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Federating Specialized Digital Libraries

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Abstract

The paper describes a procedure for creating a joint thesaurus of Architectural Heritage (AH) based on existing ones. After surveying the most important repositories of historic architectonical information and the associated thesauri, the design of a multilingual framework incorporating the different thesauri is presented and discussed. Also a system to perform semantic queries on these architectural databases is briefly presented. The implementation is based on the combination of existing technology, such as SKOS, RDF, Linked Data and semantic queries.

Categories and Subject Descriptors (according to ACM CCS): I.3.6 [Computer Graphics]: Standards âĂŞ Digital Libraries, Linked Data, Thesauri—

1. Introduction

The amount of digital information available on-line is increasing every day. Besides publications, which are nowadays easily accessible through the on-line version of journals and books, raw data are making their way on the web through a number of repositories that offer on-line access to authorized users or, in some cases, to the general public.

The best-known example is Europeana, [Eur11] which has now surpassed 10 millions of digital objects. However, what such a wide-range collection gains in coverage it may lose in focus, and serve less well research communities than it does with the public at large. Furthermore, the necessity of adopting a metadata schema that serves so diverse domains is liable to reduce the richness of the information stored in specialized digital libraries. For these and other reasons the importance of specialized digital repositories containing raw data on specific domains is likely to increase. But, to retrieve all the digital objects related, for example, to medieval castles in Europe, it is necessary to manually search a huge number of different registers, a number that is probably going to increase as research projects create more and more repositories to store their digital outcome. Just limiting to Europe, there is at least one national register per country, plus the many pertaining to countries where heritage management is delegated to regional governments like Germany. Therefore, an automated way of searching all the specialized repositories on a specific subject is, in our opinion, highly desirable, and, as we will try to show in the present paper, it is also within reach using available tools and with a minimum of cooperation.

The main problem in automating such a search system, besides agreeing on use conditions with the copyright owners of the on-line repositories, relies on the difference between the metadata schemas adopted by different repositories and in the thesauri used. A solution has been suggested to access a distributed system of digital repositories, but no such system exists to avail of the different thesauri and a "distributed" search cannot rely on this indispensable aid to retrieval.

After surveying the main thesauri of AH, the paper will describe a mechanism to access them and will focus on the issue of using a "common" thesaurus without actually building it. This will lead to the proposal of a minimum set of conditions that would enable this search paradigm, in our opinion easily obtainable because they do not interfere with the daily activity of the individual digital libraries and do not require any additional activity from them, except agreeing on some minimal interoperability conditions, such as publishing/registering their metadata schema and enabling direct access to the repository instead of allowing access only via the search page of their portal.

Most of the work done in this paper relies on previous work by other researchers and especially on work done in EU-funded projects. We only regret that some of the outcomes of these projects, potentially useful for further

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progress, disappear shortly after the project conclusion or are not available on-line.

2. Repositories of Architectural Heritage

We are now going to summarize the features of some of the most important and better organized repositories in three countries, Italy, France and England.

2.1. The ICCD/CulturaItalia Portal

CulturaItalia (CI) is a portal promoted and managed by the Ministry of Cultural Heritage and Activities (Italy). The CI repository hosts the digital resources from several Museums, Public and Private Cultural Institutions and part of the data from the Istituto Centrale per il Catalogo e la Documentazione (ICCD) catalogue. It contains 2.000.000 records [CuI11].

The digital resources related to the national CH can be consulted through the "Metadata Index", which is an ordered set with a tree structure. The resources of the Index are classified according to a thesaurus (PICO 4.2).

The index metadata are structured in four elements: Who, What, Where and When. This is the definitive profile from Dublin Core Culture, a qualified Dublin Core (DC). The metadata gathered in the CI repository have been mapped to the PICO metadata schema [ABB*07].

ICCD and the Central Office for Documentation of the Ministry of Culture Heritage developed the SIGEC (General Catalogue Information System), to support all stages of production and use of information concerning CH assets. Services offered by SIGEC will be accessible through a web interface in order to facilitate the cataloguing activities of the organizations involved in CH Conservation.

