrative and dissemination of cultural heritage. These are the only guarantee of transparency and scientific reliability of the information reported.

Starting from the field of guides and texts traditionally devoted to the description and explanation of cultural heritage for cognitive-informative purposes, the Section pledges a parallel comparison with the European framework. This is both related to contemporary French and English guides, and to the cognitive platforms for sharing data, documents, and sources inherent to artistic literature such as *Census* or the *HistAntArtSi* and *Naples Digital Archive* projects. Although focused on "Italian" fields of study, these projects involved the construction of a pioneering system (*Census*) of cross-referenced, intersecting, and searchable datasets used for sharing and consulting the sources and the surveyed documents. These are merged into up-to-date open access computing platforms endowed with shared ontologies that can be consulted in real time and are of fundamental support to research.

Finally, the third part ("Multilayered knowledge in the digital dimension for cultural heritage enjoyment and use" section), from an international viewpoint, explores current innovations in the field of designing systems for the enjoyment and valorisation of cultural heritage, making it available and enhancing the visitors' use, accessibility, and participation. It emphasises the multi-level knowledge adopted in the solutions developed by some of the most prestigious international museum institutions such as the Museum of Modern Art (MoMA) in New York and the British Museum in London. Also, specific focus is put on the multimodality as an effective system for broadening access to knowledge (cfr. "Multimodality to amplify knowledge access" section) [1–3].

Accessibility is the main topic of the "Accessibility and Inclusion Toolkit of British Columbia" (2023). This provides specific indications on the creation of digital content with reference to the diversity of users related to sensory accessibility, cultural diversity, literacy level, and to the need for multilingual information transfer.

It emerges a rich and composite framework of an experimentation based on the principles of Design for All and Human Centred Design, which are inevitable references also for the use, enjoyment, and valorisation of cultural heritage (Table 2).

The models and examples for the construction of an integrated knowledge system; the analysis of the main forms of narrative related to the complexity of sources for the dissemination of knowledge about cultural heritage; the thorough investigation of ways for sharing knowledge in the direction of inclusion, all form the operational framework for designing new tools for the personalised enjoyment and use of cultural heritage.

Further in-depth study on the topic will have to focus on the role of Artificial Intelligence in configuring new models and tools for the use and enjoyment of cultural heritage. This represents the scenario to be measured against in the immediate future in order to prefigure increasingly inclusive and adaptive solutions for sharing multi-level scientific knowledge applied to the cultural heritage sector.

Models and methods for building an integrated knowledge system around cultural heritage

The field of cultural heritage presents a complex variety of information for the identification, description, and the interpretation of content processed by different specialised disciplines.

In the field of digital humanities, the methods for data organisation and classification are analysed in the context of sharing and communication for different types of users.

Table 2 Overview of guidelines for accessibility, inclusion and data management in sharing knowledge

	Institution	Title	Web link
Accessibility and Inclusion	Pinacoteca di Brera	DescriVEDENDO	https://pinacotecabrera.org/proposte-educazione/descrivedendo-brera/
	University of Cambridge	Inclusive Design Toolkit Digital personas	http://www.inclusivedesigntoolkit.com/digitalpersonas/
	World Wide Web Consortium	Web Content Accessibility Guidelines 2018	https://www.w3.org/WAI/WCAG21
	World Wide Web Consortium	Web Content Accessibility Guidelines 2023	https://www.w3.org/TR/WCAG21/#sotd
	UNESCO	Accessible digital documentary heritage: guidelines for the preparation of documentary heritage in accessible formats for persons with disabilities	https://unesdoc.unesco.org/ark:/48223/pf0000374995
	Smithsonian Museum	Smithsonian Guidelines for Accessible Exhibition Design. Smithsonian Accessibility Program	https://access.si.edu/museum-professionals
	ART BEYOND SIGHT Bringing Art Culture to All	Art Beyond Sight's Guidelines for Verbal Description	http://www.artbeyondsight.org/handbook/acs-guidelines.shtml
	British Columbia	British Columbia Accessibility and Inclusion Toolkit	https://www2.gov.bc.ca/gov/content/home/accessible-government/toolkit/accessible-digital-content
Data Management	Agenzia per l'Italia Digitale	Guidelines for semantic interoperability through Linked Open Data (Linee guida per l'interoperabilità semantica attraverso i Linked Open Data)	https://www.agid.gov.it/sites/default/files/repository_files/documentazione_trasparenza/cdc-spc-gdl6-interoperabilitasemopendata_v2.0_0.pdf
	Ministry of Culture of Italy	Guidelines for drafting the data management plan (Linee guida per la redazione del piano di gestione dei dati) (Data Management Plan)	https://docs.italia.it/italia/icdp/icdp-pnd-dmp-docs/it/v1.0-giugno-2022/introduzione.html
	Europeana	Enrichments policy for the common European data space for cultural heritage	https://pro.europeana.eu/post/enrichments-policy-for-the-common-european-data-space-for-cultural-heritage

In the dialogue with information science, strategies are elaborated for the analysis, collection, classification, manipulation, preservation, retrieval, and dissemination of information. Moreover, methodologies and practices are implemented with reference to knowledge classification systems of bibliographic and library science origin. The original contribution of digital humanities consists of using those systems aimed at organising knowledge (taxonomies, *thesauri*, ontologies) through the "filter" of the humanist's observation of data [4].

The exponential growth of data to be preserved, organised, and made accessible, highlighted the importance of technological tools in responding to epistemological principles within the acknowledged "hypermedia" society, [5, 6] connecting all cultural heritage-related disciplines through interoperable infrastructures [5].

Cataloguing and archiving: the general catalogue of Italian cultural heritage

As a result of cataloguing actions, the set of records of assets deposited in the archives of the ICCD, The Central Institute for Cataloguing and Documentation, represent the General Catalogue of Italian Cultural Heritage. This Catalogue is the "custodian" of the vast record of knowledge about cultural heritage. In detail, the General Catalogue of Italian Cultural Heritage is formed and managed through the web-based platform named SIGECweb, ensuring interoperability between systems according to defined protocols for data interchange. The ICCD controls the entire flow of data production and defines the cataloguing standards to manage the complexity of cultural heritage knowledge.

The cataloguing process allows to explore the relationships between the catalogue records. It offers a global view of knowledge about cultural heritage continuously supplied with information from the web and through the connections between places and cultural assets.

The Portal of the Italian Catalogue is organised by "authors" and "cultural places". It allows users to navigate an interactive map to visualise the relationships between places and explore itineraries, thematic and geographical routes. In the system, the semantic-relational component of data is made explicit through Semantic Web technologies, which make searchable the digital resources and descriptive information about individual assets and about the broader context where they are located. This is supported by the relationships between heritage elements, subjects, places, and people, providing access to quality information useful for cognitive, educational, research and valorisation purposes.

The model of interoperability is shared at national level and is transversal between international organisations within the digital ecosystem, using ontologies. In fact, within the international context (IFLA, ICA, ICOM), it operates in the perspective of an integration between often divergent descriptive models, addressing heterogeneous artefacts, various media and assets (historical-artistic, archaeological, architectural and landscape, etc.), and documentary typologies. Each of them determines a different approach to cultural heritage.

Organising and classifying: shared ontologies and standards

Knowledge organisation includes the ordering techniques, the ways of consulting and using knowledge, the semantic approaches to information—*thesauri*, taxonomies, ontologies—and the languages for their representation. Standardising the procedures through shared vocabularies represents the foundation for the formal data representation with an impact on describing cultural resources.

Information structured through representational models becomes knowledge. Semantic tools guarantee its systematisation by simplifying access to information for users with different requirements for the enjoyment and use of knowledge [4].

Integrated access to information and digital objects managed by different systems, with their own characteristics and ways of organising data, can be achieved through high-level ontologies [7].

In Information Technologies, an ontology is a formal and shared representation of concepts and the joint relationships that characterise a specific domain [8, 9]. Ontologies can enhance the information potential of data in the coexistence of different knowledge representation systems. They define terms, concepts, and relationships. Also, they represent the primary tools to achieve semantic interoperability since they act as mediators for the integrated search of digital assets managed in different repositories [7].

The formalisation and adoption of glossaries and ontologies is applied at the international scientific level in the specific field of cultural heritage. Among these, the CIDOC-CRM from ICOM—International Council of Museums [10], recognised as the ISO 21127:2023 standard, is the most important and comprehensive ontology of the cultural heritage sector [11].

The ontology aims at the exchange and integration of descriptions, information, and documentation for scientific research between heterogeneous sources of cultural heritage: museum collections, archaeological sites, monuments, and scientific documentation preserved in archives and libraries [10]. The CIDOC CRM provides definitions and a formal structure for describing the concepts and implicit and explicit relationships used in cultural heritage documentation, for querying and exploring

such data. The model is "elastic" to be compatible with the "granularity" of cultural knowledge [7].

Starting from the needs of museums, CIDOC-CRM proposes a model that enables semantic interoperability between metadata schemas already structured by cultural institutions, i.e., museums, archives, libraries. This allows to represent knowledge offered by the already established information collections and to enable integrated access to the already structured data within heterogeneous and distributed archives [7].

