Greek Culture on the Map: Place-based Enrichment Scheme at the Greek National Cultural Data Aggregator

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Abstract. Since 2015, SearchCulture.gr, the Greek cross-domain Cultural Data Aggregator, a service developed by the National Documentation Centre in Greece (EKT), has collected a growing number of 810,000 digitised Cultural Heritage Objects (CHOs) from 82 cultural institutions. SearchCulture.gr, as part of its aggregation workflow, applies semantic enrichment to EDM properties that refer to contextual entities such as Types, Agents, Timespans, Subjects and recently Places. In this paper we present this latest development with regards to enriching more than 500k item records with GeoNames, facilitating spatial search and browsing functionalities and map-based discovery.

Keywords LOD Vocabularies, Geodata, GeoNames, Digital Cultural Heritage, Semantic Enrichment, Data Aggregators

1 Introduction

SearchCulture.gr (https://www.searchculture.gr) is the Greek National Aggregator for Cultural Data and National Provider for Europeana. It is being developed by the National Documentation Center of Greece (EKT), a public sector organization supervised by the Ministry of Digital Governance. Since its launch in 2015, it has kept growing in numbers and expanding its functionalities. Today, it has amassed more than 810,000 records from 82 providers such as libraries, museums, archives and, any type of institution that is custodian of cultural collections. Data ingested represent diverse fields, such as archeology, history, arts and crafts, folk and intangible heritage.

In order to address metadata heterogeneity and ambiguity and, therefore be able to offer targeted search and browsing functionalities, we have developed an innovative semi-automatic semantic enrichment strategy and infrastructure. We developed a series of bilingual Linked Open Data vocabularies that we use to enrich the aggregated content. EKT vocabularies extend, translate and link to established LOD vocabularies such as the Virtual International Authority File, UNESCO Thesaurus and Getty AAT.

As a result of this process every item record we ingest is enriched with the new fields "EKT type", "EKT subject", "EKT person (creator/referred)" and "EKT Historical period" with values from our vocabularies. These fields answer the questions: "Who", "When", "What does it refer to" and "What is it". This work is described in [1],[2] and [3].

2 Scope and objectives

Building on this previous work the next vital discovery aid we set out to develop was place-based search, highlighting location as an important property of cultural heritage items and answering the "Where" question.

Same as previously, our goal was to offer first, a new search field for searching items based on the location they relate with. The search should consider all possible alternative names of a given place, and it should make it easy for the user to disambiguate among synonimities. For example, when a user searches for items related to "Seleucia", in the Place search field, they should be provided with the different matching terms "Seleucia of Caria", "Seleucia on the Pyramus", "Seleucia of Pisidia", etc, along with qualifying information to help them select the right term, e.g. their modern names, Aydin, Misis and Bayat, respectively.

We also wanted to provide hierarchical search capturing the Has-a relationships between places. For example, when the user searches for items related to Attica, they should retrieve not only items related explicitly to Attica, but also places located in Attica, like Athens, the Parthenon or Piraeus.

Last but not least, we wanted to use the place-based values in order to locate items on a map so as to enable map-based discovery.

In order to achieve those aims, we had first to extract the spatial information from the relevant metadata fields, to identify the place through a process that often included extensive background research and disambiguation and correlate it with a single URI from an established geodata database containing coordinates.

3 Challenges

We had to address a number of challenges that we encounter across all our enrichment efforts, such as grammatical errors, as well as challenges that were specific to location-based information in the source metadata of the different providers, most importantly:

- Too broad documentation (e.g. "Greece") vs. too narrow (e.g. "Syntagma Sq, Athens, Attica, Greece").
- Common placenames in Greece, such as villages with Saint names (e.g. St. Anna) or generic names (e.g. Castle) and synonimities (e.g. "Tripolis" is the name of more than 10 settlements, ancient and current, throughout the Mediterranean, in Greece, Lebanon, and Libya). Unless provided with other contextual information, this made disambiguation difficult.
- Exonyms (name for a place or group of people that is only used outside that place or group) versus endonyms, Greek adaptations of foreign names and alternative names in the source metadata (see Sec. 6)
- Often important spatial information was not provided in spatial fields but in other descriptive fields such as the title, or the description, or other fields not exclusive for spatial information such as the subject.