2.2. The Getty Research Institute

The Getty Provenance Index Databases provide instant access to data from primary sources relevant to the history of collecting [TGP11]. Even if not directly relevant to AH, also these repositories are considered here mainly for the related Thesauri. The index contains nearly one million records of western European works of art from the late 16th to the early 20th century, including:

- Archival Inventories: it contains 5,200 inventories and more than 260,000 individual records about artworks existing in a specific collection at the time the inventory was made.
- Sales Catalogues: it contains 8,400 catalogues and more than 740,000 individual records of works of art for sale and can be used to trace the sales and ownership history for a work of art.
- Dealer Stock Books: maintained by galleries and art dealers, the database contains 15 stock books and more than 43,700 individual records.
- Payments to Artists: it contains 1,000 recorded payments to artists made in Rome between 1576 and 1711.
- Public Collections: descriptions and provenances of paintings held by public institutions.

2.3. English Heritage

PastScape is an online resource from English Heritage's National Monuments Record (NMR), which provides information about many of England's ancient and historical sites, buildings and monuments. The information within PastScape is taken directly from the NMR's national historic environment database that contains nearly 400,000 records on the archaeology and buildings of England and its territorial waters [Pas11]. The records are referred to the Thesaurus of Monument Types [NMT11].

Images of England is another English Heritage database containing a photographic record of England's 370,000 listed buildings [Ima11]. All images are stored in jpeg.

All the lists of heritage assets are being unified into the National List for English Heritage [NLE11].

2.4. The European Heritage Network (HEREIN)

The database on heritage policies in Europe (HEREIN) provides a multilingual overview of the heritage policies pursued in European countries. The new version of the system HEREIN 3 focuses on an integrated approach between AH, Archaeological Heritage and Landscape Heritage, which still in many countries fall under different policies [OvLW11].

2.5. Mérimée

The base Mérimée is a database on monumental French heritage. It was created in 1978 and put online in 1995 by the Ministry of Culture of France, Direction for Architecture and Heritage [Arc11]. The Mérimée database contains the information from the service of historical monuments and l'Inventaire général du patrimoine culturel, addressing religious architecture, domestic, agricultural, educational, military and industrial. The base Mérimée includes about 200.000 records with 147.000 for inventory and 42.000 for historic buildings.

3. Thesauri

Thesauri play an important role in information storage and retrieval systems. To assist different user communities in metadata compilation and information retrieval, libraries, museums and other CH institutions started to create controlled vocabularies to describe and manage their assets. There are thesauri specific to fields, disciplines, institutions, and even collections. Many of these thesauri have been standardized using SKOS [SKO11]. A short survey of those used in the above-mentioned repositories follows.

3.1. PICO 4.2

The thesaurus PICO 4.2 of the CI Portal is a controlled vocabulary designed to manage and organize heterogeneous information coming from different cataloguing systems. The Thesaurus is composed of keywords hierarchically structured according to the resource categories. It is "open" and can be further developed, in order to ensure a better organization of information. Moreover it is codified in SKOS [CIt].

3.2. The ICCD Thesaurus

The ICCD Thesaurus of Architecture has been recently developed and is available in printed version only [Pug09].

The framework of the thesaurus, hierarchically organized, combines a set of conventional vocabularies, referring to various types of buildings, of great value to the knowledge of Cultural Heritage (CH) and design practice. The thesaurus refers to the most popular residential architectural types and their most usual architectural and structural components, and is an open vocabulary.

3.3. The Art & Architecture Thesaurus (AAT)

The AAT is a structured vocabulary containing around 125,000 terms about architecture, fine arts, decorative arts, archival materials and material culture. It ranges from Antiquity to the present and covers all kinds of art objects and architectural elements and their descriptions.

The thesaurus may be consulted in two ways: hierarchically and the alphabetically. The layout of the hierarchical display is based on concepts arranged by facets from general to specific, or from "abstract concepts to concrete artefacts".