With the expansion of ontologies, museums and cultural institutes have progressively adapted to a shared model and transversal standards. Through the digitalisation of cultural heritage, the scale of data has grown rapidly, and the types of available data have been continuously enriched with the aggregation, organisation, and transmission of knowledge [12]. The analogical cultural resources have been transformed into information to be metadata by replacing the catalogue cards and the integrated tools with descriptive digital, multilayered elements.

Expanding and enriching: the semantic web and linked open data

Linked Data are a mode of publishing structured data based on open web technologies and standards in a space of interconnected data with semantically qualified relationships. In this space, they build an increasingly wide information network that can be directly read and interpreted through software by extracting information through semantic queries [13]. Linked Data that relate open data are referred to as Linked Open Data (LOD).

The Linked Open Data cloud diagram contains information on datasets that have been published according to linked data principles and clearly shows the growth of datasets [14].

Specifically, the LOD represent the tool for the organisation and transformation of knowledge related to cultural heritage into a space accessible to the final user.

The Semantic Web has brought about a change in the systems of digital representation of content. This change has influenced the management of catalogues, inventories, and archives of cultural institutions.

They have identified an opportunity for valorisation towards a transition from relational models of data representation to graph structures. The graph, i.e., the set of nodes connected by relationships, is the multidimensional, relational information architecture that enables the development of new knowledge about cultural collections.

Through Linked Open Data, the aim is to build a knowledge graph, defined by semantic interconnections between disseminated entities. This process began in the context of cultural heritage knowledge graph within the cultural heritage LOD Cloud, where institutions increasingly attempt to dialogue in a system of multi-directional relationships [4].

The goal is to create a network of cross-references in the MAB (museums, archives, libraries) and GLAM (Galleries, Libraries, Archives and Museums) perspective.

The collaboration among cultural organisations at the international level has supported the development of a new concept of collection, with extensive and shareable knowledge infrastructures available in the interconnected network. These methods promote digitalisation and online heritage accessibility to make available the collections through digital resources, as for the *Digital Public Library of America* and the *Europeana* initiative at the European level.

Specifically, *Europeana* includes a large dataset with millions of European cultural heritage works from about 4,000 institutions available online and constantly increasing. The collection can be explored by theme, topic, century, and organisation or through stories and online exhibitions (Fig. 1).

Europeana is structured as a network through a partnership among participating organisations. It aims to reach users who can benefit from the cultural heritage made available, as well as cultural and Information Technologies professionals who want to use this data to develop additional services and tools (*Europeana Pro*). Digitalisation is implemented through "resource aggregators" on cultural heritage that collect metadata from individual entities and make it operable through platforms. This allows simultaneous search within the collections of research institutes and museums [15].

In creating a common European space for cultural heritage data, *Europeana* has recently defined a series of principles to be followed within projects, organisations, and activities of the ecosystem with reference to the cultural sector. As stated within the principles of "Quality", "Transparency", "Interoperability" and "Reusability", it is necessary to enhance data quality and value by creating connections with other resources. These include detailed information on the purpose of processes and workflows, ensuring the use of accessible standards. Through "Collaboration", the integration with further spaces and data sectors is fostered. The attention to users' needs through "Participation, diversity and inclusion" is particularly relevant and it promotes data accessibility.

Getting back to the Italian context, the resource aggregator *CulturaItalia* collects and organises millions of pieces of information regarding cultural heritage, making them available to web users (Fig. 2). Following the logic of resource aggregators, cultural information is not produced by the Portal. They are instead provided directly by

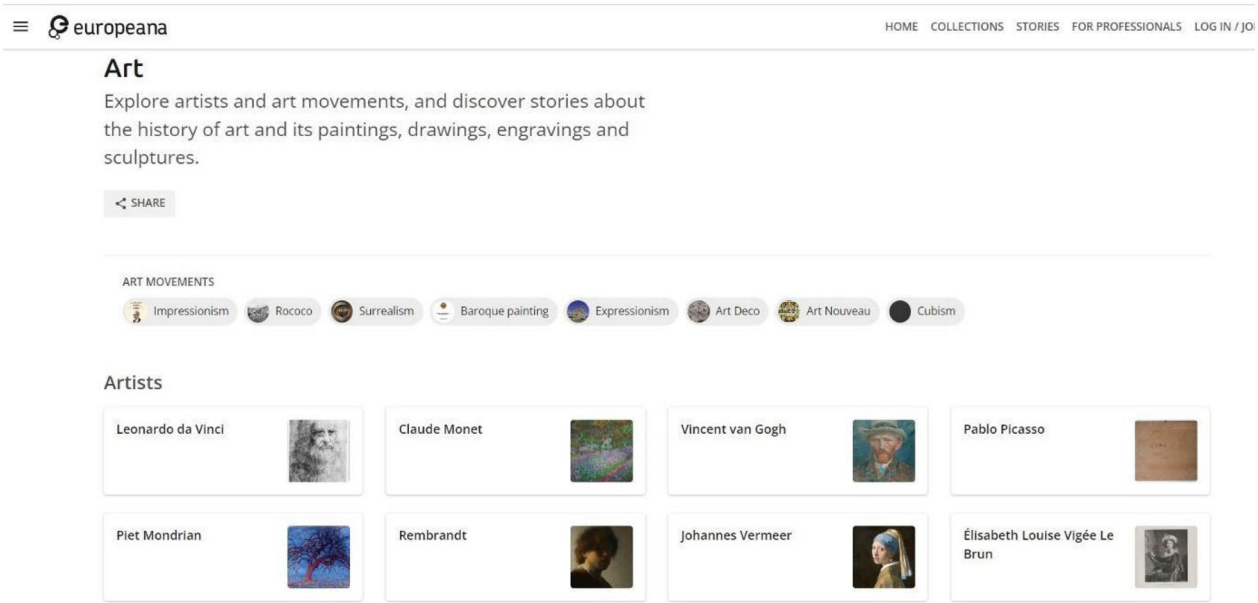

Fig. 1 *Europeana* screenshot. Navigation by topic ("Art")

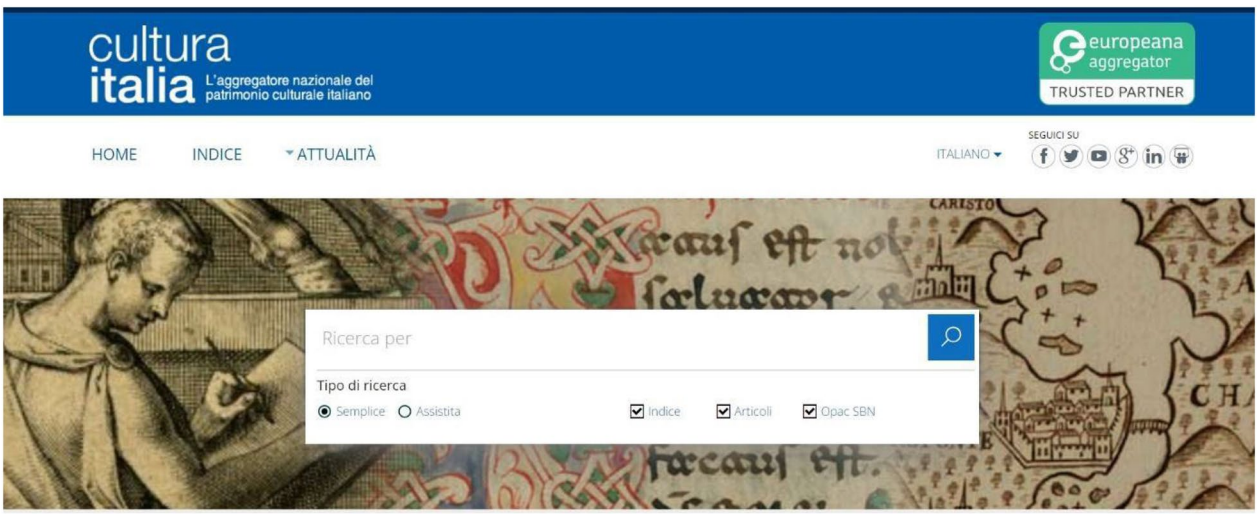

Fig. 2 *CulturaItalia* screenshot

the entities that own and manage them, while the aggregator acts as national data provider towards *Europeana*.

CulturaItalia is an "open" system, since it grows and develops along with new information about resources that enrich the database. It provides users with the opportunity to consult and search information on Italian cultural resources in a single container, acting as a starting point for exploration oriented towards other sites.

Closely integrated with the *CulturaItalia* portal, the *museiD-Italia* project aims to create a specific area dedicated to museums, where information on museums, monuments, parks, and gardens can be made accessible (Fig. 3). This is also possible by conducting research and comparisons with works from the collections of different institutions.

