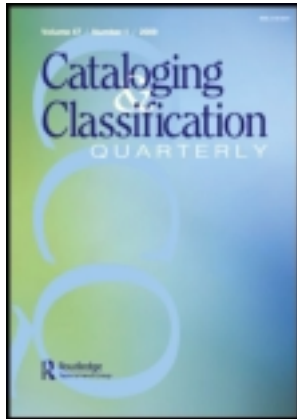


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### Data Aggregation and Dissemination of Authority Records through Linked Open Data in a European Context

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# **Data Aggregation and Dissemination of Authority Records through Linked Open Data in a European Context**

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*Throughout the analysis of the Polymath Virtual Library, data aggregation and dissemination of authority records through Linked Open Data are described. The aim of this virtual library is to reunite data, digital texts, and Web resources about Spanish, Hispano-American, Brazilian, and Portuguese polymaths from all times. Authors are the backbone of the system. For each author a MARC 21/Resource Description and Access (RDA) authority record has been created and enriched with biographical data. Specific attributes are categorized to enhance relationships and navigability of the site (profession, occupation, gender, memberships, birth and death dates and places, and languages) and visibility through Europeana and Linked Open Data.*

**KEYWORDS** *authority records, data aggregation, Linked Open Data*

## **INTRODUCTION: THE POLYMATH VIRTUAL LIBRARY**

The following reflections on aggregation and dissemination of authority records in Linked Open Data are based on a library practice currently in

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This article is an update of a paper presented at the open session of the Cataloguing Section of 77th IFLA General Conference and Assembly. It incorporates new reflections and references to crucial technical documents published in the meantime by different institutions. But what we believe is most important is that it adds new features to the described system, currently operational.

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production. These cataloging efforts are being made in the Polymath Virtual Library<sup>1</sup> that is part of the Virtual Libraries<sup>2</sup> of the Fundación Ignacio Larramendi. The main objective of the Polymath Virtual Library is to give a special relevance and significance to the work of Spanish, Portuguese, Brazilian, and Hispanic American thinkers (polymaths) from all time periods. With this aim, it creates and aggregates information already available on the Web about the thinking, philosophy, politics, science, and so on from Spain, Hispanic America, Portugal, and Brazil, written in any language (e.g., Latin, Arabic, Hebrew, Spanish, Portuguese) and from any time period. The Polymath Virtual Library aims to bring together the works of the most important Hispanic polymaths and to establish semantic relationships between them that express the different schools of thought, from Seneca to Octavio Paz in Hispania—the Iberian Peninsula now divided between Spain and Portugal.

This article highlights the importance of the bibliographical design of the project, something that should take precedence over technological issues, especially those as new as Linked Open Data. Indeed, these bibliographical objectives are the foundation of the functional requirements of both the cataloging practice and the specific developments of the Polymath Virtual Library. The project aims to collect and link data from a historical perspective about Iberoamerican thought, and to establish in turn relationships with other “civilizations,” to use the concept of Toynbee.<sup>3</sup>

## DIGITAL AGGREGATES AND AUTHORITY RECORDS

“Authors” are the backbone of the system. For each author a MARC 21/*Resource Description and Access* (RDA) authority record is made and is enriched with biographical data (see Figure 1). Specific attributes are categorized to enhance relationships and navigability (profession, occupation, gender, membership, birth and death dates, places of birth and death, and languages or script used). Digital versions of the works of each author are also described, following MARC (Machine Readable Cataloging)/RDA (14 update). Each author is related to other authors (translators, publishers, commentators, etc.), as a way of following the textual transmission and the influence of their work using author–title authority records for works, expressions, and manifestations. Thus, each authority record becomes a node of relationships that brings together data and resources from different sources, an aggregation of data or, what we would call, a “digital aggregate.”

These “digital aggregates” are the core components of the Polymath Virtual Library information system. Their style and layout are very close to traditional encyclopedia entries, with the level of complexity and completeness of some entries in Wikipedia (or DBpedia, as discussed below). The terms “aggregate” and “aggregation” have different uses, depending on the environment concerned and can generate some uncertainty in the reader.