To those challenges we must add Dublin Core[1]'s (DC) inherent limitations regarding spatial information. In SearchCulture.gr we use the Europeana Data Model (EDM)[2] to which we map the source metadata we harvest, provided usually in EDM or other DC-based schemata. In DC, geographical information is represented in the properties dcterms:spatial or dc:coverage in an equivocal way: a toponym can either indicate the place where an item was created, where it is being kept, or its subject. Regardless, therefore, of whether more nuanced information is kept in the source, place-based information is often compromised at the aggregation level. This is why the semantics of the new place field produced by our enrichments, is that of "related place".

4 Background: the enrichment scheme in SearchCulture.gr

The enrichment scheme in SearchCulture.gr is based on adding links (URI Refs) stored in separate 'EKT' fields in *Cultural Heritage Objects*' (CHOs') metadata to terms from *Linked Open Data* (LOD) Vocabularies. These links are produced from curated mappings between metadata values and Vocabulary terms.

The implementation of the scheme is done in Semantics.gr [2], a platform developed in-house by EKT that serves the development, curation and interlinking of vocabularies, thesauri and authority files and their publication as LOD.

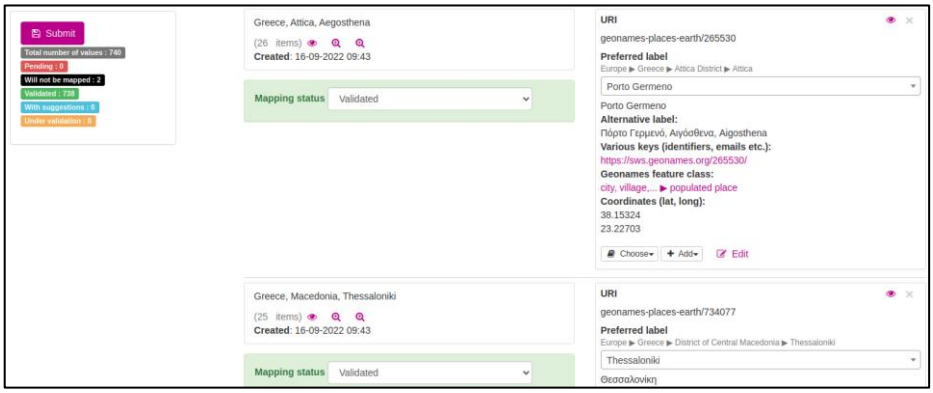


Fig. 1. Two validated mappings in a dcterms:spatial Mapping Form for a specific collection

Semantics.gr contains a *Mapping Tool* used to set mappings in order to perform bulk data enrichment in collections of aggregators or repositories. The GUI environment includes advanced automated functionalities that help the curator easily define mappings from collection source metadata values (either distinct field values or distinct words/phrases contained within field values) to terms from a target vocabulary. Each *Mapping Form* regards a collection, a metadata field and one or more vocabularies. The mapping form incorporates a self-improving automatic suggestion mechanism. The curator can further correct, refine or create new mappings manually. Validated mappings

[1] https://www.dublincore.org/specifications/dublin-core/dcmi-terms/
[2] https://pro.europeana.eu/page/edm-documentation

are served on request via a RESTful API in JSON format which can be used by the aggregator or repository to enrich the collection easily and en masse. The tool is thoroughly described in [1].

5 Adapting the enrichment scheme for Places

The general approach we followed aligns with our previous enrichments. Metadata records are enriched with a new field "EKT Place" that holds URI Refs to a Vocabulary of places that we developed in Semantics.gr. For each collection, after examining their metadata particularities with respect to spatial information, we created one or more Mapping Forms, one for each target metadata field that contains spatial information. In each Mapping Form we conducted mappings from distinct metadata values to terms from our Place vocabulary. The tool provided suggestions and the curator confirmed/corrected/refined them. When there was no match, a new term was added to the vocabulary. A series of adjustments were made to our enrichment scheme to accommodate the particularities of the place-based enrichments as described below.

