Unraveling the geographical maze: extracting Place information for enhanced metadata enrichment at SearchCulture.gr

Agathi Papanoti [0000-0002-3564-6739] and Elena Lagoudi [0000-0002-3431-4513], Georgia Angelaki [0000-0001-6360-2664], Haris Georgiadis [0000-0003-1137-6583]

[1] National Documentation Centre, Greece
apapano@ekt.gr

Abstract. In the pursuit of making cultural heritage more intellectually accessible to a broader audience, the Greek Cultural Aggregator, SearchCulture.gr, recently underwent a transformation- adding map-based discovery to its services.

This paper aims to delve into the methodology of semantic enrichments of spatial metadata using state-of-the-art semantic technologies and to discuss how transforming Searchculture.gr into a portal where geospatial data can be visualized, queried, and interlinked is fostering intellectual accessibility and adding value to cultural data. Furthermore, related initiatives are presented which apply customizable, expert-assisted semantic enrichment strategies with the scope to improve data quality, disambiguation, and multilingual capabilities in cultural heritage collections

Keywords: Digital Cultural Heritage, Semantic Enrichments, Geospatial Information, Data aggregators, LOD Vocabularies.

1 Introduction

Since 2015, SearchCulture.gr, the Greek cross-domain Cultural Content Aggregator, developed by the National Documentation Centre in Greece (EKT), has collected a growing number of more than 815.000 digitized Cultural Heritage Objects (CHOs) from a multitude of cultural institutions.

With the goal to tackle metadata heterogeneity - the biggest challenge a large cross-domain aggregator faces – SearchCulture.gr, as part of its aggregation workflow, applies semantic enrichment to EDM properties that refer to contextual entities such as Types, Agents, Time Spans, Subjects/Concepts and recently Places.

Our enrichment strategy deploys state-of-the-art tools, a systematic approach and expert human validation and curation mechanisms achieving high quality and retrieval precision. It semantically links people, topics, places and types of items opening new insights into Greek cultural heritage. It also constitutes a solid ground on which other interested parties can build on, since our vocabularies are provided via APIs with an open license.

This paper presents the journey of transforming the aggregator into a portal where geospatial metadata can be visualized, queried, and interlinked. With an output of 585,000 items enriched with geolocation and a Geonames-based Vocabulary of more than 12,000 terms as well as an interactive map of CHOs, the project contributed to fostering deeper and wider community engagement with digital cultural heritage.

The paper explores the variability in how content providers document spatial information and discusses the effort of extracting geographical information from metadata, presenting a flexible methodology for extracting, disambiguating, and enriching such data, which involves, among other issues, solving identity puzzles, and capturing spatio-temporality by adding historic toponyms as alternative names.

Furthermore, the article explores the intricacies of disambiguating place names, especially in regions with rich historical contexts, and presents the output of this effort emphasizing the significance of map-based discovery tools in understanding and engaging with cultural heritage.

2 Background

2.1 The enrichment scheme for SearchCulture.gr

The enrichment scheme in SearchCulture.gr involves linking metadata of Cultural Heritage Objects (CHOs) to terms from Linked Open Data (LOD) vocabularies using curated mappings. This is implemented via Semantics.gr, a platform developed by EKT for managing vocabularies and thesauri as LOD[1]. The platform's Mapping Tool enables bulk data enrichment by allowing curators to map source metadata to target vocabulary terms, using automated suggestions and manual curation. These mappings are provided through a RESTful API in JSON format for easy integration.

In the past four bilingual vocabularies covering Types, Historical Periods [2], Subjects and Persons [3] were created and used to enable advanced multilingual search and browsing. Our main scope was to cover the basic search parameters facilitating discovery in an aggregator. Having enriched SearchCulture.gr collections with structured metadata that answer the key questions – What (types' enrichment), What is it about (subjects' enrichment), When (chronological homogenization and historical periods), Who (agent/persons' enrichment)- the next vital discovery service would be Where.