The screenshot shows a web page titled "Menéndez y Pelayo, Marcelino (1856-1912)". The page is part of the "Colección de Polígrafos Españoles" and features a portrait of Marcelino Menéndez Pelayo. The main content area includes a navigation menu on the left with options like "PRESENTACIONES", "INTRODUCCIÓN", "BÚSQUEDA", "OBRAS COMPLETAS", "EPISTOLARIO", "BIBLIOGRAFÍA", "LIBROS ELECTRÓNICOS", "AUTORES RELACIONADOS", and "ENLACES RECOMENDADOS". The main content area displays the name "MARCELINO" and "MENÉNDEZ PELAYO" above a portrait. Below the portrait, there is a social media link "Síguenos en:" with Facebook and Twitter icons. The main content area also includes a "Formato:" section with options for "Ficha", "MARC XML", "CEAC-CPF", and "RDF", and an "Exportar" button. The main content area also includes a "Filiación:" section listing various institutions, a "Profesión / Ocupación:" section listing various professions, a "Género:" section listing "Hombre", and an "Apuntes biográficos:" section providing a detailed biography of Menéndez Pelayo.

**FIGURE 1** HTML Display of Menéndez Pelayo, Marcelino (1856–1912). <http://www.larramendi.es/aut/POLI20090015098> (Color figure available online).

Thus, in metadata harvesting processes, harvesters that also can be harvested (e.g., Hispana),<sup>4</sup> are called aggregators. However, the concept of digital aggregate used in the Polymath Virtual Library is much more in line with the definition conveyed by the Open Archives Initiative Object Reuse and Exchange (OAI-ORE),<sup>5</sup> for which an aggregate is a resource itself consisting of a set of inter-related resources. A “digital aggregate” would then be the set of data and digital information resources gathered around a particular author, its structure being a MARC 21 authority record (see Figure 2).

### Authority Control Process

The process of authority control carried out by the Fundación Ignacio Larramendi is much broader than the one that traditionally takes place in large libraries or bibliographic agencies. According to the Functional Requirements for Authority Data (FRAD),<sup>6</sup> the process covers not only the task of identification of the entity “person,” but also the tasks of contextualization. Therefore, authority records contain the following blocks of information:

- Identification of the name
- Biographical information

MARC 21 etiquetado | Aplicar | Exportar

Formato: MARC 21 etiquetado | Aplicar | Exportar

Enlace persistente

MARC XML | AAC-GPP | RDF

LDR 00000czm a2200000n 4500

001 POLI20090015098

003 FILA

005 20120626143723.0

008 090822n|az|nnaaan n a|a d

024 7 |\$a|http://viaf.org/viaf/64018425/|\$2|uri

024 7 |\$a|http://dbpedia.org/page/Marcelino\_Men%C3%A9ndez\_y\_Pelayo|\$2|uri

024 7 |\$a|http://id.worldcat.org/fast/15574|\$2|uri

025 |\$a|BNE1990010067

040 |\$a|BVFIL|,\$a|spa|,\$c|BVFIL|,\$a|rda|,\$a|BVFIL

042 |\$a|FIL

046 |\$f|1856|,\$g|1912

100 1 |\$a|Menéndez y Pelayo, Marcelino|,\$d|1856-1912

336 |\$a|Texto|,\$2|rdacontent

370 |\$a|Santander|,\$l|Cantabria|,\$c|España

370 |\$a|Santander|,\$l|Cantabria|,\$c|España

373 |\$0|FILA20100026915|,\$a|Universidad de Barcelona

373 |\$0|FILA20100025307|,\$a|Universidad de Madrid

373 |\$0|FILA20100027578|,\$a|Universidad de Valladolid

373 |\$0|FILA20090003538|,\$a|Real Academia Española

373 |\$0|FILA20090022126|,\$a|Biblioteca Nacional de España

374 |\$0|FILA20100005251|,\$a|Real Academia de la Historia (España)