The *CulturaItalia* portal re-maps the collected metadata according to the *Europeana* Data Model (EDM) and the CIDOC-CRM international standard format. However, the attempts to use semantic technologies to support the evolution of the portal into a digital library

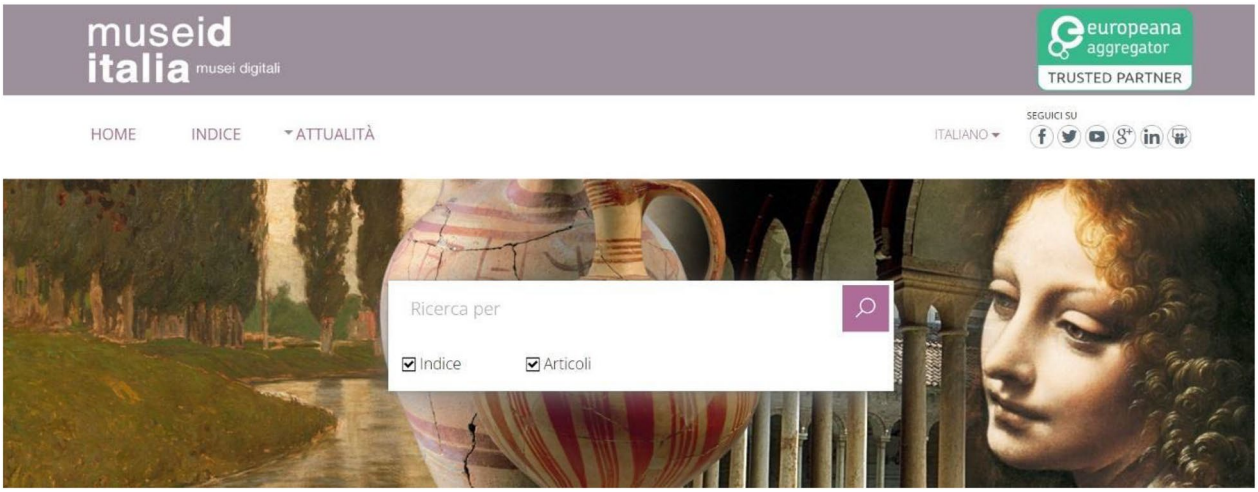

Fig. 3 *museiD-Italia* screenshot

have faced intrinsic limitations, i.e., the limited capacity to represent cultural heritage information starting from data [16].

Collection digitisation projects differ from resource aggregators. They are classified as digital libraries, i.e., repositories of digital representations of objects by different type, structure and location and aggregated on the grounds of the linking relationships. These are not static spaces where heritage information can be placed, but tools available to users with specific knowledge needs.

Collections from international museums and cultural institutes such as the Paul Getty Museum, the British Museum, and the Prado Museum, among others, are made accessible. The aim is preserving, describing, and enhancing cultural heritage and making the assets available to the public in digital formats.

For digitisation and cataloguing activities, the data management process is crucial for ensuring the accuracy and representativeness of information, from creation to web release and to end-user [17]. From a trans-disciplinary perspective, a series of actions need to be undertaken for the creation of a digital collection in continuous dialogue between development activities and the community of domain experts. In cultural heritage, data management introduces new ways of data representation. An articulated, robust, structured, and well-documented methodology must be adopted, as demonstrated by the digital collection of the Zeri Photo Library Archive.[2] The whole data management process is also necessary and fundamental for heritage (re)valorisation to ensure access to the end user [17].

Besides data, the Egyptian Museum of Turin (Italy) has released the images of its collections under an open license through a Data Management Plan for systematically opening all the institution's content and information. The online searchable collection includes a selection of 4700 objects of the collection from a total of approximately 40,000.

It is interesting to note that in the Italian context, despite the numerous digitisation and online publication initiatives launched by cultural institutions, no real digital library can be traced, but rather several aggregators and portals of access to cultural heritage with a mainly "thematic" structure [16]. This criticality is attributable to the absence of shared descriptive parameters and models and of a system for sectoral and intersectoral coordination. This can define guidelines and standards to be adopted regarding metadata structures, digitisation procedures and data format, with particular attention to open formats [16].

Within the cultural heritage sector, the publication of collection data in Linked Open Data format has led to increased awareness of the potential offered to cultural heritage institutes. They can "open" data and make them accessible through innovative ways, allowing for the mutual enrichment of source information.

Given the plurality of institutions and actors that play an active role in the processes of cultural heritage information creation, it is necessary for data to be processed according to principles, methods and tools that facilitate their sharing and re-use to generate further knowledge

[2] The ZERI & LODe project is the result of a collaboration between the Federico Zeri Foundation and a team of computer scientists and experts in digital humanities at the University of Bologna. The project aims to transform the Fototeca Zeri catalogue into Linked Open Data, to make them accessible, traceable and reusable by users and other applications, according to the needs of the new semantic web.

coherent with the FAIR principles (Findable, Accessible, Interoperable, Re-Usable).

In the Italian context, the information heritage is published on an experimental platform according to the logic of Linked Open Data (LOD), linking together datasets from different sources. The National Catalogue is part of the Linked Data Cloud, i.e., an open database correlated with other databases that is continuously expanding and that has numerous datasets published by international cultural and museum institutes in the cultural sphere. In view of this knowledge sharing at the national level, the *ArCo* project, *Architecture of Knowledge*, was born. This represents a network of ontologies for structuring descriptive data of cultural heritage. It aims to publish the Catalogue of Cultural Heritage in Linked Open Data to make data accessible, traceable, and reusable by users and applications by restoring the complexity of cultural heritage.

Cultural heritage as a relational system

In digital humanities, data processing and management are based on a series of basic computational activities: digitisation, classification, description and metadata, organisation and navigation, and a few analytical-interpretive operations: curation, analysis, editing and modelling [18]. Sharing and communicating should be added to these operations, with reference to the enjoyment and use of cultural heritage sources within digital information archives.

Aiming to enhance cultural heritage and increase the user's cognitive experience, source information needs to be made accessible. This is possible by making available the reliable, documented, scientific data, and the information supported by the indispensable paratextual, metatextual and intertextual set.

In fact, the complexity of cultural heritage is only partially valorised compared to the potential that could derive from the amount of data (and metadata) of the bibliographic, archive and museum fields [4].

The possible network of relationships established by the cultural object with other objects in the Semantic Web still appears limited. Cultural objects are polysemous [19] and multidimensional [4], they are connected to other objects and collections, and they collect a history, since exhibitions, research and preservation techniques develop and change over time [19]. Information referable to objects changes over time due to various factors such as re-classification, inclusion in a temporary exhibition, repatriation, or other forms of organisational change [20]. According to some scholars, current classification systems and the creation of structured vocabularies has limited the polysemous nature of the cultural object as a carrier of knowledge [19–21].

It is therefore necessary to configure systems for managing and sharing information that can support multiple information about the object. Asset description should be rethought from the perspective of documenting the "stratification of sources" and their expressive capacity, separating content from container, analogue from digital, descriptive card from artefact [4]. To extend the information heritage, it is necessary to enrich cultural data, and thus the information experience, through the integration of heterogeneous and transversal resources, as are, by their very nature, the cultural artefacts.

The digitisation process has brought to the foreground the polysemic nature of artifacts as carriers of information. Museums can support and enhance the use and interpretation of their heritage by enriching metadata. Documentation, indexing and metadata enrichment practices need to be adapted to the new information space where users interact. In the digital information space, artifacts, metadata, collections, museums, and users, all exist as independent nodes in a wide universe of data. Information systems must also accommodate different vocabularies for different types of users [21, 22].

Sources for rewriting cultural heritage in the Digital Age. The guides

With reference to the new ways for narrating cultural heritage, the tourist guides "genre" conveys a specific role within a defined field of application. This refers to the process of interpretation and translation of the values of a site or a cultural artefact *tout court*. Much more than for sedentary or entertainment tourism, guides become an ineluctable tool since they play a role of "cultural mediation", explanation and compendium that enables touristic experiences [23, 24].

They represent the first "coded" forms of narrative and description of cultural heritage addressed to an audience of visitors/users interested in expanding their knowledge. Thus, they denote a basic source and an obvious model within the processes of knowledge translation, transmission, and assimilation regarding cultural heritage.

Over time—from *Notitie del bello, dell'antico e del curioso della città di Napoli* by acknowledged Carlo Celano, 1692, divided into days; to *Guida di Roma e dintorni* by Antonio Nibby, 1826; to *Handbooks for Travellers* by Londoner John Murrey, 1836; and on to the celebrated *Baedeker*, whose first volume came out in 1832,—guidebooks have shown their progressive ability to shape and commensurate with the routes of travellers and with art itineraries (particularly from the *Grand Tour* onward). This until they became ineluctable tools for the enhancement and knowledge of territories. They provide an image as exhaustive and complete as possible of the *identity* of the places and of

the reference works by interweaving historical-artistic and cultural events with the "myths" and founding stories of the cities [25].

It is precisely since the 19th Century, from *Baedeker* onward, that the guidebooks narrative "warping" changes considerably, transforming from travel reports for educated visitors to useful tools for in-depth study and knowledge. Places and works are now described and organized in succession according to thematic or geographic visit itineraries. These increasingly tend to frame the works and sites included in the proposed knowledge paths by means of accurate descriptions and cataloguing.