At the top of the AAT hierarchy is positioned the so-called root and below this level the seven facets are located. Within the facets there are more levels organized in 36 hierarchies containing 2.949 guide terms and 27.992 concepts. The vocabulary, originally in XML, has been converted to SKOS by the MultimediaN E-Culture Project [TvOSW10].

3.4. English Heritage

English Heritage is continuously developing new thesauri to provide structure and guidelines for the standardization of terms to be used when creating new records of the past. Among the available thesauri, we mention here the Thesaurus of Monument Types, which is a standard produced by the Royal Commission on the Historical Monuments of England (RCHME) in 1995 [NMR11]. The purpose of this thesaurus is to standardise the terms used to describe archaeological sites or standing buildings in the UK. The terms may be accessed hierarchically or alphabetically. This thesaurus is now maintained by English Heritage, and is available on-line. It has been converted into the standard SKOS RDF format by the STAR project [Sta11].

Other thesauri include:

- Buildings material thesaurus: construction materials for monuments, relating to the built and buried Heritage.
- Components thesaurus: elements of a monument relating to the built or buried Heritage.
- Evidence thesaurus: terminology covering the existing physical remains of a monument, or the means by which a monument has been identified where no physical remains exist.

3.5. Mérimée

The Mérimée thesaurus was developed by the Direction de l'Architecture et de Patrimoine, Ministère de la Culture et de la Communication, in parallel with the homonymous repository It is maintained by the Inventaire général du patrimoine culturel, des Monuments historiques, and by the Médiathèque de l'Architecture et du Patrimoine. It ranges from the prehistory until 1970.

Each term of the thesaurus is classified according to functional categories related to religious use, funeral, industrial and so on. It also includes all necessary references, definitions, summaries, and usage notes.

For each term there is the correspondence with the American and English equivalents used in the thesaurus of ATT and the RCHME [Arc11], [LvCM08]. Part of the descriptors have also been translated into the Italian ICCD thesaurus terms.

3.6. The European Heritage Network (HEREIN)

The multilingual thesaurus attached to the HEREIN project and database intends to offer a terminological standard for national policies dealing with architectural and archaeological heritage. This tool is intended to help the user of the website when surfing through the various on-line national reports, covering more than 500 terms in sixteen languages [Car11]. The terms of the thesaurus are gathered into nine classes which represent nine top terms around which concept are organized. Each class forms a structured grouping of descriptors and non-descriptors around a top term. The semantic relations used within a monolingual thesaurus are equivalence, hierarchical, associative, and the multilingual ones are: exact equivalence, inexact equivalence, single to multiple and non-equivalence.

4. Interoperability between thesauri: related work

Numerous projects interested in establishing interoperability between indexing languages and in the development of on-line catalogue and database began to emerge in the 1970s and continued to develop as online networks and shared cataloguing programmes in the 1980s. In this period, many projects dealing with thesauri mapping were supported by

the ISO 5964 standard with the publication of the "Guidelines for the establishment and development of multilingual thesauri".

Lately the possibility of linking, mapping and merging various subject tools has been increased by the availability of metadata and digital collection. Many projects and methods have been used to establish some form of interoperability, among them WebDewey, Carmen, UMLS, and HILT [LvCM08]. Other projects aimed at establishing interoperability between similar kinds of indexing languages, for example subject headings (MACS), Mérimée (Thesauri), Renardus (Classification). Most of the mappings projects were based on the intellectual manual approach: for example, the already mentioned mapping between Mérimée, AAT and NMR thesauri. It developed a notion of optimal mapping, paying attention to the intellectual quality mappings between terms from different vocabularies and to problems of polysemy [Doe01].

A new approach that allows interoperability and mappings between thesauri is based on the adoption of RDF [TOS07]. Some examples are the conversion of WordNet to RDF representation [vAGS06], [vAMS*04] or the integration of ontologies and thesauri for building RDF schemas [AF99]. Another work uses the instance-based ontology mapping for measuring the similarity between sets of annotated instances [IvdMSW07]. Among the projects for defining interoperability between thesauri it is important to mention a schema-based thesaurus mapping of five thesauri of interest for the European Union Institutions having only schema information available by proposing and testing logical views and related ranking functions to establish similarity between terms. The thesauri of interest were converted in RDF SKOS Core representation using XSLT techniques [FFM*08].