5.1 Developing a vocabulary of Places

We used GeoNames as the basis for our vocabulary of places. GeoNames is a user-editable global geographical database available through various web services, under a Creative Commons Attribution license. The database contains over 11m places with multiple names in various languages, coordinates and administrative subdivisions. Places are categorized into 646 feature classes.

We opted to create 2 derivative vocabularies based on GeoNames and not use the GeoNames per se for several reasons: i) to have a more manageable number of entries ii) to apply some changes in GeoNames' administrative hierarchy (inserting entries with different feature classes when needed or skipping hierarchy levels that were of no use in our process like low level administrative divisions) and iii) to be able to add useful information like bibliographic references and notes.

Utilizing the GeoNames API, we selected a "starter set" of ~6K terms. For that initial selection our thresholds were the first level of each country's administrative hierarchy and cities with population over 100k globally. For Greece, our thresholds were three levels of administrative divisions and all the settlements of more than 1K inhabitants.

The "Vocabulary of geographical names GeoNames (EKT version)"[3] is hierarchical ("Has-part" hierarchy aligned to the official administrative hierarchy of each country), bilingual (Greek and English) and conforms to the edm:Place contextual class of EDM. At the end of our enrichments it reached ~12K terms.

In addition to the main vocabulary, we developed a supplementary EKT vocabulary[4] in order to include features that didn't fall under the strict administrative hierarchy described above, adding, for example, historical areas (e.g. Soviet Union), placenames

[3] https://www.semantics.gr/authorities/vocabularies/geonames-places-earth

[4]https://www.semantics.gr/authorities/vocabularies/geonames-supplementary-places

that include many different states (e.g. the Balkans) or geomorphological elements that may transcend different states, such as rivers etc.

Those two vocabularies were interconnected using two custom fields ekt:isPartOfMatch and ekt:hasPartMatch (similar to the skos:broaderMatch and skos:narrowerMatch, respectively from the SKOS data model) that we created in order to express the hierarchical "Has-Part" relationships between the two vocabularies, avoiding clashing with the current administrative hierarchy.

5.2 Extensions in the Mapping Form to meet new requirements

Initially, an extension in the Mapping Form of Semantics.gr was developed to facilitate and accelerate search and import of GeoNames terms. When a place is not already included in neither vocabulary, the curator uses the extension to search in the GeoNames database using its Search API, without leaving the enrichment form (Fig. 2). Retrieved terms are shown in a list that includes their URIs, labels, feature codes and administrative areas, helping the curator select the correct term. The selected term is then imported in the appropriate vocabulary and is edited, when needed.

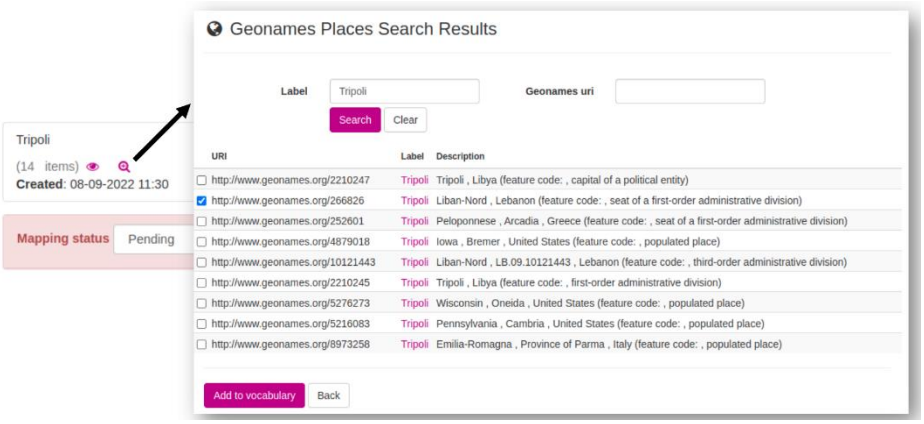


Fig. 2. The curator can search directly in GeoNames.org and import automatically a term

The tool supports automatic suggestion of mappings based on string similarity between metadata values and indexed labels of vocabulary terms (preferred and alternative). The following extensions were made to the indexing system (Apache Solr) used for automatic suggestions. Solr indexes parent labels in the hierarchy, to facilitate disambiguation. For example, the metadata value "Naousa, Imathia" in the source metadata obviously refers to the city of Naousa in the Imathia prefecture. In our Vocabulary there are two "Naousa" toponyms under two different hierarchies, "Greece→ District of Central Macedonia→ Imathia Prefecture" and "Greece→ District of South Aegean→ Prefecture of Cyclades→ Paros". With the new adjustment, the mapping tool will suggest a mapping to the former, since it includes the "Imathia" in its path.