374 |\$0|FILA20100026599|,\$a|Filólogos

374 |\$0|FILA20100025697|,\$a|Historiadores

374 |\$0|FILA20100026380|,\$a|Traductores

374 |\$0|FILA20100026410|,\$a|Bibliotecarios

375 |\$a|Hombre

377 |\$a|spa

400 1 0 |\$a|Menéndez Pelayo, Marcelino|,\$d|1856-1912

400 1 |\$a|Menéndez Pelayo, M.|,\$d|1856-1912

500 1 |\$0|FILA20120027589|,\$a|Milá y Fontanals, Manuel|,\$d|1818-1884|,\$f|http://dbpedia.org/ontology/influencedBy|,\$i|Influído por|,\$u|

500 1 |\$0|POLI20090014992|,\$a|Llorens y Barba, Francisco Xavier|,\$d|1820-1872|,\$c|http://dbpedia.org/ontology/influencedBy|,\$i|Influído por|,\$u|

500 1 |\$0|POLI20090019362|,\$a|Laverde Ruiz, Gumerindo|,\$d|1835-1890|,\$f|http://dbpedia.org/ontology/influencedBy|,\$i|Influído por|,\$u|

500 1 |\$0|POLI20090015128|,\$a|Unamuno, Miguel de|,\$d|1864-1936|,\$c|http://dbpedia.org/ontology/influenced|,\$i|Influye en|,\$u|

500 1 |\$0|POLI20090015159|,\$a|Menéndez Pidal, Ramón|,\$d|1869-1968|,\$f|http://dbpedia.org/ontology/influenced|,\$i|Influye en|,\$u|

500 1 |\$0|FILA20090030435|,\$a|Bonilla y San Martín, Adolfo|,\$d|1875-1926|,\$f|http://dbpedia.org/ontology/influenced|,\$i|Influye en|,\$u|

500 1 |\$0|FILA20120007154|,\$a|Bullón y Fernández, Eloy|,\$c|marqués de Selva Alegre|,\$d|1879-1957|,\$f|http://dbpedia.org/ontology/influenced|,\$i|Influye en|,\$u|

**FIGURE 2** MARC 21/RDA Display of Menéndez Pelayo, Marcelino (1856–1912). <http://www.larramendi.es/aut/POLI20090015098> (Color figure available online).

- Occupation
- Family relationships
- Affiliation and membership to institutions and formal groups
- Philosophical schools and movements
- Influence and professional relationships to other authors
- Resources available on the Web
- Links to other resources available as Linked Open Data

## Identification of Names and Multilingual Headings

Each authority record is defined, following the MARC 21 Format, by its main heading (1XX), its variants of name (4XX), its relations with other names (5XX), and the heading equivalence in other languages (7XX). An example of the importance of recording linguistically equivalent headings can be seen in authors such as Averroes, Maimonides, or Seneca. It is very well known how large databases, such as Europeana or WorldCat, give different results depending of the name used in the query. Only if we use the multiple language variants for names recorded in authority files will we be able to discover which of these authors' works are held in libraries and in which

countries; which works have been translated, into which languages, when and by whom; or what authors have been studied and by whom. In this way it is possible to follow the transmission of texts worldwide, and in consequence, to have a big picture of the influence and impact of ideas. This aspect is of great importance for the Polymath Virtual Library since all authors are selected not only for their importance within the Iberoamerican culture, but for the contribution of Iberoamerican culture to universal culture, and the reason why there is an absolute need for having equivalents in other languages. This same situation exists in Spain where, together with Castilian or Spanish, other languages such as Catalan, Valencian, Galician, and Basque coexist.