3 Methodology

3.1 Harvesting Place: the challenges of extracting geographical information

In the context of aggregation, place metadata are important as access enhancers and facilitate cultural discovery. Most content providers provide their metadata in aggregation schemata that are based on Dublin Core (such as EDM [4]). Europeana developed EDM specifically to address issues around resource aggregation and linked open data, which DC could not fully support alone due to its less expressive nature. EDM, as a

semantically rich model, enhances DC by integrating it with other metadata standards, but the inherent simplicity of DC can limit expressiveness for more detailed metadata needs, such as contextual information specific to cultural heritage items or layered metadata for complex digital objects like multimedia or multi-part collections. Both DC and EDM have been critiqued [5] for lacking the granularity required for complex metadata representation, especially when it comes to fully describing nuanced or multi-faceted cultural heritage items in sufficient detail.

In the context of Humanities in general, place-based information plays diverse roles and thus can be expressed in various schemata. Felicetti and Lorenzini [6], [7] describe using CIDOC-CRM, a conceptual reference model, within the Fedora digital repository system to manage metadata related to the physical location, provenance, and spatial context of heritage objects.

In context of Archaeology, place-based metadata are very important when documenting cultural heritage artifacts in fieldwork settings. Here, place information is meticulously recorded as part of a broader context that includes both physical and cultural dimensions, supporting accurate documentation and aiding the digital stewardship of heritage objects in situ, for example MAD (Managing Archaeological Data), an application designed to manage structured and un- structured archaeological excavation datasets in order to create complete XML-based systems [7].

In an aggregation context, aiding discovery is the key goal. When ingested, digital collections include metadata about place- usually embedded in a range of data fields. In Dublin Core and subsequently EDM, an item's geographical information is represented in dcterms:spatial or dc:coverage. A toponym in dcterms:spatial can indicate the place where the item was created or the place it refers to. Respectively, dc:coverage besides containing both spatial and temporal information, vaguely refers to the object's spatial applicability or thematic relevance. Additionally, crucial spatial information was often not found in spatial fields but instead in other descriptive fields, such as the title, the description, or even in non-spatial-specific fields like the subject.

A starting point was to capture the way each content provider recorded spatial information for their data and develop a flexible methodology adjusted to each digital collection. As with our previous enrichments, typical challenges included grammatical errors and foreign characters. However, some difficulties were specific to location-based information in the source metadata of the content providers, for example recurrent placenames- such as villages with Saint names (e.g. St. Anna) or generic descriptive toponyms (e.g. Castle). There were also cases of synonyms, such as "Tripolis", which is the name of more than 10 settlements, both ancient and current, all around the Mediterranean. Another issue was the use of an exonym rather than an endonym, Greek adaptations of foreign names and alternative names in the source metadata.

3.2 Methodology of enrichments

The key aim of the enrichment scheme was to emphasize "Place" as a critical property of cultural heritage items and to clarify how different datasets refer to the same location, despite varied expressions and levels of granularity. The search functionality had to account for all historical and current alternative names of a place and help users

disambiguate between synonymous terms. For instance, a search for “Seleucia” should present all results: “Seleucia of Caria,” “Seleucia on the Pyramus,” and “Seleucia of Pisidia,” with additional information like their modern names (Aydin, Misis, and Bayat) to assist in selection.

Additionally, hierarchical searches were to be enabled, reflecting mereology relationships, so a search for "Attica" would also retrieve items related to places within Attica, such as Athens, the Parthenon, or Piraeus. The goal was also to facilitate map-based discovery by using place-based values to locate items geographically. To achieve these aims, the methodology adhered to the following:

- Extracting geographical information from various fields across collections through multiple enrichment iterations
- Solving identity puzzles by linking different data points (e.g., toponym, geographical position) to a single locality
- Capturing spatio-temporality by adding historic toponyms as Alternative Names to modern place names
- Addressing the needs of native users who might search using historical Hellenic exonyms instead of modern foreign endonyms

3.3 Disambiguating the palimpsest of Greek Placenames throughout history

In the Mediterranean regions, the palimpsest of toponyms mirrors stratifications of regimes, occupations, relocations, and conquests [8]. Disambiguating placenames from the source documentation often involved extensive research, as several of these toponyms appeared in the aggregated metadata when a placename changed at different time periods.

Especially in Asia Minor, where Hellenic presence has a 10-century history, the process of capturing in semantic terms the spatio-temporal changes in toponyms was of particular importance for the project.