The erudite traveller is replaced by the publisher. The guarantee of truthfulness and reliability of the content is entrusted to his editorial choices and good name, as well as the possibility of periodically updating it. The gradual consolidation of increasingly competitive publishing logics will entail the need to characterise and make immediately identifiable the *products* of each publishing line. This will be obtained by connoting them with a series of distinctive elements—first and foremost, the format and colour. The latter will become *the* preponderant feature to the point of "taking over" the titling as proved by the meaningful cases of the *blue guides* of Hachette, the *red guides* of Baedeker, or the *red* and *green guides* of Touring [26].

The *Guida d'Italia*—otherwise known as the *guida Rossa* (red guide)—1914, by *Touring Club Italiano* (TCI) deserves special attention in this context. It was first drafted with reference to the itineraries connected with the Association's activities. Later, it became an instructive and in-depth editorial product entrusted to an *equipe* of scholars and local experts distributed throughout the country. They took care of its editing by selecting the different itineraries and "hierarchically" organizing the system of knowledge. This was made according to a model that was not very different from the one inaugurated in the mid-eighteenth Century by the *Encyclopédie*, a true archetype in terms of knowledge organisation and scientific dissemination.

Founded in Milan in 1894, the *Touring Club Italiano* saw a particular impetus starting in 1914 due to the choices of co-founder Luigi Vittorio Bertarelli. He personally selected new destinations to be included in the tour itineraries, foreseeing for the first time locations, sites and works that were usually neglected by other guidebooks because they fell within territories and realities that were little or not at all known and experienced. Consider for example the Apennine areas or the South and the islands, which were rarely included in the routes drawn by the tourist itineraries of the time, except for a very few established destinations (the archaeological sites of *Magna Graecia*).

According to the famous definition by Indro Montanelli, the purpose of the Touring guides was related to the desire and commitment to *make Italy known to Italians*, expanding the target audience to include a not necessarily expert (or educated) public. They were accompanied by different tools, i.e., the different guides offered, to approach the historical-artistic and cultural heritage of their own country [27].

The knowledge system provided by the *guide Rosse* (red guides) and the cultural policy pursued marked from the outset the substantial distance that separated them from coeval texts of the genre.

The quality of the reported information, the thoroughness and attention to sources, the presence of *appendices*, and the conspicuous *note bibliografiche* (long descriptive notes placed at the end of the text) of the guide, still make it one of the most rigorous and cultured scholarly productions in the field. Its success was ratified by the evolution from the seven initial volumes to the final twenty-three, with a circulation of about 8 million copies. The abundance and precision of the historical-descriptive content, the contributors' expertise, the general approach, the explicit reference and the obvious overtake of the *Baedeker* model, make it a clear example of great influence on all subsequent publications [28]. The project breadth and the participation of local scholars from various fields in elaborating the texts, have contributed to avoiding the standardised accumulation of only "monumental" data selected by appropriate asterisks and isolated from the geographical context, that was employed by other guides in the field [28].

To overcome this approach, from the 1970s some of the *Guida Rossa* (red guides) titles have replaced the list of historical-artistic "emergencies" preceded by cold historical summaries, with a documented analysis of the territory that introduced a "methodological revolution". Practical news has disappeared, being intended for the TCI series that are easier to update. The "red guides" focus on unusual details and historical connections [29] highlighting the breadth and variety of the sources used.

In this context, the later and less specialized TCI *guida Verde* (Green guide) emerges. This has been published from the 1960s onwards and initially it was intended for foreign destinations. The guide introduced a concise and streamlined approach to cultural itineraries by addressing a wider but less educated audience of travellers than the *guida Rossa* (Red guide). Opening to the mass tourism market with a progressive reduction in content and a renewed focus on versatile and immediately readable dissemination models, the guide can bring non-expert readers closer to a fluent and dynamic consultation of the topics covered, including aspects of daily life and curiosities. Compared to the rigour of content entrusted to the

precipitous use of written text—which continues to be *the* preferred means of communication of the *guide Rosse* (Red guides)—in the green guides images are introduced, boxes are added, literature and customs are discussed [29]. Having categorised the texts by *fields* entrusting specific topics to recognisable boxes, the *Green guide* accompanies the reader in an intuitive and directional-or if preferred, *selective*-consultation of content. This somehow anticipates the current models of text delivery and consultation.

Thus, there is a progressive compressing of content as the guidebook's genre becomes more specialised and categorised, commensurate with the tourism market. Diversifying guidebooks contributes not so much to "the content itself" but to the ways how they are carved out and assembled, hierarchised, emphasised, belittled even directing the readers' practices. They will know a given territory/work according to that specific grid, to the "form" assigned to content [25].

More recently, through the digitisation tools and by means of the plural access to the Internet, the transition from texts to hypertexts has entailed the possibility of overcoming some of the limitations inherent in the more usual (but not for that reason obsolete) formula of the printed page enhancing new possibilities of narrative and enjoyment. By taking advantage of the joint action of new devices and mobile devices that allow unlimited and continuous access to the network and information platforms, the reader becomes a user and enjoyer of cultural content.

Within the construction of "an ordered hierarchy of values," the guidebook revises and updates the models of previous guidebooks, in its traditional as well as in its more technological and advanced form. It proposes itself as a product stratified in time and content. It is the result of research work and the comparison and integration of different sources that are not necessarily homogeneous and whose memory it restores by placing itself within an established serial sequence [30].

The source that has reached us and was identified as such can be described as a palimpsest. It can be represented as the result of overlapping layers, i.e., a multilayered complex of relationships where each element is related to the others from the same layer and simultaneously to those in the below and above layers. Also, each layer is related to the others [31].

In structuring the guides, three main layers of learning have been identified: *cognitive*, *sensory,* and *consultative*, all connoted by an obvious "didactic component" [30, 32].

The *cognitive* level, related to "making known", can be traced back to the actions of *interpreting*—what lays beyond the surface of sensory perception [33]—and *elucidating*,[3] as defined by Hausendorf in the field of artistic communication. He identifies a model according to which the artwork is verbally represented (in guides and audio guides) through four main actions: *describing, interpreting, elucidating,* and *evaluating* [33, 34]. In this context, the *sensory* level identified by Moirand [32] is referable to the action of *describing*—those aspects of the artwork/artefact/site which can be perceived through senses. The *consultative* level instead corresponds to the action of *evaluating* and it concerns subjective considerations related to the work.

Information-descriptive and persuasive functions prevail therefore in the guides [35]. The basic requirements for a guide include:

- the explanatory clarity and periodic updating of information;
- the exhaustiveness, completeness and speed of information;
- the comparative use of sources;
- the selection of information based on the visitors' profile;
- the use of informative language;
- the ability to act as an intermediary between assets, visitors and the territorial context, directly influencing the construction of the cultural identity of places;
- the duration and impact of its effects or, if allowed, *the timing* of the guide. In fact, each guide has a *predictive* function—it anticipates the visitors' experience, orienting and accompanying them in the discovery of places and selected works. It has an *immediate* function that is carried out *on site* and *in presence* by providing clear and exhaustive answers to users' questions. Moreover, its *enduring* instructive function extends well beyond the time of the visit, allowing to systematise the learned information and insights a posteriori, to anchor them to prior knowledge and enrich one's educational background [26].

From this point of view, the guide really takes on the connotations of a "text-document". Its heuristic possibilities increase in relation to the texts that preceded it (memory retrieval and transformation) and to those that will follow it (constitution, reiteration, and infringement of the model) [26]. Moreover, its effects are commensurate with the visitor's individual experiences, whose profile and interests they intercept. This allows the personalisation of content and paying attention to new

[3] This represents additional knowledge about the work concerning information on the artist, the art-historical context, the genre covered [33].