The *Discussion Paper 2001-DP05 Multilingual Authority Records in the MARC 21 Authority Format*<sup>7</sup> recommended a context marking technique to specify the language for headings (700 04 \$a Juan Pablo \$b II, \$c Papa, \$d 1920- \$7 aacr//spa). MARC 7XX fields allow one to register equivalent headings in different languages and, through this technique, the language of the heading, which is especially necessary in multilingual authority files. However, this recommendation was not ultimately included in the MARC 21 Format for Authority Records. Other mechanisms for expressing languages have limitations: the 008/08 position only codes English and/or French as language of the catalog and the 040 \$b only allows one to set the language of cataloging that often differs from the language of the heading. Of course, this situation derives from the MARC Format evolution, specifically since the Format Harmonization of USMARC and CAN/MARC in late 1990s. This is something that surely will be considered by the *Bibliographic Framework Transition Initiative*<sup>8</sup> because it is absolutely necessary in order to transform MARC authority records to Linked Open Data.

This situation is reasonably resolved in the Metadata Authority Description Schema (MADS) and certainly in the MADS/Resource Description Framework (RDF),<sup>9</sup> but it should not be forgotten that most MARC authority records do not have information about the language of headings and therefore it will be difficult to move this type of data immediately to the Linked Open Data environment. The Virtual International Authority File (VIAF) has inherited this problem and while it is possible to recognize the institution and country of origin of a record, it cannot be known, except by inference, in which language a heading is expressed. This is especially important in the case of headings produced in the same linguistic area that can be very similar or indistinguishable (e.g., “Geografía” in Spanish and “Geografia” [no accents] in Italian or Catalan).

## Variants of Personal Names

Authority files provide not only linguistic equivalences but also a large number of variants of names. The Polymath Virtual Library runs the integrated

library system (ILS) DIGIBIB,<sup>10</sup> which has its cataloging module fully integrated with authority records. Furthermore, this software uses all variants of names recorded in an authority record (4XX fields) to manage the ingestion of bibliographic records. So, all bibliographic records with non-authorized headings in their access points (i.e., with 1XX, or 6XX or 7XX, matching one 4XX), will be automatically modified in the ingestion process to be linked to the established heading in the 1XX field of the authority record that already exists in the Polymath Virtual Library database. Obviously, the more variants of names are recorded in an authority record, the greater the ability of authority records to provide consistency to the bibliographic database. This is especially important for the Polymath Virtual Library since one of its objectives is to gather bio-bibliographic information already available on the Web in digital format, but available metadata about these resources are very diverse in terms of quality. Furthermore, the many possibilities to reuse data provided by Linked Open Data require that data can be captured in a controlled way. For example, the authority record for Alfonso X, Rey de Castilla<sup>11</sup> contains 86 non-preferred names in its respective 400 fields, which means that any bibliographic record ingested containing one of these 86 variants as an access point is automatically linked to the accepted heading (i.e., the 100 field is rewritten with the established heading).

That authority control process is slower in the beginning, at the time of the creation of the authority record, but is much more productive in the medium term and offers much higher quality. As we shall see, this is essential in massive ingestion of bibliographic data from external sources. Also, it must be noted that the underlying bibliographical project is much better if these external sources pass through the sieve of authority records.

This procedure is especially important when we consider that polymaths are authors ranging from Seneca (Córdoba, 4 BC–Rome, 65 AD) to Octavio Paz (Ciudad de México, 1914–Ciudad de México, 1998) and many of them have used different names depending on the language in which they wrote, not to mention that these names have been translated and transliterated into several languages along with their works (e.g., Averroes is the Latin name of Ibn Rusd). Thus, registering variants and linguistically equivalent names helps to maintain consistency and quality of data, which also contributes to the bibliographical objectives of the Polymath Virtual Library. But most important, this allows any user to query the database not only for the established name or names appearing in the bibliographic record (i.e., 245), but also for all variants or equivalent names in authority records, and that is done automatically by the system; users do not need to go through complementary indexes of headings. That is, the system will respond with the same results if the query is “Alphonse le Sage” (400), “Alphonse, King of Castile and Leon” (700), or “Alfonso, Rey de Castilla” (100) (see Figure 3).

The image shows a web browser window displaying the search interface of the Fundación Ignacio Larramendi. The page title is "Bibliotecas Virtuales FHL > Buscar polígrafos o autores". The main heading is "Buscar polígrafos o autores en Bibliotecas Virtuales FHL".