Matching Greek exonyms with the corresponding endonyms was a challenge. Most refugee archives document their content using the Greek placenames and not their official Turkish names established after the end of the Greco-Turkish war in 1922. There was also the issue of transliteration of Turkish names with Greek characters. Especially in the case of landmarks related to the GrecoTurkish War of 1919-1922 the lack of use of the official placenames in Turkish led us to extensive research in military archives. For example, a Turkish village was described in a Greek war photograph with the phonetic transcription “Inetzilar” (“Ινετζιλάρ”). The curator in this case had to research the movements of the Greek army at the time indicated in the photograph in war archives. The research indicated that the Turkish placename was İğciler, a fact that could not have been made known without some research.

Another frequent type of change is translocation, when a particular locality changes its geographic location while retaining its name, especially relevant to the earthquake-prone Anatolia. For example, there were cases where entire cities were rebuilt at a near location after a quake or temple systems were dismantled and transferred to another location for restoration or prevention, as is the case of Kalabsha temple in Egypt. The

original documentation placed the temple in the old location, from where it was moved in the 1970s, after the Aswan Dam was built, in order to preserve it.

A decision was made to semantically unify the histories of places in the terms of the Vocabulary, by gathering the successive rewritings of the place through time as Alternative Names and making them searchable. Therefore, for example, if someone is looking for CHOs with 'Seleucia' in the Place field, unaware of the current Turkish toponym, the search will retrieve all the locations that once shared the name, i.e. Seleucia of Caria, Seleucia on the Pyramus, Seleucia of Pisidia, Seleucia of Isauria and Seleucia of Pieria, which in Turkish today are respectively Aydin, Misis, Bayat, Siflike and Samandag.

On the domestic front, there were cases of toponyms that are common in Greece, such as villages with Virgin Mary of Saint names or generic names indicating a land feature such as Kastraki (Little Castle), Pigi (Water Spring) etc. Synonym cross border cities were an issue too, for example Tripolis is a placename that refers to a city in Greece, the second largest city of Lebanon and the capital of Libya, not to mention 10 more ancient or medieval cities throughout the Mediterranean.

Another problem was the renaming of many Greek settlements, which took place quite often in the Hellenic state, from1831 and up until 2011. Reflecting the necessity of new toponyms that would capture the "unity of Hellenism in space and time", more than 5.000 settlements were renamed. For example, the village Gropino-Γκρόπινο (which is a bulgarian name) in 1928 was renamed Tropino-Τρόπινο in an attempt to "hellenize" the name. Later in 1940 it was renamed Valtolivado-Βαλτολείβαδο (a name indicative of its natural environment as it translates "meadow with swamps") and finally in 1961 it was again renamed Daphne-Δάφνη (Laurel). In a notary document of 1930, the spatial information value would be "Τρόπινο " a placename not in use for the past 80 years, thus obliging the enrichments' curator to conduct extensive research in several databases to assign the correct geoname.

A smaller but interesting challenge was achieving the right granularity in cases whereby the tool does not differentiate between administrative divisions with the same name. In such cases, the mapping tool always picks the same entity (based on the administrative order of the vocabulary), which can result in partial (and approximate) enrichments. For example, for the named reference Chios the Mapping Tool always suggested the Regional Unit Chios which includes 3 islands, one of which is Chios Island. In these cases, the curation process was necessary to achieve the right granularity by picking the right term in the hierarchy.

Finally, a less frequent problem had to do with vagueness and descriptive information in geospatial fields. Places related to CHOs are often qualified by such terms as "near," and "north of," which made the disambiguation search often demanding.

Sometimes spatial data included temporal and even imagined conceptions of place [9], such as "Arcadia", "Elysian Fields" or spatio-temporal, for example "Cycladic Aegean" or "Minoan Crete", as well as extinct kingdoms and empires, such as "Phrygia", "Lydia", "Byzantium" etc.

3.4 Adapting the enrichment scheme for Places

A new field titled "EKT Place" was added to hold URI references to a custom Vocabulary of Places developed in Semantics.gr. For each collection, Mapping Forms were created to map spatial metadata values to terms from this vocabulary. The tool provided suggestions which curators confirmed, corrected, or refined. When no match was found, terms were added to the vocabulary.