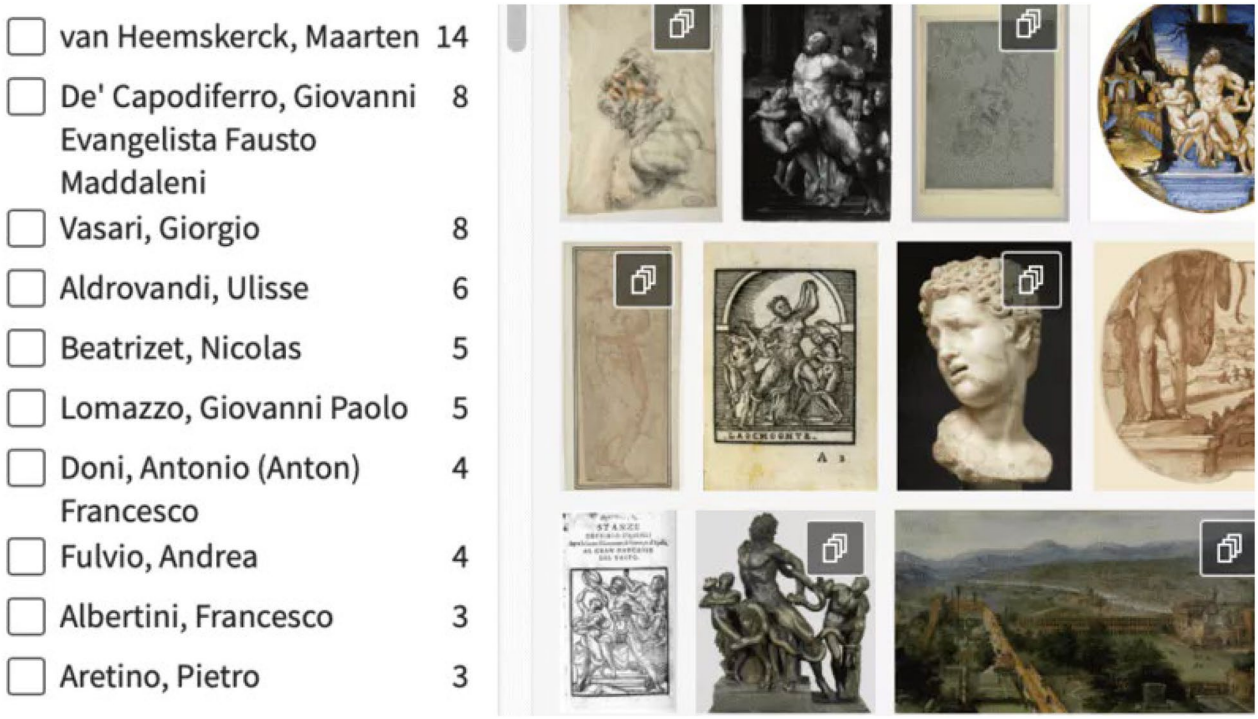

Fig. 4 *Census* database screenshot

modes of interaction and User Experience Design characterised by ductility and richness of information [35].

Platforms and documentary databases: knowledge repositories

The need for up-to-date digital platforms for the dissemination of knowledge related to cultural heritage requires the configuration of new modes of construction and comparative consultation of sources. Given their polysemous nature, these will have to be read with reference to the different levels of "production in context", "transmission in time" and "interpretation in the present" [31].

Moreover, the interoperability between databases, digital libraries, and open archives, made compatible with each other through Linked Open Data (cfr. "Models and methods for building an integrated knowledge system around cultural heritage" section), has multiplied the research possibilities and the availability of sources on the web, significantly changing the conditions of knowledge production and dissemination [36].

The *Census Project—Census of Antique Works of Art and Architecture Known in the Renaissance*—of the Humboldt University of Berlin (Fig. 4) is a valuable source with reference to the creation of a database for the retrieval and consultation of rare documentary materials for the enhancement of cultural heritage. The project started in 1946 as a collaboration between art historian Richard Krautheimer, director of the Warburg Institute in London Fritz Saxl and archaeologist Karl Lehmann of the New York University. It expanded its repertoire being constantly updated with respect to contemporary needs and tools.

The need to trace the real consistency of information and studies related to the artistic heritage of Renaissance entailed the creation of a "*corpus of known antiquities*" from the 15th and 16th Centuries to be documented through the construction of a rigorous system of cataloguing and comparison of documentary and iconographic sources of the period. These suffered enormous difficulties for retrieval and consultation.

The idea of creating a *dynamic* and ductile sharing tool to systematically record visual and textual sources of the time enabled the compilation of a true census filled by following the *Art History Information Program*. This was initiated by the Paul Getty Trust in the same years aiming to test the possibility of employing electronic data processing also in the field of humanities.

The informatised database of the entire *Census* card system (created since the 1980s) relates the ancient monuments known during the period between 1400 and 1600 with the corresponding Renaissance sources including guidebooks, prints, drawings, and generally the reference textual and iconographic sources. The indexed written sources include travel guides, archival documents,

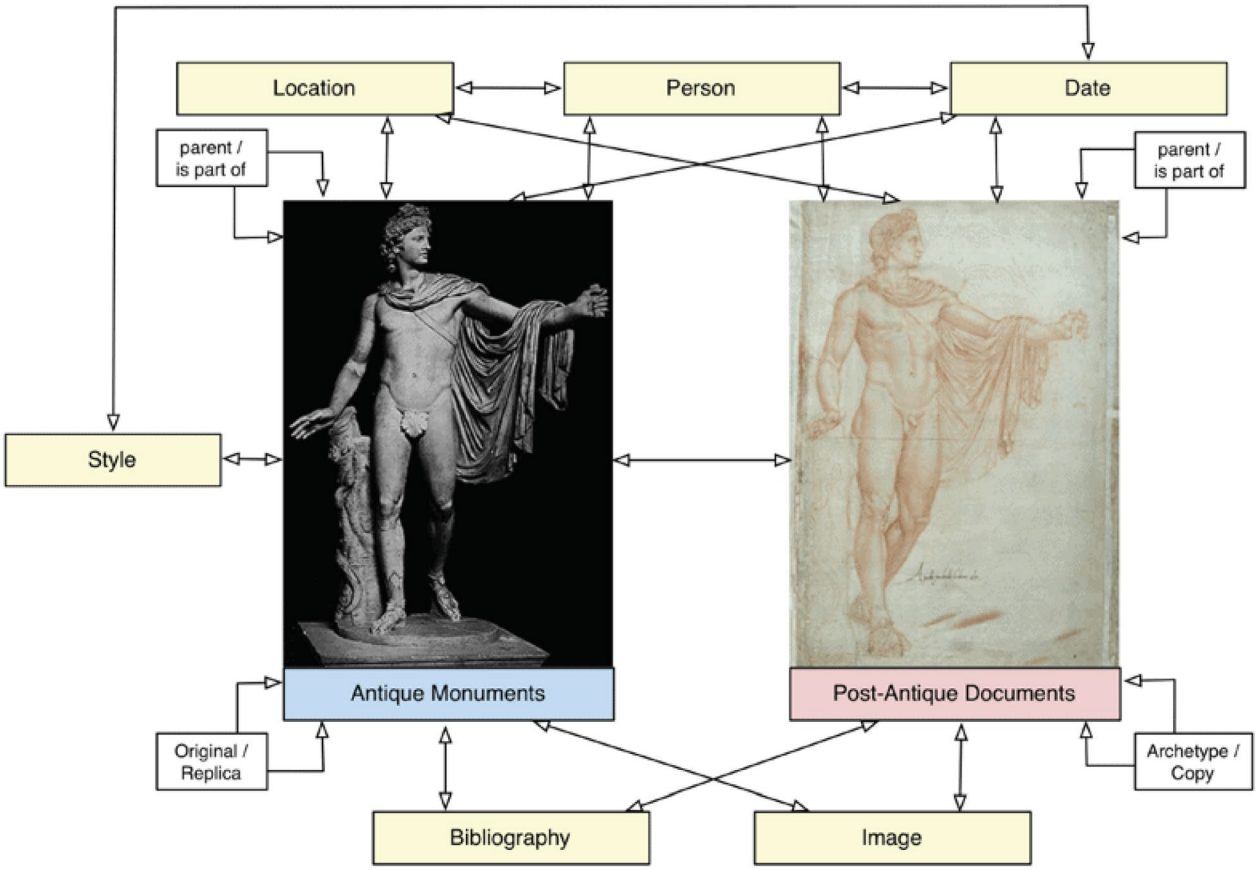

Fig. 5 *Census* data model

and *Lives* of artists, while visual sources include mainly sketchbooks, albums and collections of drawings and prints.

Currently, the database is an indispensable resource for sharing knowledge about the cultural heritage of the Renaissance and beyond. It is open access, constantly updated, and it consists of more than 200,000 items including monuments, visual and written sources, works, authors, bibliography (Fig. 5).

A collaboration with the Committee for the study of art history (CORDH) is underway to facilitate search operations and enable the integration of *Census* with other projects in the historical artistic field. Moreover, since 2022 the mapped data use the formal ontology CIDOC (CRM). Since 2023, *Census* is a partner of the *Ariadne Plus* consortium aiming to share archives and projects on topics related to archaeology [37].

The *Census* is welded to the *HistAntARTSI Project (Historical memory Antiquarian culture, Artistic patronage: Social Identities in the centres of Southern Italy between the Medieval and Early Modern period)* (2011–2016) coordinated by Bianca de Divitiis of the University of Naples "Federico II". This project aims at the elaboration of an open access database of antiquities, works of art and architecture, and local erudite history in mainland Southern Italy between the 14th and the 17th Centuries. The open and implementable database includes information on authors, artists, owners, location, and state of conservation of the works and the possible reuse of ancient materials.

The *Memofonte* platform is among the platforms and tools that identify artistic literature and guidebooks as the main sources for the analysis and knowledge of cultural heritage, preparatory to re-writing interactive, updated, and documented guidebooks that take due account of the memory of the places and works mentioned.

Conceived and directed by Paola Barocchi since 2000 within the framework of *Associazione Memofonte* (later *Fondazione Memofonte*) the platform aims at the creation of a textual database of ancient sources and guidebooks of various Italian cities including different types of writings related to cultural heritage (charters, inventories, diaries, catalogues, *Lives*, treatises, guides, visual atlases, etc.). In addition to the mostly integral consultation of texts in electronic format, transcribed according to strict philological criteria, it is possible to carry

out a free cross-query of the texts that enables comparison of the results and of the selected themes. This outlines the platform as a useful survey and research tool for broader studies in the field.