On the left side, there is a navigation menu with the following items: INICIO, LA FUNDACIÓN, IGNACIO HERNANDO DE LARRAMENDI, BIBLIOTECAS VIRTUALES FHL (with sub-items: Buscar polígrafos o autores, Buscar obras, Guía de uso de esta edición digital, Características de esta edición), IGNACIO LARRAMENDI DE POLÍGRAFOS, PENSADORES TRADICIONALISTAS, COMENTARISTAS DE ARISTÓTELES, DOCUMENTACIÓN HISTÓRICA EN CATEDRALES, ESCUELA DE SALAMANCA, MENÉNDEZ PELAYO, FRANCISCO SÁNCHEZ, EL ESCÉPTICO, DOCUMENTACIÓN TÉCNICA (with a "L.A.M." logo), CARLISMO, ARCHIVO FAMILIAR MONTIANO, PUBLICACIONES DE LA FUNDACIÓN, NOTICIAS, SALA DE PRENSA, PREMIOS Y CONCURSOS, DIGIBIB, COLECCIÓN DE CLÁSICOS TAVERA, and ESTADÍSTICAS. At the bottom of the menu are social media icons for Facebook and Twitter.

The central search form includes the following fields:
 

- Cualquier campo: [input type="text"]
- Polígrafo o autor: [input type="text"]
- Colección: [dropdown menu]
- Escuela o movimiento: [dropdown menu]
- Fecha de Nacimiento: [input type="text"] entre [input type="text"] y [input type="text"]
- Fecha de Defunción: [input type="text"] entre [input type="text"] y [input type="text"]
- Ocupación: [input type="text"]
- Género: [dropdown menu]
- Lenguas: [dropdown menu]

 Buttons for "Buscar" and "Limpiar" are located at the bottom right of the form.

Below the form is an "Ayuda" section:
 

- Si quiere buscar una frase, enciérrala entre comillas. Por ejemplo: "Miguel de Cervantes".
- En cada campo puede introducir una o más palabras; el operador que enlaza los términos es Y.
- Los caracteres \* y ? buscan términos que comparten una misma raíz o palabras de ortografía dudosa. Por ejemplo: "ilustr\*", recuperará las palabras ilustrador, ilustraciones, ilustrada, ilustrativo, etc.; y "primiti?a" recuperará los términos primitiva y primitiva. No deben usarse estos caracteres como inicio de un término de búsqueda.
- En "Cualquier campo" encontraremos todos los resultados relacionados con el término que buscamos.

On the right side, there are four vertical panels, each with a portrait of an author and a title:
 

- COLECCIÓN DE POLÍGRAFOS ESPAÑOLES
- COLECCIÓN DE POLÍGRAFOS HISPANOAMERICANOS
- COLECCIÓN DE POLÍGRAFOS PORTUGUESES
- COLECCIÓN DE POLÍGRAFOS BRASILEÑOS

**FIGURE 3** Query Form. [http://www.larramendi.es/i18n/consulta\\_aut/busqueda.cmd](http://www.larramendi.es/i18n/consulta_aut/busqueda.cmd) (Color figure available online).

## Contextual Information

MARC 21 Format updates, from No. 9, published in September 2008, to No. 14 of 2012, consolidate a number of fields, following RDA, which are essential for the aggregation of information about persons. We refer, of course, to 37X fields. From a historical standpoint,<sup>12</sup> some elements that initially were intended to differentiate between homonyms, have gradually acquired a constitutive value in themselves. Thus, subfields of field 100 that were recommended only to distinguish between authors with the same name, became mandatory, most notably \$d, because they immediately contextualize an author from a chronological point of view, which often helps to resolve attribution errors. Until the adoption of RDA by MARC 21<sup>13</sup> there were no specific elements for attributes as expressive as the birth place, among others. These attributes refer not to the *name* of the person but to the *person* themselves and give MARC records an essentially encyclopedic look, almost “dbpedic,” if we may use this neologism. This greatly extends the traditional function of authority files, turning them into nodes of data and relationships that enable the aggregation of all kinds of information in an organized way, according to a clearly defined framework.