Semantic interoperability has been developed within the GIIDA project [PDFDS*10] and inter-thesaurus mappings and equivalence relationships, have been developed within the SWAD-Europe Thesaurus Activity [MM01].

An important research carried out recently within the EU project NatureSDIplus (a Best Practice Network for SDI in Nature Conservation) [MA11] proposed a Common Thesaurus Framework for Nature Conservation, a multi-thesauri framework where different available Knowledge Organization Systems (KOS) of the relevant domains are assembled together in order to provide an integrated terminology of the chosen thesauri. To ensure the architectural flexibility they adopted Linked Data and Semantic Web technologies to publish the thesauri as a whole in machine-understandable format. For KOS interlinking, it adopted three strategies: one is based on the exploitation of automatic tools; the second one relies on the exploitation of a priori knowledge, highlighting whether a KOS had been built including parts of other pre-existing resources; and finally the third one is based on the exploitation of domain experts, with interlinking defined manually by domain experts. All these strategies were adopted and the result is a Common Thesaurus Framework for Nature Conservation which includes more than 200.000 concepts [CTF11].

The approach proposed in the present paper adopts the third strategy mentioned above: since there exists already a mapping between the Mérimée, AAT and NMR thesauri and partially with the ICCD one, this mapping can be exploited to interlink these thesauri and navigate them as if they were one. We will show in the next section how this can be achieved.

5. Interlinking the Architectural Heritage thesauri

The procedure we propose here is based on the work presented in [MA11].

The approach aims at considering existing thesauri as parts (sub-thesauri) of a global one, resulting from their union and availing of connections defined by the mapping. In other terms, existing thesauri become modules of a global framework. This approach has the advantage of not adding yet another super-thesaurus to the plethora of the existing ones; of not changing the habits and practices of current users of the individual modules; and of making the best out of work already done, which can be exploited by enriching the internal connections of the global framework as equivalences between terms are discovered and made explicit.

The thesaurus framework created in this way is also modular, because other thesauri (possibly in different languages) may be added as long as it is available (in SKOS/RDF) its mapping to one already incorporated in the framework. The framework is open because new modules may be added without limitations, and the overall infrastructure may be accessed on-line.

It avails of the Linked Data paradigm by encoding inter-thesauri relations into SKOS/RDF and publishing a dereferenceable URI associated to each concept.

A fragment RDF describing the equivalence between the terms "Château fort" in Mérimée and "Castle" in NMR is shown in Figure 1.

The overall assemblage concept is shown in the Figure 2, representing the same example. The two components keep their identity in the overall framework, but they are interrelated by equivalence between the two terms, depicted by a dotted line.

Following the guidelines described in [MA11], the creation of the overall framework comprises of these steps:

1. Thesauri selection: we have discussed here some very important ones for their extension and coverage, but more can be added.
2. Thesauri SKOS-ification: this was already available for some of the resources selected.

```
<?xml version="1.0" encoding="UTF-8"?>

<rdf:RDF xmlns="http://www.w3c.rl.ac.uk/2003/11/21-skos-core#"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  xmlns:map="http://www.w3c.rl.ac.uk/2003/11/21-skos-mapping#"
  xmlns:nmr="http://thesaurus.english-heritage.org.uk/nmr#" xmlns:mer="http://www.culture.fr/documentation/merimee#">

<rdfs:Class rdf:about="http://www.culture.fr/documentation/merimee#Concept">
  <rdfs:label>Merimee Thesaurus Concept</rdfs:label>
  <rdfs:subClassOf
        rdf:resource="http://www.w3c.rl.ac.uk/2003/11/21-skos-core#Concept"/>
</rdfs:Class>

<rdfs:Class rdf:about="http://thesaurus.english-heritage.org.uk/nmr/Concept">
  <rdfs:label>NMR Concept</rdfs:label>
  <rdfs:subClassOf
        rdf:resource="http://www.w3c.rl.ac.uk/2003/11/21-skos-core#Concept"/>
</rdfs:Class>

<mer:Concept>
  <descriptor xml:lang="fr">Château fort</descriptor>
  <map:exactMatch>
        <nmr:Concept>
                <descriptor xml:lang="en">Castle</descriptor>
        </nmr:Concept>
  </map:exactMatch>
</mer:Concept>

...

</rdf:RDF>
```