Moreover, when there are two matching terms, one of each is a parent of the other, the later (narrower) is always preferred. This means, for example, that if a city has the same name as the prefecture it belongs to, the city will be preferred over the prefecture.

5.3 Enrichment Workflow

Mapping forms were created after the spatial fields (dcterms:spatial or dc:coverage) for the majority of the collections.

We procceeded with conducting enrichments in descriptive fields (dc:title or dc:description) or other structured fields (dc:subject) for collections that either did not have metadata in spatial fields or had very broad terms, as well as for collections that we felt that more precise toponyms could be extracted with this process.

Descriptive fields, such as dc:title and dc:description, are highly selective (the number of distinct values approaches the number of all items). A mapping form for non-spatial fields can be specially configured in order to search inside the values for specific words. The tool scans all distinct values of the field (e.g. all titles) and searches for inclusion matches against all the indexed labels of our Vocabularies of Places. The search for inclusion matching is based on the matching algorithm that is used for automatic mapping suggestions. Only the matching terms are considered candidates for toponyms and are exposed as values to be mapped. However, this technique will mine only placenames that match existing vocabulary entries. This is the reason why we first completed all mapping forms for dcterms:spatial or dc:coverage for the available collections, so as to add as many terms as possible in the vocabularies. Indeed, after all those mapping forms were processed, the vocabularies were critically enhanced, which significantly increased the possibility that a toponym will be mined and given a chance to be mapped in non-spatial fields in consecutive enrichments.

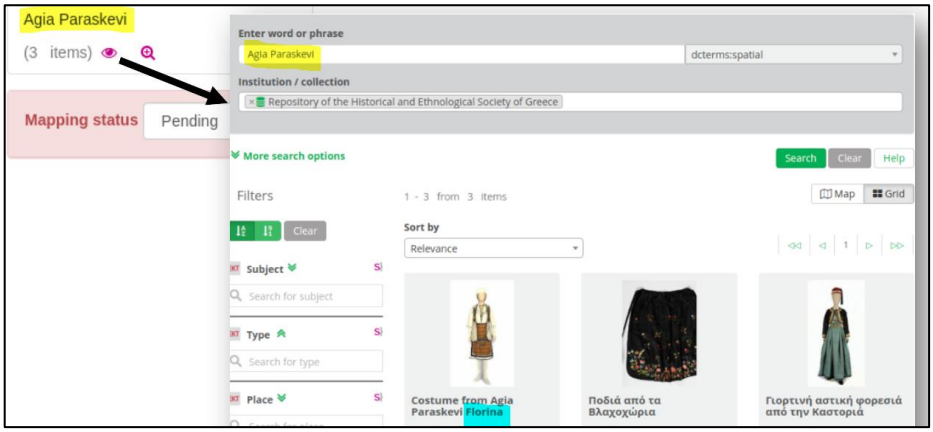
5.4 Supporting the curator in the disambiguation process

The mapping form is designed in a way to accelerate the disambiguation process. First of all, place entities from the vocabulary that appear in mappings are presented in a panel which shows useful contextual information from the vocabulary record such as alternative labels, feature codes and administrative hierarchy. The curator has immediate access to all this information that will help them in making the correct decision, without having to access the full vocabulary term.