GeoNames, a global geographical database, served as the basis for this vocabulary. GeoNames contains over 11 million places with multiple names, coordinates, and administrative subdivisions. We created two derivative vocabularies instead of using GeoNames directly to manage entry numbers, adjust administrative hierarchies, and add useful information such as bibliographic references.

Using the GeoNames API, a "starter set" of approximately 6,000 terms was selected, focusing on major administrative levels and cities with populations over 100,000 globally. For Greece, more detailed thresholds were used, including smaller settlements.

The "Vocabulary of geographical names GeoNames (EKT version)" [10] is hierarchical, bilingual (Greek and English), and conforms to the edm:Place class of EDM. A supplementary EKT vocabulary [11] was also developed to include features beyond the main administrative hierarchy, such as historical areas (e.g., Soviet Union), regions spanning multiple states (e.g., the Balkans), and geomorphological elements (e.g., rivers). This supplementary vocabulary is linked to the main vocabulary using custom fields ekt:isPartOfMatch and ekt:hasPartMatch, which indicate hierarchical relationships without conflicting with the administrative structure.

To facilitate this process, an extension was created for the Mapping Form of Semantics.gr to search and import GeoNames terms directly into the enrichment form. This allows curators to search the GeoNames database and import relevant terms efficiently.

Spatial fields (dcterms:spatial or dc:coverage) were mapped for most collections. Subsequently, enrichments were conducted in descriptive fields (dc:title, dc:description) and structured fields (dc:subject) for collections lacking precise spatial metadata. This process led to a critical mass of terms in the vocabularies, increasing the likelihood of mapping toponyms in non-spatial fields during subsequent enrichments.

3.5 Contextual resources

In this process, historical gazetteers such as Pleiades, Pelagios, and the Archaeological Atlas of Antiquity (Vici.org) were used as reference materials. Despite the limitations noted by Garbacz et al. [12]-specifically that these gazetteers focus more on storing historical information in a computer system than making it “computer-readable”-they were invaluable for curators in disambiguating ancient sites.

Pelagios Network’s “World Historical Gazetteer” was used more extensively for cross-referencing place identifications. Pelagios Network is critical in advancing the field, as it outlines a framework for linking historical places using open data and Linked Open Data (LOD) principles, aiming to foster greater interoperability among historical and cultural heritage data. While this approach has commendable strengths, particularly in enhancing accessibility and enabling cross-dataset connections, some critiques arise

regarding its reliance on LOD infrastructure. The assumption that all users possess the technical expertise to engage with LOD may limit broader usability, especially for smaller institutions without dedicated resources for managing linked data. Additionally, the reliance on LOD requires continuous maintenance and data quality control to avoid inconsistencies or link rot over time. However, the Pelagios framework is a valuable initiative that encourages collaboration and makes historical geographic information more accessible for scholarly and public applications.

Wikipedia was also utilized, often consulting versions in various languages, as the Greek articles frequently differed from the English and German ones in terms of historical toponymy.

Additionally, diverse sources like community blogs and pages documenting Asia Minor history from a refugee perspective, such as *The Historical Archive of Refugee Hellenism* [13] provided useful information. This inquiry offered valuable insights into toponym changes post-1922, a significant period for place name changes in Greece and Turkey due to large-scale population exchanges following the Greco-Turkish War.

3.6 Output

By leveraging the Apache Solr [14] search platform and a custom indexing scheme, SearchCulture.gr now offers enhanced multilingual search and browsing functionalities that significantly improve discoverability. Key features include:

- Searching by place using a controlled hierarchical list.
- Hierarchical navigation and faceting for places.
- An interactive tag cloud of place names.
- Displaying alternative labels and direct links to vocabularies and GeoNames.org for easier selection of the correct place.
- Enhanced item pages with location maps showing all related places.