Figure 1: *RDF description of the mapping Mérimée - NRM, showing the example of the correspondence between "Château fort" and "Castle".*

3. Framework publication: each resource (thesauri and mappings) should be published as Linked Data. This of course depends on the resource owner, but it is a process that is increasingly happening.
4. Interlinking and growing: new thesauri may be added as additional modules, by publishing them and the linking to already incorporated ones.

The creation of an overarching (multilingual) thesaurus enables more efficient searches in the distributed repository formed by the different ones concurring to the joint framework, as will be shown in the next section. Furthermore, it provides a safe harbour for other repositories that do not have their own thesaurus: they will simply avail of the global one. If there are language issues, for example the language used by the new repository is not present or is insufficiently covered by the global framework, it will be sufficient to translate the necessary terms, already existing in one of the languages already in use, and exploit the hierarchy and interrelations of the framework. This will in practice avoid the effort of creating a brand new thesaurus and reduce the problem of interlingual mapping, in the terminology of [RDF11], to the much simpler one of multilingual labelling. Cases in which a perfect correspondence does not exist, or more detail is required with a larger number of NTs, may be treated separately with small, specialized sub-modules, easily inserted in the global framework.

6. A distributed Architectural Heritage repository

Once that a joint thesaurus has been created with the method described in the previous sections, there remains the issue of accessing the separate databases where the relevant information is stored and querying them semantically.

A solution to the problem of searching a generic database whose structure is known, via, for example, a SPARQL search using D2R [D2R11] has been proposed for CH repositories by Felicetti et al [EFO*08]. We will briefly summarize how this works.

D2R is a server that enables performing semantic searches on non-RDF databases via a mapping file as shown by the picture below.

A SPARQL client queries the non-RDF database through the D2R Server by converting data on-the-fly using the mapping file. Results are returned as digital objects. The same process may be repeated for all the relevant databases obtaining a union set of the individual results. The mapping files are created once for all when the database is associated to the overall query framework. In fact, such mappings are already available for the repositories considered here, or may be easily created.

In conclusion a distributed system may rely on:

- A joint thesaurus framework built as described in section 5
- A query system based on D2R and a set of mappings for individual databases, which are interrogated in sequence via the mechanism described above.

The only conditions that are necessary to setup such a system consist in:

- Grant of direct access to repositories to D2R requests
- Availability of mappings for the repositories metadata schemas