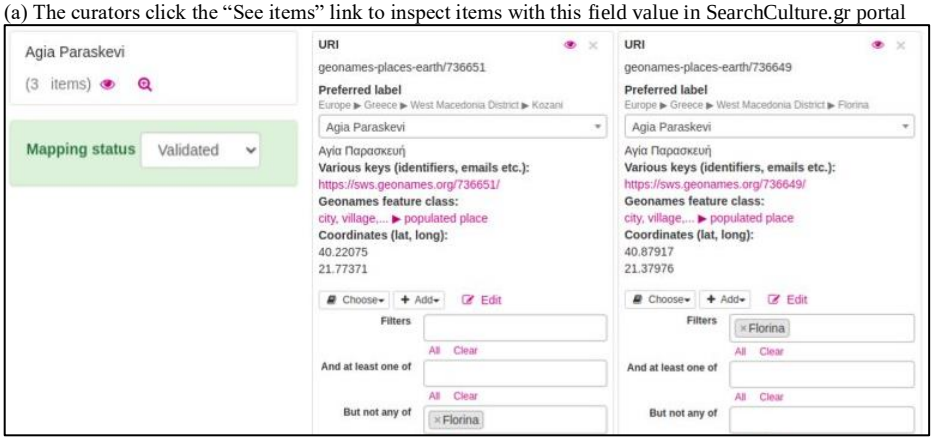
Moreover, for each metadata value or phrase which is subject to mapping, there is a “see items” hyperlink that curators use to search SearchCulture.gr for items having the specific values in the metadata field in the specific collection. This way, the curator can easily preview all items that would be enriched according to the mapping.

In the case of synonimities, filters can be used (values or phrases from the same or other metadata fields) and create logical expressions in order to fine-tune the mappings and avoid false positives. For instance, they can use the logical NOT operator to set exceptions. An example of this is illustrated in Fig. 3. The placename “Agia Paraskevi” either refers to a village in the Municipality of Florina or to one in the Municipality of Kozani. To disambiguate the two places, we used as filter a phrase from the dc:title

field: only when a CHO has the phrase “Florina” in the title is it enriched with the former Geoname.



(a) The curators click the “See items” link to inspect items with this field value in SearchCulture.gr portal



(b) The final mapping assigns the 3 items to two places, according to the filter configuration

Fig. 3. A mapping on place value refined by filters.

5.5 Desk research

There is no complete Greek placenames gazetteer. In the information gathering process we, therefore, relied on a number of online resources including historical gazetteers such as the database “Name Changes of Settlements in Greece” created by the Institute of Neohellenic Research of National Hellenic Research Foundation[5], Pleiades and Pelagios[6], as well as the Archaeological Atlas of Antiquity[7]. We also used Wikipedia,

[5] http://pandektis.ekt.gr/pandektis/handle/10442/4968
[6] https://pelagios.org/about-us/
[7] vici.org

often in various language versions. Finally, we sometimes located interesting and useful information in unofficial sources, such as community blogs and local history pages.

5.6 Effort

The retrospective enrichments for 90 collections took 12 man-months. 119 Mapping forms were created, 25K mappings were made for more than 28K unique spatial values. Overall, 585K items were enriched with geolocation out of a total of 810K.

6 The palimpsest of Greek Placenames throughout history

In the Mediterranean basin the palimpsest of toponyms reflects the stratification of changes in regime, empire, and occupation which is also is reflected in the source documentation. This complicated the disambiguation process as illustrated by the following indicative examples.

During the course of centuries Istanbul (or Stamboul or Stambul) has been known by a number of different names: Lygos (Λύγος), Byzantium or Byzantion (Βυζάντιον or Βυζαντίς) in ancient years, Augusta Antonina (Αυγούστα Αντωνινή) during the Roman Period, Alma Roma (Άλμα Ρώμα), Eastern Rome (ἑῴα Ῥώμη) or Roma Constantinopolitana in the early Byzantine Period and Kōnstantinoúpolis (Κωνσταντινούπολις), Constantinopolis and Constantinople, Βασιλεύουσα ("Reigning City") or simply Polis (Πόλη) up until the Ottoman conquer. Several of these terms appeared in the metadata of objects located in this area at different time periods.