For each author, in addition to the canonical form of the name, its variants and equivalents in other languages, we provide the author's biography (678), dates of birth and death (046), birth and death places (370) and any other place of activity (370), occupation (372 and 374), the language used (377), gender (375) and associated group (373).

```
046 ## $f1856$g1912
100 1# $aMenéndez y Pelayo, Marcelino$d1856-1912
370 ## $aSantander$fCantabria$cEspaña
370 ## $bSantander$fCantabria$cEspaña
373 ## $OFILA20100026915$aUniversidad de Barcelona
373 ## $OFILA20100025307$aUniversidad de Madrid
373 ## $OFILA20100027578$aUniversidad de Valladolid
373 ## $OFILA20090003538$aReal Academia Española
373 ## $OFILA20090022126$aBiblioteca Nacional de España
373 ## $OFILA20100005521$aReal Academia de la Historia (España)
374 ## $OFILA20100026359$aFilólogos
374 ## $OFILA20100025697$aHistoriadores
374 ## $OFILA20100026380$aTraductores
374 ## $OFILA20100026410$aBibliotecarios
375 ## $aHombre
377 ## $aspa
```

These attributes of persons ultimately aim to support semantic search and navigation among data. They allow the Polymath Virtual Library Web site to offer the ability to search authors by dates of their activities, the places associated with their biography, their professions and occupations, not only by their works, as is relatively common in Web online public access catalogs (OPACs).

For the purpose of the Polymath Virtual Library, the release of RDA strengthened its bibliographic strategies and its primary priorities. First, in the retrieval of information about authors, following user tasks defined in FRAD as contextualization and search; and secondly, structuring its information resources in the form modeled in RDA, following Functional Requirements for Bibliographic Records (FRBR), as Work-Expression-Manifestation-Item.<sup>14</sup> User tasks posed by FRAD, contextualization and search, are a crucial extension of the usual functionality of authority files, mainly focused on the identification of names. For Polymath Virtual Library the focus of authority files has changed to the search for information about people and their context, as well as covering the traditional functionality of identification. Similarly, the WEMI structure of FRBR and RDA to organize in a logical manner all original works (W), translations (E) and manifestations (M), including digital versions is especially important since the Polymath Virtual Library attempts to bring together digital resources available on the Web that may refer to different works, expressions, and/or manifestations. Similarly, this

view is of interest to all virtual and digital libraries that run on DIGIBIB. For this reason, subsequent new versions of DIGIBIB implemented the MARC 21 updates immediately to the extent that the ILS DIGIBIB paced its new release to MARC 21 updates.

### Authority Records in Other Metadata Schemas

Information on corporate bodies, persons, and families from archives has the same interest to the Polymath Virtual Library. The need for convergence of archives, libraries, and museums data is taken into account and some examples of excellent quality can be accessed.<sup>15</sup> They often arise as unified query interfaces that contribute to strengthening the informative capacity of such data. DIGIBIS has recently carried out a work of this kind with the project of the Junta de Castilla-La Mancha dedicated to Archivo de la Imagen<sup>16</sup> (photographs) and the Archivo de la palabra (sound recordings).<sup>17</sup> For all this, a systematic mapping of MARC 21 to EAD and EAC-CPF has been done, as well as ISAD (G) and ISAAR (CPF). This mapping has been incorporated into the Polymath Virtual Library; all digital aggregates (MARC 21/RDA records) can be downloaded as EAC-CPF Schema and viewed following ISAAR-CPF. It is becoming very clear that the maintenance of authority files, as parallel and isolated files, in libraries, archives, and museums is economically unsustainable and that this mapping can contribute to the reuse of data from these files in environments other than those for which they were created.<sup>18</sup> And, of course, they could become a powerful tool for discovering and retrieving information.