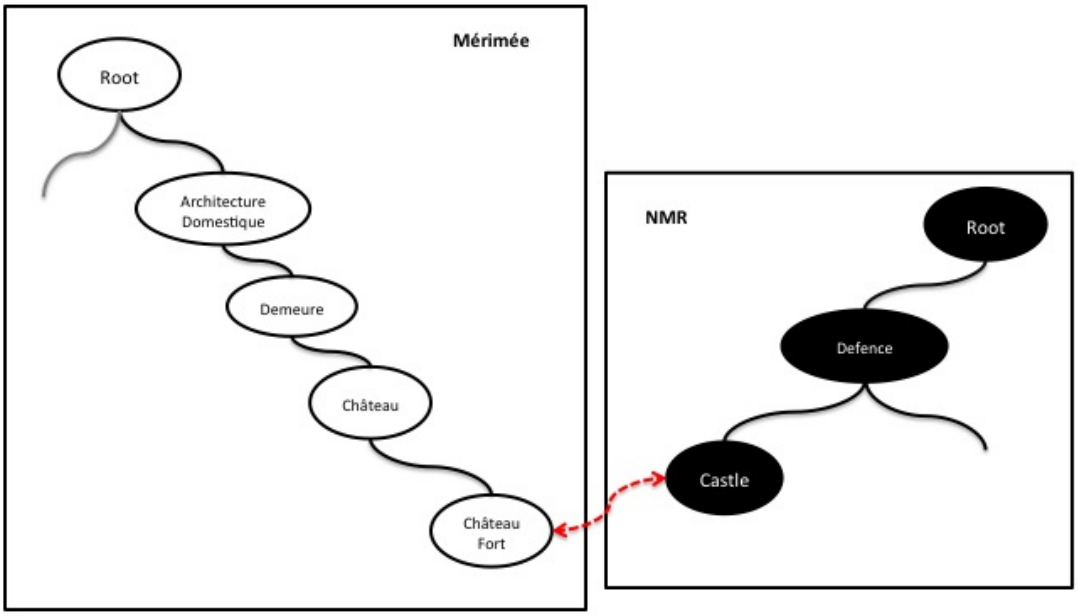

Figure 2: *Part of the framework resulting from the combination of the two thesauri and the interlinking determined by the equivalence established between two terms belonging to different thesauri. There will be of course many of these interconnections.*

- Publication of thesauri
- Publication of mappings

As it can be seen, it is mostly a matter of agreement between institutions than of technological implementation, required only to create the necessary user interfaces.

7. Conclusions and further work

The research presented here is at the beginning, and conclusions are premature. However, it seems that all the necessary premises are set to enable the creation of a powerful distributed and modular search framework, basing on existing repositories and studies on the correspondences of their structures and terminologies. Also the technology necessary for the purpose is already available.

A necessary step concerns the publication of resources according to the Linked Data paradigm. This requires the collaboration of the institutions owning the repositories and the thesauri. Their recent activities in the field of digital CH, and the convincement that this is a public service suggest that there should be no real concern on this aspect.

Believing that it would be a useful service to the research community, the authors have concrete plans to implement what in the present paper is just designed.

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References

[ABB*07] AMATURO M., BERARDI E., BUONAZIA I., LATTANZI M., MASCI M., MERLITTI D., T. T. S.: *Mapping dei*

metadati tra le schede ICCD e PICO Application Profile per il Portale della CulturaItalia. ICCD, 2007. 2

[AF99] AMANN B., FUNDULAKI I.: Integrating Ontologies and Thesauri to Build RDF Schemas. In *Proceedings of ECDL '99* (1999). 4

[Arc11] Ministère de la Culture et Communication: Architecture & Patrimoine. http://www.culture.gouv.fr/culture/inventai/patrimoine/, July 2011. 2, 3

[Car11] CARLISLE P.: HEREIN Thesaurus Editing Software. Thesaurus Guidance Manual, March 29, 2011. 3

[CIt] Thesaurus PICO 4.2, CulturaItalia Portal. http://www.culturaitalia.it/pico/thesaurus/4.2/thesaurus_4.2.0.skos.xml.July2011. 3

[CTF11] Common Thesaurus Framework for Nature Conservation. http://linkeddata.ge.imati.cnr.it:2020/, July 2011. 4

[CuI11] CulturaItalia. http://www.culturaitalia.it/pico/catalogo/navigation.html?T=1310148166029, July 2011. 2

[D2R11] D2R Server. Publishing Relational Databases on the Semantic Web. http://www4.wiwiss.fu-berlin.de/bizer/d2r-server/, July 2011. 5

[Doe01] DOERR M.: Semantic Problems of Thesaurus Mapping. *Journal of Digital Information 1* (2001). 4

[EFO*08] EIDE O., FELICETTI A., ORE C., D'ANDREA A., HOLMEN J.: Encoding Cultural Heritage Information for the Semantic Web. Procedures for Data Integration through CIDOC-CRM Mapping. In *Procedings of the EPOCH Conference on Open Digital Cultural Heritage Systems '08* (2008), Arnold D., Niccolucci F., Pletinckx D., Gool L. V., (Eds.). 5

[Eur11] Europeana: Linked open data. http://www.europeana.eu/portal/thoughtlab_linkedopendatahtml, July 2011. 1