Similarly, from the founding of the Greek state in 1831 and up until 2011 there was a systematic attempt to change the placenames of several Greek settlements. This renaming is connected to administrative reforms that highlight the priorities of the state policy aiming to establish a new toponym map that would capture "the unity of Hellenism in space and time". As a result, more than 5K settlements were renamed as often as every 20 years. For example, the village Γκρόπινο (a name of Bulgarian origin) in 1928 was renamed Τρόπινο in an attempt to "hellenize" the name. Later in 1940 it was renamed "Βαλτολείβαδο" (a name indicative of its natural environment as it translates "meadow with swamps") and finally in 1961 it was again renamed to the more "elegant" Δάφνη (Laurel). In a notary document of 1930 the spatial value would be "Τρόπινο" a placename not in use for the past 80 years. As a result the curator must conduct extensive research in order to assign the correct Geoname.

Similar issues arose in the case of Greek placenames in Asia Minor. Most refugee archives use the Greek terms in their documentation and not the official Turkish names. Another common issue was the attribution of Turkish names with Greek characters. Both issues occurred often in the case of landmarks related to the Greco-Turkish War of 1919-1922. For example a Turkish village was attributed in a Greek war photograph with the phonetic transcription "Inetzilar" or "Ινετζιλάρ". The research indicated that the Turkish placename was "İğciler", a link that could not have been made without extensive search in archives documenting the movements of the Greek army at the time indicated in the photograph.

7 Place-driven search and map-based browsing functionality

The place-based enrichments has added the dimension of space to the discovery of items on SearchCulture.gr.

We stored the "EKT place" field as a dcterms:spatial property in a separate ore:Proxy object of the internal-EDM model and we indexed it using multiple fields of Apache Solr. In order to support hierarchical searching and faceting on place in a way that captures the semantics of "Has-A" relationships (part-of) between places, we index for each item all broader terms as well, using a separate auxiliary Solr field. This way, for example, when a user searches items of "Attica" the results will also include items of "Athens".

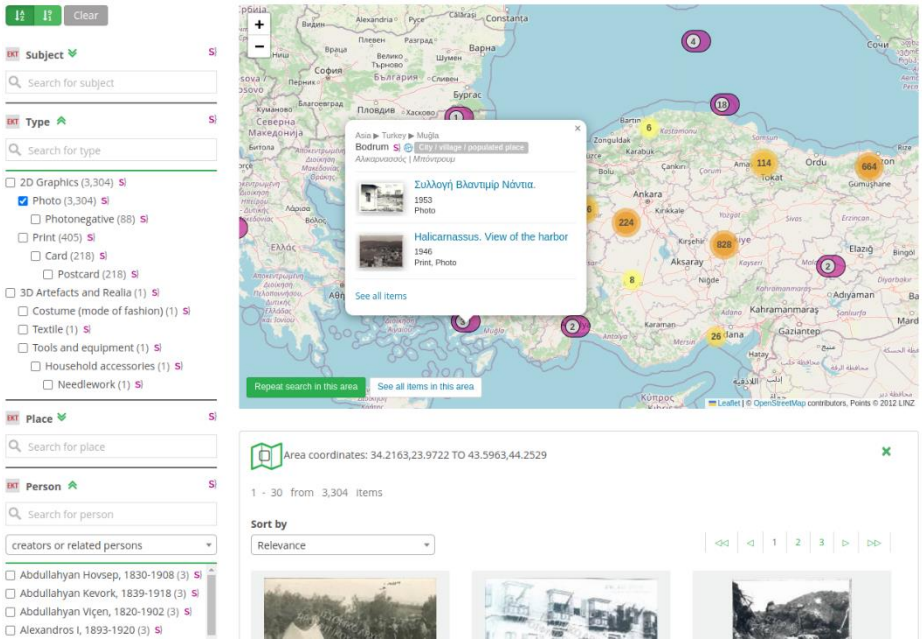


Fig. 4. Discovering items in map

Leveraging the Apache Solr search platform and our indexing scheme, we enhanced SearchCulture.gr with new multilingual search and browsing functionalities that improve discoverability including searching by place using a controlled hierarchical list of values, hierarchical navigation on all places through a separate page, hierarchical faceting on places and an interactive tag cloud. All the above hierarchical place lists show all alternative labels and direct links to our vocabularies and GeoNames.org, helping the user choose the right place. Moreover, earch item page shows a map with all its related places.