The digitisation tools are used to make immediately usable and consultable the (direct and indirect) texts and sources that are difficult to consult, guaranteeing their due protection. In addition, the database, the processing of which continues over time, allows the intersection of different kinds of sources and documents to build links, outlining new elements capable of configuring a significant advancement of knowledge about cultural heritage.

The site's architecture allows the consultation of full transcriptions (in PDF format), digital reproductions of manuscripts and printed texts of ancient editions, and the database, to be explored through search paths and indexes, while still ensuring that the digitised or transcribed sources can be traced back. In addition, the website is structured according to two main fields of interest: the "Authors" field, which gathers documents that can be traced back to the same extender along with reference texts, and the "Research" field where it is possible to access sources in textual and visual version. The collection allows for a diachronic retracing of the indexed and catalogued sources, highlighting their lexical layering and the reported information.

The *Naples Digital Archive—Moving Through Time and Space* project underway at the Hertziana Library in Rome should be noted with reference to updating and intersecting documentary, graphic and iconographic sources, which is aimed at the innovative reading and interpretation of the historical knowledge of Neapolitan cultural heritage. As a result of the collaboration signed in 2018 with the CIRICE Centre of the University of Naples "Federico II", the project aims to construct a "Graphic, alphanumeric and hypertextual Digital Archive of the historical iconography of Naples from the 15th to the 20th Century". It can be consulted on the web, and it provides for the identification of the main places in the city described on the basis of periegetic literature allowing to move through time and space of the historical city [38] with the support of cartographic layers.

The possibility of intersecting heterogeneous sources, artefacts, and materials, properly indexed and computerized, guaranteed by the new digital tools, offers the unparalleled opportunity to dispose of open and "dynamic" documentary, iconographic and textual data. This is capable of scientifically supporting the configuration and continuous updating of new categories of data and content (narratives) that are increasingly timely, accurate and reliable allowing a thorough and dynamic knowledge of cultural heritage.

Within the trans-discipline of digital humanities, the digital history is not only made of the use of new digital tools that enhance old practices. It is also about the development of a tight connection with technologies that might modify the research parameters requiring new epistemological questions in analysing the past [36].

The opportunity to compare data from different research and databases or to conduct cross-referenced search raises the question of interoperability between data and software and of the concurrence of information, with the consequent construction of databases interacting with each other and with the user. Their reconversion in IT development will have to be foreseen, which is not different from what is already happening with the cataloguing criteria of libraries or *thesauri* (cfr. "Models and methods for building an integrated knowledge system around cultural heritage" section").

These forms of co-operative development aim at the construction of common protocols for the creation of a single implementable and updatable database that refers to disseminated sources that are not collected in one place [31].

Sharing-generated guiding. Platforms for digital storytelling

The evolution of increasingly innovative and dynamic technological tools applied to cultural heritage and tourism has led to the development of new publishing products, including the field of "share-generated guides", developed and managed by digital platforms.

Among them, the *izi.TRAVEL the storytelling Platform*, specific to participatory and generative guides and audio guides, deserves particular attention. The platform, particularly for the version of the *#iziTRAVELSicilia* project curated by Elisa Bonacini, represents a significant model for the creation and dissemination of digital cultural content aimed at the personalised knowledge and dissemination of cultural heritage to be used in institutional and museum settings.

The platform includes about 20,000 audio tracks and has been used by several museum institutions such as the Smithsonian Institution in Washington D.C., which has adopted it in the *Handobook* of the *Museum on Main Street (MoMS)* program. A further example is represented by the Brera Art Gallery which has developed a version also dedicated to visually impaired visitors.

Founded as a start-up in 2011, the platform, which became operational in 2013, specialises in the creation of customised museum audio guides and audio tours. Their textual content can also be enjoyed in audio mode supported by photographs and videos, and it can be transformed into hypertext content in order to make the visiting experience more pleasant and thorough [39].

The organisation of museum cultural content is structured by means of a sequence of cards divided by freely consultable themes, rooms, and topics, with possible cross-references to other guides and links to external web resources.

In particular, the section of the project *#iziTRAVEL-Sicilia*, has resulted in the creation of a considerable number of audio guides as part of museum and heritage education projects conducted in collaboration with schools and universities. The audio guides were published on the platform through the institutional profiles of the project partners, or through the profiles of the institutions within which the project matured. This required previous validation of the content by the partners who "own" the heritage [39].

The possibility of multiplying reading paths has led to an increasing *fragmentation of content* by allowing visitors to participate in the construction and selection of cultural itineraries related to their own interests [29] This determined a more rapid and discontinuous approach to information from users who have reshaped their cognitive processes according to online consultation modes [40]. Thus, it emerged the need to "calibrate" the use and impact of the digital on traditional forms of narrative of the past and on the *timescale* of history (cfr. "Multilayered knowledge in the digital dimension for cultural heritage enjoyment and use" section).

Multilayered knowledge in the digital dimension for cultural heritage enjoyment and use

The transformations of the methods for organising content and the evolution from an analogic dimension to digitisation claim for new ways of transferring knowledge [41] to reach a diversified audience within cultural institutions. The updated museum definition by ICOM (International Council of Museums) places accessibility, inclusion and diversity among the main elements that will have to guide cultural institutions in the process of sharing knowledge. The digital dimension of cultural heritage mediated by advanced technologies can provide visitors with the possibility to also use and enjoy cultural assets or sites usually inaccessible to the public or partially closed. Moreover, it has the potential to increase access for users with specific needs.

Despite the potential of these tools, the limitations related to sensory, cognitive, economic, and social accessibility are still evident [42]. They require searching for new ways of enjoyment and use to deliver content in an inclusive manner. It is crucial to shift attention on access to information to guarantee the "circulation of knowledge" [43]. The adopted solutions should be able to satisfy the different needs of users [44].

Digital as a "tool" to increase accessibility to information

Nowadays, most cultural data within museum archives and repositories is still inaccessible even to museum staff. It is estimated that the part of collections available to the public is around 5–15% [45]. This difference between accessible and inaccessible cultural heritage has grown with the collection and conservation of different types and large amounts of materials, which makes it difficult to select the content to be shared with the extended range of users through digital tools.

The continuously transforming technological solutions have the potential to increase access to large quantities of information with the possibility to adapt to different styles, interests and needs of visitors [46]. However, at the same time, they might limit access for specific users [47] with reference to their own affinities in using technology. The *Digital Divide* represents the new "divider" of society based for example on the users' familiarity and competence in use, and on their attitude towards technology [48]. These have an impact on the human-device relationship and can therefore be reflected in the experience of enjoyment and use. To reduce these barriers in using digital systems, the design of advanced technological tools for knowledge sharing will have to consider the diversity of visitors' needs and adapt to different user-profiles by intersecting their personal characteristics with the various ways of relating with technology.

In the Italian context, *The National Plan for the Digitalisation of Cultural Heritage 2022–2023* [13] is oriented towards increasing accessibility for different segments of audience. Among its objectives, it aims to expand the forms of access to digital heritage enhancing cultural inclusion. Also, it aims to provide the opportunity to open cultural heritage to new audiences that were previously excluded from traditional enjoyment and use [13]. This can be obtained by increasing the quantity of available resources and organising them as to allow easy consultation and sharing. On the other hand, it is about working on quality, on the ways of enjoyment and reuse to overcome physical, cultural, cognitive and psychosensory barriers [13].

In 2021 the European Commission has recommended the creation of a common digital space for cultural heritage to accelerate digitisation of cultural assets, sites, and monuments, and thus increase audience access. It promotes the digitisation—until 2030—of all monuments and sites at risk and that of at least half of the ones particularly frequented by tourists [49].

The growing interest for accessibility and inclusion is also reflected in the European directives and standards focusing on different aspects such as accessibility to information through ISO/IEC 30071–1: 2019 "Information technology—Development of user interface

accessibility—Part 1: Code of practice for creating accessible ICT products and services" [50]. In this case, it highlights the need to implement ICT systems, products and services that are accessible to the diversity of users, including people with particular needs and elderly.

In the same direction, the harmonised European standard EN 301 549 v3.2.1 (2021) "Accessibility requirements for ICT products and services" provides instructions on the accessibility requirements applicable to ICT products and services with reference to the diversity of users [51]. This supports the application of the "European Accessibility Act"—882/2019 Directive related to the accessibility of products and services [52]. The document foresees to provide information through "more than one sensory channel", to render it understandable and present it in perceivable ways. It will be necessary to allow "sufficient and flexible time for interaction" [52], foreseeing, among other, the possibility for a non-visual use, a use with limited sight, with limited hearing or with limited cognitive abilities. Thus, more than one way for transferring information should be considered to increase accessibility.

With specific reference to online content, the "Web Accessibility Directive" and different guidelines orient towards providing content in an accessible manner [53]. In this sense, the Web Content Accessibility Guidelines (WCAG) highlight the need for content to be perceivable, operable, understandable, and robust. They should be adaptable and provide alternatives to written text also in formats that respond to particular needs, e.g., in Braille, simplified languages, etc. The same document provides instructions regarding the use of colour, audio control, minimum contrast, text dimensions, characteristics of images, use of audio descriptions, sign language, etc. These guidelines are integrated with instructions for people with specific needs such as cognitive difficulties. These documents may be useful in defining and organising digital content and in sharing information with an extended range of users.