[FFM*08] FRANCESCONI E., FARO S., MARINAI E., BIASIOTTI M. A., BARGELLINI F.: A Framework for Schema-based Thesaurus Semantic Interoperability. In *Proceedings of ICEGOV '08* (2008), pp. 251–257. 4

[Ima11] English Heritage. Images of England. http://www.imagesofengland.org.uk/, July 2011. 2

[IvdMSW07] ISAAC A., VAN DER MEIJ L., SCHLOBACH S., WANG S.: An empirical study of instance-based ontology matching. In *Procedings of ISWC '07* (2007), pp. 253–266. 4

[LvCM08] LANDRY P., ŽUMER M., CLAVEL-MERRIN G.: The European Library TEL-ME-MOR. Modular extensions for mediating on line resources. Report on Cross-Language Subject Access Options, May 2008. 3, 4

[MA11] MARTINO M. D., ALBERTONI R.: A multilingual/multicultural semantic-based approach to improve Data Sharing in an SDI for Nature Conservation. *International Journal of Spatial Data Infrastructures Research 6* (2011), 206–226. 4

[MM01] MILES A., MATTHEWS B.: A guide to the SKOS-Mapping RDF schema for inter-thesaurus mapping. Deliverable 8.4. SWAD-Europe Thesaurus Activity, 2001. 4

[NLE11] English Heritage. The National List for English Heritage. http://list.english-heritage.org.uk/default.aspx, July 2011. 2

[NMR11] National Monuments Record. http://www.english-heritage.org.uk/professional/archives-and-collections/nmr/, July 2011. 3

[NMT11] NMR Monument Type Thesaurus. http://thesaurus.english-heritage.org.uk/thesaurus.asp?thes_no=1, July 2011. 2

[OvLW11] OLIVIER A., VAN LINDT P., WOLFERSTAN S.: HEREIN 3 Database Questions, June 2011. 2

[Pas11] Pastscape. http://www.pastscape.org.uk/, July 2011. 2

[PDFDS*10] PLINI P., DI FRANCO S., DE SANTIS D., URICCHIO V. F., DE CARLO D., D'ARPA S., DE MARTINO M., ALBERTONI R.: A Joint Initiative to Support the Semantic Interoperability within the GIIDA Project. In *Proceedings of Gi4DM '10* (2010). 4

[Pug09] PUGLIANO A.: *Il riconoscimento, la documentazione, il catalogo dei beni architettonici : elementi di un costituendo thesaurus utile alla conoscenza, alla tutela, alla conservazione dell'architettura*. Prospettive, Roma, 2009. 3

[RDF11] RDF Encoding of Multilingual Thesauri. http://www.w3.org/2001/sw/Europe/reports/thes/8.3/, July 2011. 5

[SKO11] SKOS Simple Knowledge Organization System. http://www.w3.org/2004/02/skos/, July 2011. 2

[Sta11] STAR Project. Semantic Technologies for Archaeological Resources. http://hypermedia.research.glam.ac.uk/kos/star/, July 2011. 3

[TGP11] The Getty Provenance Index Databases. http://piprod.getty.edu/starweb/pi/servlet.starweb?path=pi/pi.web, July 2011. 2

[TOS07] TORDAI A., OMELAYENKO B., SCHREIBER G.: Thesaurus and Metadata Alignment for a Semantic ECulturE Application. In *Proceedings of K-CAP '07* (2007), pp. 199–200. 4

[TvOSW10] TORDAI A., VAN OSSENBRUGGEN J., SCHREIBER G., WIELINGA B.: Aligning Large SKOS-like vocabularies: Two Case Studies. In *Procedings of ESWS '10* (2010), pp. 198–212. 3

[vAGS06] VAN ASSEM M., GANGEMI A., SCHREIBER G.: Conversion of WordNet to a standard RDF/OWL representation. In *Proceedings of LREC '06* (2006). 4

[vAMS*04] VAN ASSEM M., MAARTEN R., SCHREIBER G., WIELEMAKER J., WIELINGA B.: A Method for Converting Thesauri to RDF/OWL. In *Proceedings of ISWC'04* (2004), pp. 17–31. 4