Geospatial data visualizations were emphasized using OpenStreetMap. Open-source, community-driven tools like OpenStreetMap (OSM) and Geonames offer unique benefits compared to traditional GIS systems, particularly in accessibility, adaptability, and up-to-date data. Unlike proprietary GIS platforms, these tools are free to use, making them accessible to organizations of all sizes and resource levels. The crowd-sourced nature of OSM means it's continually updated by a global community, ensuring that changes to infrastructure, new developments, and other geographic features are quickly reflected. This is particularly valuable in rapidly changing or underserved areas where traditional GIS data might lag. Geonames enhances this by providing a vast database of geographic names and coordinates, enabling easy integration of place-based information. Both tools also support custom, user-generated data layers, allowing communities and researchers to adapt the data specifically to their needs without the restrictions of commercial licenses

Due to the large volume of data, results are grouped in clusters on the map, with different colors indicating the density of items in each location. The map-based discovery and interactive navigation increase accessibility and provide a visual understanding of the geographical reach and record density of Hellenism.

Search and navigation results can be displayed in a grid (default) or on an interactive map. The map shows the number of items per place or cluster, allowing users to navigate by clicking on clusters or places of interest and retrieve items within the current map frame.

Additionally, this visualization feature was integrated into Thematic Exhibitions. Ten new exhibitions focusing on Asia Minor illustrate the rich geolocated cultural assets and reflect the historical areas, empires, and peoples of the region.

4 Related Work

Different semantic enrichment strategies are adopted by large cultural heritage aggregators as a means to contextualize resources, disambiguate, add multinguality and offer search and browsing functionalities across multiple heterogenous source datasets. The EuropeanaTech TaskForce on Multilingual and Semantic Enrichment Strategy [15], [16] identified a number of issues affecting semantic enrichments and made a number of recommendations to improve data quality and resulting semantic enrichments by providers: use of URIs at source metadata, careful choice of the target vocabularies to fit the context of the records to be enriched, development of reference resources by providers and aggregators for certain metadata fields with limited amount of values that would be less error-prone. Acknowledging that no one size fits all, the design of a customized enrichment strategy that considers the particularities, language and context of a given dataset is stressed.

Europeana uses automatic text linking between the source dcterms:spatial and dc:coverage fields and Geonames [17]. However automated enrichment approaches on structured fields, also with respect to geolocations mostly adopt an “enrich-if-you-can” strategy, horizontally, resulting in low enrichment coverage and high percentage of mistakes [15] therefore unable to be exploited for building advanced search functionalities [18]. For example, in the case of Europeana the tool is unable to discern between different levels of administrative division with the same name, therefore always picking the same entity as reported in [15], [19].

The comparative evaluation performed by EuropeanaTech Task Force [16] of different automatic and semi-automatic enrichment tools largely confirms the problems with original data quality issues identified in the previous report. Different endeavors are therefore investigating involving human-in-the loop to complement automatically produced enrichments. SAGE[20], a semantic enrichment and validation platform developed by the National Technical University of Athens deploys state-of-the-art AI tools assisted by human-in-the-loop validation mechanisms. The platform has been applied in the context of several Europeana-related projects (XX, Pagode-Europeana China and CRAFTED) also with regards to place-name enrichments [15], [16]. Crowdsourcing and in particular niche-sourcing which taps into expert knowledge, has been investigated to add clarity, disambiguate or provide geolocation information. NTUA has also developed CROWDHERITAGE as a crowdsourcing platform for geotagging and validating geo-tags [21].

Among the national initiatives, the work at the Finnish CultureSampo portal [22] stands out. The portal is based on the FinnONTO collaborative network of ontologies. With regards to location-based enrichments CultureSampo utilizes a geographical registry of 800,000 places in Finland, a spatiotemporal ontology of historical Finnish municipalities 1865–2007 [23]. Some manual processing is performed in order to refine the semantic thesaurus relations into full-blown subsumption hierarchies with the use of entity extraction and validation tools. An innovation of Culture Sampo is that it includes the temporal and historical aspect on the visualization of resources on maps, something that forms part of our future work.

Among the various domain and thematic aggregators of Europeana, some demand the data is enriched prior to ingestion, transferring the responsibility to the providers [24], others undertake semantic enrichment post-ingestion [25], while the majority just indexes string data without applying any semantic enrichment before delivering data to Europeana. Place-based search is offered by Deutsche Fotothek[26] and the German Digital Library[27]. Kringla[28] offers province-based filtering and map-based search but geolocating only a fraction of the objects on the map and only in Swedish.