To enhance digital access to cultural heritage, in 2020 UNESCO developed the "Accessible Digital Documentary Heritage—A set of Guidelines for the preparation of documentary heritage in accessible formats for persons with disabilities". To this purpose, some examples of platforms for sharing knowledge are illustrated, such as the Memory of the World UNESCO platform. This collects archive documents, books, manuscripts, letters, maps, photographs from around the world aiming to enhance the conservation of documentary cultural heritage especially in areas of conflict or affected by natural disasters. Universal access to this kind of heritage is fostered by increasing audience awareness. The document provides an evaluation of the platform accessibility level with reference to several criteria requested by the Web Content Accessibility Guidelines WCAG 2.1, i.e., quality of navigation, respect of the necessary colours and contrasts, clarity of links, implementation of alternative texts with reference to images present on the site.

Making knowledge accessible through online museum collections

To date, a process of change has been undertaken by cultural institutions in the "human-centred" direction, where accessibility has gradually transformed into a magnifying glass enabling closer observation of the relationship between museums and audiences [54]. Having access means being able to use, interact, be engaged, and enjoy an object/a space/an artefact [55, 56]. The use of digital can enhance hybrid experiences to increase users' agency and autonomy and thus enable the participation of new categories of audience.

The digital solutions provided by cultural institutions will need to be interconnected with the physical ones to allow users to move and explore freely the artefacts and the related contents within shared spaces, where digital accessibility will provide visitors with "new ways of visualization, engagement, interpretation and meaning making" [57].

It will be useful to shift towards methods and tools able to enhance access to an audience with different needs [58].

Solutions should be configured that are able to communicate through objects, to narrate and remotivate people's knowledge of the past [59]. Museum institutions should be increasingly oriented towards sharing the collections on online platforms to increase audiences' access to all instances produced by museums [54], therefore including the digital field.

In this sense, the Metropolitan Museum of Art (Met) is a representative international example. In 2018, this museum has released a public API (Application Programming Interface) in collaboration with Google, making available to users the continuously updating collection. In fact, if at launch 200,000 artefacts were shared online, nowadays the collection contains more than 490,000 artworks that explore more than 5000 years of history. These artworks can be freely visualised on the platform with reference to the curatorial area, e.g., "American Art", "Asian Art", "Drawings and Prints", or in relation to specific topics such as "Architecture", "Contemplation", "Skies", "Portraits", etc. The selection of one of the identified categories redirects users to a page containing all the related artworks where further filters can be applied to facilitate search of a specific artwork (Fig. 6). Most of these artworks are open access, providing the possibility to download photographs even for commercial uses. The card of the artwork provides general information

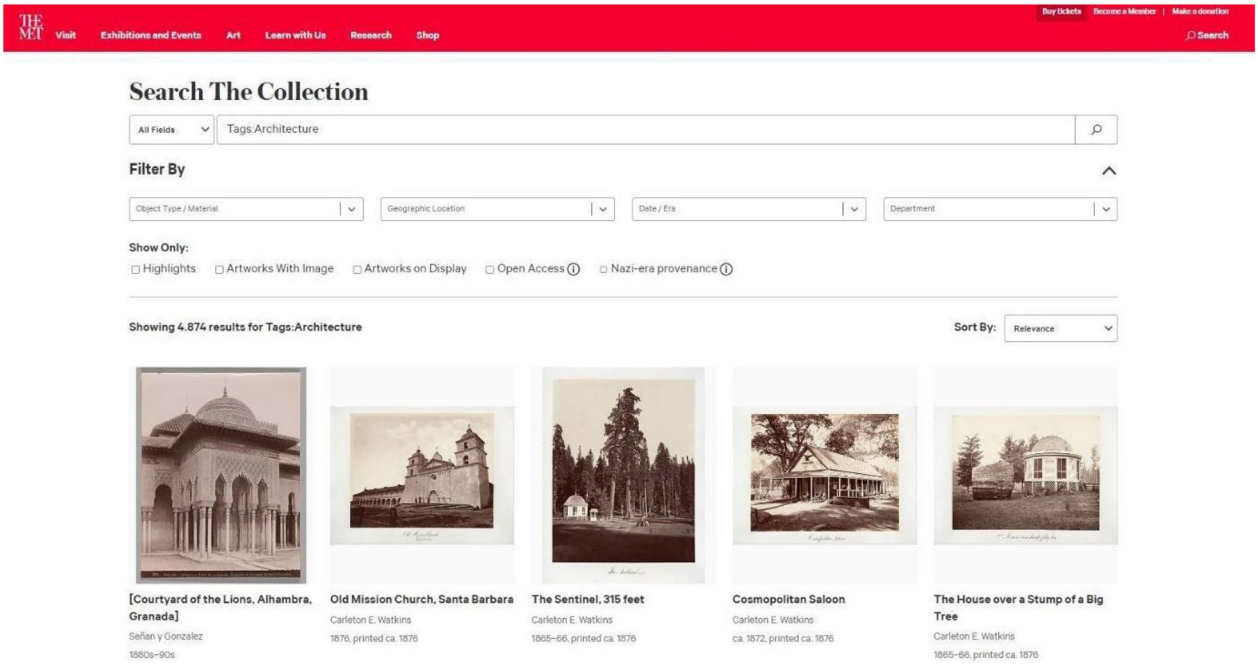

Fig. 6 Online platform of the Metropolitan Museum of Art

on the artefact and on its source, allowing to thoroughly investigate the possible connections with other artworks or exhibitions at the Metropolitan Museum of Art. With reference to the specific selected artworks within the collection, detailed descriptions or the delivery through accessible languages such as Braille, LIS, Augmentative and alternative Communication, seem to be not yet adequately addressed. In some cases, videos are shared for further information and other resources are to be found on the museum website.

An interesting approach is that of the Rijksmuseum in the Netherlands. On the museum's online platform, content organised with reference to the main artists of the collection are shared, also providing the opportunity to explore more than 777,052 artworks. Through the "Closer to Johannes Vermeer" section, details of the selected artworks can be explored through enlargements that would be hardly visible *in loco*. Therefore, the platform encourages visitors in exploring minimal details of the artworks through high resolution photographs, through immersive narratives, and by providing the possibility to create a "personal collection". In fact, the platform offers different opportunities for enjoyment and use, from the guided virtual tour through a narrative voice, i.e., "With Stephen Fry", to the "Discover for yourself" tour. In this case, artworks can be selected and explored through insights on specific aspects referred to the painter's works (Fig. 7). This represents an innovative way to transfer information in order to increase accessibility of artworks and include

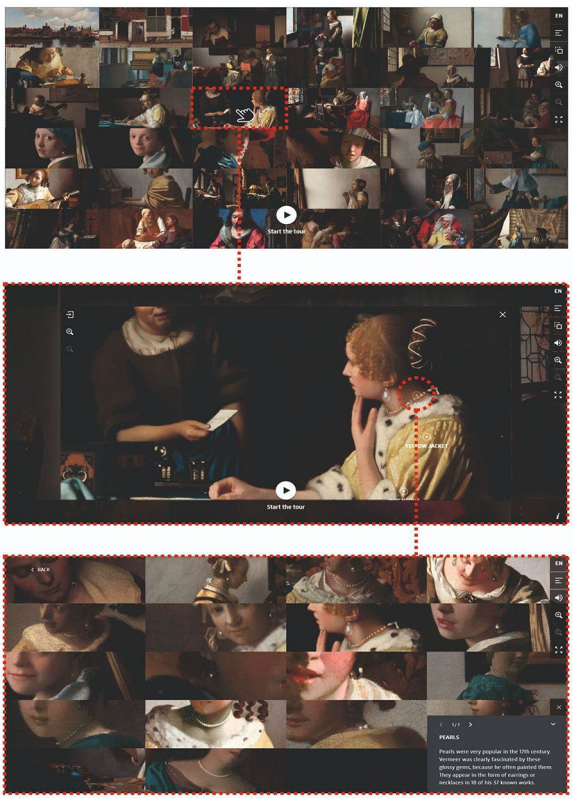

Fig. 7 Insights of the artworks through the Closer to Johannes Vermeer platform

visitors in the research process providing different methods for detailed exploration.

Moreover, the example of the British Museum is of particular relevance, where the online collection offers insights regarding the narrative of the selected artworks through texts and images. Also in this case, there seems to be no evidence of delivering specific content on the selected artworks through inclusive languages and the possibility to enjoy and use information through sensory channels other than sight is not yet sufficiently developed.

In this direction, the Canadian Museum for Human Rights provides instructions for sharing artefacts in an accessible way both on site and online through the "Inclusive and Accessible Design Guidelines". They suggest standards for the exhibit design as well as instructions for writing texts with reference to the artworks and regarding tools for content sharing (video, immersive media, interactive media, design of inclusive interfaces, etc.). For sharing content on the web, these guidelines refer to the instructions provided by the World Wide Web Consortium W3C (cfr. "Digital as a "tool" to increase accessibility to information" section).