Moreover, the enrichments are used to locate the items on an interactive map (Fig. 4). To do so, we index for each item all the coordinates of its related places on a separate

Solr field of type "LatLonPointSpatialField"[8]. The implementation of the map navigation was based on leaflet.js[9] and OpenStreetMap[10]. Displaying thousands of items on the map has been a major challenge, both in terms of user experience, system response, computational resources and memory requirements. On the one hand, the number of distinct locations that appear in the results of a search can be exceptionally large (potentially more than 12,000). On the other hand, a very large number of items are linked to each location. To address the problem, items appear in clusters that can be further expanded as the user clicks or zooms on the map.

Search and navigation results are now displayed in two ways, in a grid (default) or on a map. The map shows the number of items per place or cluster. Users can navigate the interactive map by clicking on clusters or places of their interest. Users can retrieve items belonging to a specific place or all items located in the current map frame (within its coordinates).

The new visualization feature was also added on the Thematic Exhibitions, providing a new dimension with regards to showcasing the items included. Ten new exhibitions were inspired by the new feature that showcase cultural heritage of the Hellenism of Asia Minor.

8 Related Work

Different semantic enrichment strategies are adopted by large cultural heritage aggregators as a means to contextualise resources, disambiguate, add multilinguality and offer search and browsing functionalities across multiple heterogenous source datasets. Our overall strategy complies with the EuropeanaTech TaskForce on Multilingual and Semantic Enrichment Strategy [8] recommendations.

Europeana uses automatic text linking between the source dcterms:spatial and dc:coverage fields and GeoNames [9],[10]. 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 [4] therefore unable to be exploited for building advanced search functionalities [7]. 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 [10], let alone to disambiguate synonyms when not qualified information is provided.

In the comparative evaluation performed by EuropeanaTech Task Force [10] the necessity of human-in-the loop methodologies to complement automatically produced enrichments is implied, which perfectly aligns with our approach. SAGE[11] is a semantic enrichment and validation platform that deploys state-of-the-art AI tools assisted by human-in-the-loop validation mechanisms to produce automatic mappings. However,

[8] https://solr.apache.org/guide/solr/latest/query-guide/spatial-search.html
[9] https://leafletjs.com/
[10] https://www.openstreetmap.org/
[11] https://pro.europeana.eu/page/sage

it lacks the sophistication provided in Semantics.gr such as the use of filters to refine mappings (Sect. 5.4).

Among the various domain and national aggregators of Europeana, some demand the data is enriched prior to ingestion, transferring the responsibility to the providers [6], others undertake semantic enrichment post-ingestion [13], while the majority just indexes string data without applying any semantic enrichment. Place-based search is offered by Deutsche Fotothek[12] and the German Digital Library[13]. CulturaItalia.it offers place-based filtering of results and Kringla[14] offers province-based filtering and map-based search but geolocating only a fraction of the objects on the map.

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 and disambiguation process and iii) uses a controlled target vocabulary that is gradually expanded to cover the needs of the specific collections

As part of our future work, we are inspired by the Finnish CultureSampo portal [14] that uses a spatiotemporal ontology of historical Finnish municipalities [12] and exploits these temporal and historical aspects to produce different multi-layered map visualizations.

9 Conclusions

The comprehensive work presented in this paper on the retrospective and ongoing geolocation of Greek cultural heritage items completes the vision we set out to carry out 7 years ago which was to enrich CHOs included in the Greek national cultural aggregator in a way that responds to the fundamental search questions of “Who”,”What”, ‘What-is-it-about’, ‘When” and “Where”. 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 surfaces and interlinks 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 as our vocabularies are provided via open APIs with an open license.

In the next phase of our work we aspire to continue building on this solid ground further refining and expanding our vocabularies also with the involvement of expert communities, opening up the functionalities of the portal to the users, inviting them to build and share their own exhibitions, and implement new features that can also be embedded in 3rd party applications, like in educational and research environments, including new multilayered interactive maps, as well as develop new engaging, riveting and accessible formats to indulge in culture.

[12] https://www.deutschefotothek.de/
[13] https://www.deutsche-digitale-bibliothek.de/
[14] https://www.kringla.nu/kringla/

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