Given the related efforts, the semantic enrichment scheme that we present in this paper, achieves high coverage and effective disambiguation because i) it adjusts to the documentation particularities of the individual collections ii) it combines self-improving, automatic and fuzzy-based suggestions with a suite of tools that support the curation process and iii) uses a compact target vocabulary that is gradually expanded to cover the needs of the specific datasets iv) it involves expert knowledge in the process of validation.

5 Conclusions

Maps, one of humanity's oldest forms of communication, are here exploited to their fullest potential through interactivity, combining traditional cartographic clarity with modern data visualization techniques. This not only enhances the graphic quality of the map but also enables a search tool that is highly effective, inclusive, and appealing, allowing users to engage with content in a dynamic and personalized way. The map fosters deeper engagement with Greece's cultural heritage, encouraging users to draw connections between diverse elements of history, place, and tradition.

The interactive cultural heritage map on SearchCulture.gr consolidates vast amounts of information into a visually engaging and accessible format that connects users with both tangible and intangible heritage of Hellenism. By showcasing ancient sites, craft heritage, and elements of intangible culture, the map serves as a gateway to understanding the socio-spatial evolution of Greek identity and cultural practices. These spatial visualizations offer a narrative framework that makes Greek history more accessible, helping users intuitively explore and understand the interplay between geography, history, and cultural expression.

SearchCulture.gr redefines cultural heritage exploration, making the past more accessible and relevant to modern audiences. It enables users to actively participate in a

spatial exploration of history that enhances perspective, enriches understanding, and promotes a profound connection with the depth and breadth of Greek cultural heritage.

References

1. Georgiadis, H. et al. (2022). Publishing LOD Vocabularies in Any Schema with Semantics.gr. In: Garoufallou, E., Ovalle-Perandones, MA., Vlachidis, A. (eds) Metadata and Semantic Research. MTSR 2021. Communications in Computer and Information Science, vol 1537. Springer, Cham. https://doi.org/10.1007/978-3-030-98876-0_25
2. Haris Georgiadis, Agathi Papanoti, Maria Paschou, Alexandra Roubani, Despoina Chardouveli, Evi Sachini, Using type and temporal semantic enrichment to boost content discoverability and multilingualism in the Greek cultural aggregator SearchCulture.gr. Int. J. Metadata, Semantics and Ontologies, 2018, Vol. 13, No. 1, pp.75–92.
3. Georgiadis, H. *et al.* (2022). Enriching the Greek National Cultural Aggregator with Key Figures in Greek History and Culture: Challenges, Methodology, Tools and Outputs. In: Silvello, G., *et al.* Linking Theory and Practice of Digital Libraries. TPDL 2022. Lecture Notes in Computer Science, vol 13541. Springer, Cham. https://doi.org/10.1007/978-3-031-16802-4_4
4. Europeana Data Model Primer, accessed on 2024/11/21
5. Kakali, C., Lourdi, I., Stasinopoulou, T., Bountouri, L., Papatheodorou, C., Doerr, M., & Gergatsoulis, M. (2007). Integrating Dublin Core Metadata for Cultural Heritage Collections Using Ontologies. *International Conference on Dublin Core and Metadata Applications*, *2007*. https://doi.org/10.23106/dcmi.952108714
6. Felicetti, A., & Lorenzini, M. (2007). Spatial and non-spatial archaeological data integration using MAD. Layers of Perception, Proc. of the 35th CAA International Conference on Computer Applications and Quantitative Methods in Archaeology, Edited by A. Posluschny, K. Lambers, I. Herzog.
7. Felicetti, A., D'Andrea, A., Perlingieri, C., & Lorenzini, M. (2008). Spatial and non-spatial archaeological data integration using MAD. Layer of Perception. Advanced Technological Means to Illuminate Our Past. Berlino, 2-7 - 9-Aprile 2007, BONN: Rudolf Habelt, ISBN/ISSN: 978-3-7749-3556-3
8. Woodard, R. D. (Ed.). (2008). *The Ancient Languages of Asia Minor*. Cambridge: Cambridge University Press.
9. Loukissas, Y. A. (2016). A place for Big Data: Close and distant readings of accessions data from the Arnold Arboretum. Big Data & Society, 3(2). https://doi.org/10.1177/2053951716661365
10. https://www.semantics.gr/authorities/vocabularies/geonames-places-earth, accessed on 2024/11/21
11. https://www.semantics.gr/authorities/vocabularies/geonames-supplementary-places, accessed on 2024/11/21
12. Garbacz, P., Szady, B., & Ławrynowicz, A. (2021). Identity of historical localities in information systems. Applied Ontology, 16(1), 55–86. https://doi.org/10.3233/AO-200235
13. The Historical Archive of Refugee Hellenism Ιστορικό Αρχείο Προσφυγικού Ελληνισμού – ΙΑΠΕ – Δήμου Καλαμαριάς accessed at 11/5/2024
14. Welcome to Apache Solr - Apache Solr accessed at 11/6/2024
15. Manguinhas, H. et al. (2016). Exploring Comparative Evaluation of Semantic Enrichment Tools for Cultural Heritage Metadata. In: Fuhr, N., Kovács, L., Risse, T., Nejdl, W. (eds) Research and Advanced Technology for Digital Libraries. TPDL 2016. Lecture Notes in