From the configuration of online platforms for sharing cultural content, the digital dimension provides an opportunity to explore exhibitions through interconnected narratives and through virtual tours. For example, in the case of the Vatican Museums, the digital reconstruction of some of the rooms allows remote enjoyment and use by exploring the environments and the artefacts.

Furthermore, anticipating instructions represents an essential feature to allow enjoyment and use especially for visitors with cognitive difficulties, with reference to spatial organisation, to the layout of artefacts and to the sensory stations.

Multimodality to amplify knowledge access

Making cultural heritage accessible and inclusive implies updating content and the message transferred to users in order to reach a wide audience and adapt to visitors [60]. Tools cannot be designed without taking into consideration who is represented in the artworks, whose story is being narrated and how visitors will interact with it [61].

When sharing content through digital tools, adaptive languages and inclusive ways for the representation and transfer of information are required to satisfy the needs of users with cognitive, visual, sensory impairments and with reference to previous knowledge.

The paths for the enjoyment and use of cultural heritage are usually addressing a specific category of users when they should be instead considering the audience diversity extending the range of users. It is even more evident how for example in paths addressing a specific "category" of impaired users, the levels of previous knowledge and the motivation for the visit are not taken into consideration. It is necessary to go beyond the risk of the "ghetto effect" by reaffirming the different abilities [54] through content bound for specific targets and instead consider providing adaptive contents able to satisfy the diversity of users [41].

Museums are looking for a better comprehension of the past fostering inclusion also through the works shared with the public. They are trying to avoid generalisations and highlight "micro-stories" about the reference communities, sequences of everyday life in relation to the visitor's experience, autobiographical documents and personal testimonies with an impact on the structure and organisation of content both in the physical and digital environment [59]. An effective narrative activates an emotional involvement in users and guides them, almost unconsciously, into a multifaceted process of knowledge transfer.

The National Association for Interpretation in the United States of America defines the interpretation of cultural heritage as a communication process that creates emotional and intellectual connections between the audience's interests and the resource significance [62]. Shawn et al. [63] have classified narratives based on scale, distinguishing between *long narratives* related to historical periods and communicated by museums, and *short narratives* represented by the stories told by (real or imaginary) characters from the historical period enabling the creation of a personal connection of visitors with that historical period. The short narratives may also be represented by visitors' feedback with reference to the experience of enjoyment and use [64].

The integration of interactive, "easy to read", audio and video content, may extend access to a diversified audience. Furthermore, providing the possibility to enjoy experience according to their own time becomes a fundamental aspect to also open cultural heritage to neurodiversity, as well as the use of audio guides to facilitate the sensory processing [65].

In order to make content accessible to a wide audience, cultural institutions are oriented towards providing them not only through graphical and textual information but also through audio descriptions and/or inclusive languages. The *Easy Access for Social Inclusion Training* (EASIT) project from the Universitat Autonoma de Barcelona is an interesting example for the definition of accessible languages [66]. This provides instructions on how to render information "easily understandable" with reference to methods like "Easy-to-Read" and "Plain Language".

In the same direction, the "Accessibility and Inclusion Toolkit" from the British Columbia stands out. This

provides specific instructions on the construction of digital content for different users both with reference to sensory accessibility and to cultural diversity, to the level of literacy, to the need to transfer multilingual information, etc. It also regards information about the construction of digital content concerning colours and contrasts, sharing documents, images, videos and multimedia, texts, etc.

Some museums have started sharing information through audio content on site or through online platforms, providing the possibility to listen to the narratives both remotely or during the on-site tour. The use of audio descriptions is useful to increase information levels shared with visitors and at the same time to extend the target of users also to blind or sight impaired people. In some cases, verbal descriptions are provided, distinguishing them from audio descriptions since they provide increasingly evocative information [67]. In fact, verbal descriptions have the potential to stimulate mental images that enable users-visitors to "enter" the story even only through audio, thus increasing inclusion and contributing to immersion in the experience [68].

Some studies have proved that verbal descriptions contribute to rendering content accessible also to users with sight impairments, but in these cases the mental representation is mainly influenced by the motor or haptic sensations [68]. This aspect should be taken into consideration in creating audio content according to the visitors' needs or preferences [68]. In this sense, there are particular critical points in the ways of describing the visual characteristics and in stimulating the creation of mental images able to increase understanding and enjoyment of artefacts.

Knowledge and perceptions contribute to the interpretation and to the aesthetic experience of artefacts. Therefore, when creating descriptions, it is important to select the relevant aspects to be transferred to the visitor, respecting the aim of the artwork, and "translating" its message in order to satisfy the different users' needs [68]. To enhance accessibility, it is necessary to take into consideration both visual aspects of the artefacts and the cognitive, social, and emotional ones [67].

Despite the importance of audio descriptions to increase accessibility to cultural heritage, there are still no regulations regarding their use. There are difficulties both in selecting content to be delivered and in choosing the features of the artefacts or the ways to provide details [67]. Furthermore, the existing guidelines in the field are different between countries, with variations between Europe and the United States of America [56, 67].To render audio descriptions accessible, specific criteria should be respected, such as the use of a clear and precise language [69], taking into consideration the heterogeneity of users-visitors in terms of physical needs (e.g., users with visual impairments) and with reference to the cultural background, familiarity with specialised languages and with artistic content [70]. The description should be brief but informational, objective, and evocative at the same time, focused on content but also intriguing, and it should avoid the use of very complex structures or "exuberant" vocabulary [71].

Within the description, it is important to provide information on the mood and on emotions, to describe facial expressions, gaze, gestures, posture, or other elements that might be present in an artwork to build a more detailed context able to solicit empathy and involve users in the process of enjoyment and use. To increase accessibility, other senses may also be used in describing surfaces, for example by introducing details on the tactile properties of a material [68].

Audio descriptions/tracks normally used by museums vary between 3 and 5 min and they can be found on museum websites, mobile applications and within media devices on site [68]. In Europe, audio descriptions are of an average of 3 min (varying between 1,5 and 10 min), while in the United States they are of an average of 4 min long (between 2 and 20 min) [67]. The example of the digital collection of the Museum of Modern Art MoMA, New York, is of particular interest, where artefacts are interconnected and there is often the possibility of enjoyment and use also through audio descriptions. The descriptions are different with reference to the delivery time and to the different target users they address.

Accessibility in all its forms becomes an "enabler of rights" and a "prerequisite for the full participation" fostering "equal opportunities in the access to […] culture" [72]. It means opening cultural places to a wide audience to increase inclusion.

Conclusion

Starting from the Italian context, the paper has analysed the current models for the digital organisation of knowledge comparing them with the international scene. The analysis of systems for cataloguing and sharing information on cultural heritage highlights the multidimensionality of each artefact and the strong tendency of "relating" with other artefacts and contexts through dynamic exchanges.

In order to create value chains in such a structured ecosystem, it is necessary to identify languages, forms of communication and technological solutions capable of representing the semantic stratification of "digital products", limiting the dispersive power of the network [13]. This activates "instantaneous" approaches to information to the detriment of "multilayered" knowledge of the artefacts.

In this direction, Semantic Web technologies represent the tool to enhance cultural collections and ensure the enrichment of cognitive experiences, necessary for providing user access. The trajectory shifting from objects to relationships aims to allow an interdependent ecosystem able to enhance the semantic capital, the true wealth of the public information heritage. This change provides the possibility to create new knowledge models, located at the heart of the organisation of cultural institutions [13].

At the national level, the absence of a "knowledge space" can be highlighted, within which the organisation and dissemination of continuously updated cultural information can be satisfied with reference to sources, research, and the definition of diversified target groups.

The survey of the main sources, from guidebooks to systems and platforms for digital storytelling and sharing-generated guides, highlighted the complexity and richness of cultural content.

Museum and tourist audio guides and platforms dedicated to cultural tourism will require a content approach characterised by a *dynamic* and diverse use of information and communication interfaces and technologies based on human–machine interaction, on user experience and intelligent access to information. These are to be combined with a rigorous and accurate selection and comparison of sources for processing and delivery of quality cultural content [73] by structuring organised multi-layered texts that go beyond the visible and linear screen surface [40].

The future goal of "open" and accessible data will be to intercept the users' needs. This will serve to make the artefacts-related content available in different forms and ways, using technologies to build digital connections networks for continuously nourishing knowledge.

Adaptive exchanges between users and cultural heritage will have to be activated in order to increase multidimensionality and multisensoriality of artefacts and of the collections "immersed" in a space with "permeable" boundaries, as well as that of the digital dimension. This can multiply the layers of information and amplify the sensory perceptions of an extended range of users. The diversification of the ways for transferring information becomes fundamental to also stimulate senses different from sight and therefore engage an increasingly wide audience.

In this sense, the potential of audio descriptions emerges in the process of knowledge sharing to provide personalised information with reference to the different user needs.

In order to make cultural heritage accessible, usable, transferable, and sustainable, it is necessary to accelerate in the direction of digitisation, modelling, interoperability of content and sources, terminologies, and long-term preservation [74]. Focused processes of planning and design need to be activated in order to allow living the emotional visiting experience fully, beyond their specific needs, to whomever wants to share the invaluable cultural heritage [75].

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