Polymath Virtual Library also uses authority records to link bibliographic and archival materials, as is the case of Agustín de Montiano y Luyando (1697–1794), historian and playwright, who is well remembered as the first director of the Real Academia de la Historia, founded in 1735, and whose papers are part of the Larramendi Virtual Libraries.<sup>19</sup>

### LINKING DATA

The Polymath Virtual Library is a content provider for Europeana,<sup>20</sup> harvested by Hispana,<sup>21</sup> which is the Spanish national aggregator in the Europeana network, and also uses its database as a source of information. This is one of the reasons why the Polymath Virtual Library has analyzed the Europeana Data Model (EDM)<sup>22</sup> and decided to incorporate Linked Open Data<sup>23</sup> technology. Linked Open Data (LOD) is evolving in an extremely rapid way and is providing vast amounts of data (e.g., VIAF<sup>24</sup> or DBpedia<sup>25</sup>). Since Linked Data was first proposed by Tim Berners-Lee in 2006, reusable data structured semantically have been published at a rate surely not seen on the Web before, perhaps with the exception of library MARC bibliographic records.

Regarding the library contribution to LOD, it should be noted that the W3C Library Linked Data (LLD) Incubator Group<sup>26</sup> was created in 2010 and ended its work in 2011. This group released its *Final Report*<sup>27</sup> on October 25, 2011, jointly with the use cases<sup>28</sup> collected by the Group to analyze the extent of LLD, and the datasets, value vocabularies, and metadata element sets<sup>29</sup> in use in the library community. The activity of the LLD community can be followed on the Web site, LLD, of The Data Hub.<sup>30</sup>

For the Polymath Virtual Library, LOD and related technologies represent an opportunity to fully realize the approach of the “digital aggregates” as nodes of Linked Data. In fact, the Polymath Virtual Library is one of the use cases<sup>31</sup> reviewed by the LLD. It is not only about capturing information, but also about linking it to relevant nodes of the LOD cloud and its resources, according to the rules of the game where it is expected that each one fulfills its role. Each resource available in a LOD dataset is identified by a Uniform Resource Identifier (URI) with special characteristics.<sup>32</sup> This URI drags a network of relations, attributes, to other resources that define, following the model used (Web Ontology Language [OWL] ontology or RDF Schema), entities, and properties of a given functional area. But what really adds value is that it provides a way to state that an entity from one environment is the same or very close to another entity in another environment. Thus, Maimonides is a philosopher for DBpedia and the name of a person for VIAF. The process consists of linking such data through URIs, opening them for reuse, and, through appropriate tools,<sup>33</sup> to analyze them and deduce other data from their relations and inference rules, and to update original data to serve them again, once they have been modified and expanded. And so on, repeatedly.

These ideas can be illustrated with a subset of the Polymath Virtual Library dedicated to Francisco Sánchez, the Skeptic (1550–1623).<sup>34</sup> This author was influenced by Pyrrho<sup>35</sup> and Sextus Empiricus,<sup>36</sup> through the translation of the *Outlines of Pyrrhonism* by Sextus Empiricus into Latin in 1562, the date in which its princeps edition appeared. Links to other resources that describe these authors can be established, via URIs. Since Montaigne<sup>37</sup> and Descartes<sup>38</sup> were in turn influenced by Sanchez and Pyrrho himself, via Sextus Empiricus—in fact the famous *Que sais-je?* comes from Pyrrho—there is an obvious interest in linking these two French writers to the Spanish author, or to a third one called Gomez Pereira,<sup>39</sup> in whom already appears explicitly the Cartesian dictum *Cogito, ergo sum*. These influences are shown by means of semantic relationships between authors and their works, using the mechanisms that LOD allows.