Computer Science(), vol 9819. Springer, Cham. https://doi.org/10.1007/978-3-319-43997-6_21
16. EuropeanaTech Task Force on a Multilingual and Semantic Enrichment Strategy: final report, https://pro.europeana.eu/files/Europeana_Professional/EuropeanaTech/EuropeanaTech_taskforces/MultilingualSemanticEnrichment/Multilingual%20Semantic%20Enrichment%20report.pdf
17. Stiller, J., Petras, V., Gäde, M., Isaac, A.: Automatic Enrichments with Controlled Vocabularies in Europeana: Challenges and Consequences. EuroMed: 238-247 (2014)
18. Gavrilis, D. and Ioannides, M. and Theofanous, E.: Cultural Heritage Content Re-Use: An Aggregators's Point of View, ISPRS. II-5/W3: 83-87 (2015)
19. Manguinhas H., Europeana Semantic Enrichment Framework, technical documentation 2016, available at https://docs.google.com/document/d/1JvjrWMTpMIH7WnuieNqcT0zpJAXUPo6x4uMBj1pEx0Y/edit#heading=h.bz78ahr21sjd and https://pro.europeana.eu/page/europeana-semantic-enrichment
20. Kaldeli, Eirini, Combining AI tools with human validation to enrich cultural heritage metadata, https://pro.europeana.eu/post/combining-ai-tools-with-human-validation-to-enrich-cultural-heritage-metadata
21. Kaldeli, Eirini, Orfeas Menis-Mastromichalakis, Spyros Bekiaris, Maria Ralli, Vassilis Tzouvaras, and Giorgos Stamou. 2021. "CrowdHeritage: Crowdsourcing for Improving the Quality of Cultural Heritage Metadata" Information 12, no. 2: 64. https://doi.org/10.3390/info12020064
22. Hyvonen, E., et al., CultureSampo - Finnish Culture on the Semantic Web 2.0: Thematic Perspectives for the End-User." Accessed July 5, 2023. https://www.archimuse.com/mw2009/papers/hyvonen/hyvonen.html.
23. Kauppinen, T., J. Väätänen, J., E. Hyvönen (2008). "Creating and using geospatial ontology time series in a semantic cultural heritage portal". In Proceedings of the ESWC 2008, Tenerife, Spain. Springer–Verlag.
24. Linked Open Data for Libraries, Archives and Museums, EuropeanaTech Insight, Issue 7, available at https://pro.europeana.eu/page/issue-7-lodlam
25. Smith, M.: Linked open data and aggregation infrastructure in the cultural heritage sector, A case study of SOCH, a linked data aggregator for Swedish open cultural heritage, in Information and Knowledge Organisation in Digital Humanities, Routledge (2021), https://www.taylorfrancis.com/chapters/oa-edit/10.4324/9781003131816-4/linked-open-data-aggregation-infrastructure-cultural-heritage-sector-marcus-smith
26. https://www.deutschefotothek.de/, , accessed on 2024/11/21
27. https://www.deutsche-digitale-bibliothek.de/?lang=en, , accessed on 2024/11/21
28. https://www.kringla.nu/kringla/, , accessed on 2024/11/21