This aspect can be seen also in the subset of the Polymath Virtual Library called *School of Salamanca*.<sup>40</sup> This collective name includes a set of Spanish and Portuguese scholars (mostly theologians, jurists, and economists) who participated directly in the Renaissance in the sixteenth and early seventeenth centuries that follows the discovery of the New World, with roots in

the intellectual and pedagogical work of Francisco de Vitoria, to cite one eminent case, at the Universidad de Salamanca. The ultimate goal is simply to follow the influence of these precursors of some fields of law, politics, and especially economy.<sup>41</sup> The Modern Age was a significant change in the concept of man in society and it is precisely the *Escuela de Salamanca* that addresses these issues from new approaches. That way, Francisco de Vitoria, Domingo de Soto, Martín de Azpilcueta, Tomás de Mercado, and Francisco Suárez attempted to reconcile the Thomistic doctrine with the new social and economic order. Thus we find a group of authors that forecast economic science,<sup>42</sup> were concerned about the moral legitimacy of the conquest, and developed very innovative theories.<sup>43</sup>

### DBpedia and VIAF

In 2010 the Polymath Virtual Library began to link authority records with similar existing resources in LOD. VIAF URIs are registered in the MARC 21 field 024 of authority records. The RDF resource Maimonides (rdf:about = "viaf/100185495") groups established headings for this author from seven different authority files, with 255 variants of names, but also provides links to the content of DBpedia (<http://dbpedia.org/resource/Maimonides>). If the librarian is experienced and has expertise in this area (i.e., a senior cataloger), he or she can deduce from the net of VIAF relationships up to twelve different headings for Maimonides,<sup>44</sup> from various countries and languages.

```
024 7 # $ahttp://dbpedia.org/page/Maimonides$2uri
024 7 # $ahttp://viaf.org/viaf/100185495$2uri
024 7 # $ahttp://viaf.org/viaf/100185448$2uri
024 7 # $ahttp://id.worldcat.org/fast/29218$2uri
040 # # $aBVFIL$bspa$cBVFIL$dBVFIL
046 # # $f1138$g1204
100 1 # $aMaimónides$d1138-1204
370 # # $aCórdoba$cEspaña$fAndalucía
370 # # $bEl Cairo$cEgipto
373 # # $0FILA20120000087$aEscuela de Traductores de Toledo
374 # # $0FILA20100025369$aTeólogos
374 # # $0FILA20100025383$aFilósofos
374 # # $0FILA20100026762$aMédicos
```

Among the general sources of data used in the Polymath Virtual Library, VIAF has been included preferentially. VIAF gathers a number of authoritative sources of information such as the Library of Congress, the British Library, or the Deutsche Nationalbibliothek. The great advantage of VIAF is its ability to navigate from authority record clusters to each of the constituent

headings from different authority files that contribute to VIAF. This allows the selective choice of headings by source: the National Library of Spain for Spanish authors, the National Library of Portugal for Portuguese authors, the National Library of Brazil<sup>45</sup> for Brazilians, and so on; and, as a common bond, those from the Library of Congress. It is essential that from a query one could establish a new, very important and universal feature consisting of a digital aggregate with all bibliographic records linked to authority records. As mentioned later, VIAF has a Search/Retrieval via URL (SRU) server that undoubtedly can facilitate the complex retrieval tasks outlined in this article.

VIAF can connect at this time to nearly twenty authority files through which it gives access to a large number of library catalogs. It is very important to note that only in some cases are authority fields 100 linked to subject headings (6XX fields) in bibliographic records. If this functionality were always present it would also provide access to works about an author,<sup>46</sup> and then VIAF could be used as a library resource hub not only for works by an author but also works about the same author.

The Polymath Virtual Library is interested in expressing relations between people or between people and institutions in other ways than defined by the MARC 21 format. LOD technologies have expanded the ability to reflect these influences for the benefit of those interested in the genealogy of ideas. This is the case of influence properties defined in DBpedia Ontology (<http://dbpedia.org/ontology/influenced> and <http://dbpedia.org/ontology/influencedBy>). We are currently working on implementing a set of properties for all relevant relations to the Polymath Virtual Library not defined in MARC 21, reusing those defined in other vocabularies and metadata element sets, basically DBPedia,<sup>47</sup> FRAD,<sup>48</sup> FRBR,<sup>49</sup> and RDA Elements<sup>50</sup> or RDA Relationships.<sup>51</sup> Following the recommendations of the W3C Library Linked Data Incubator Group and Linked Open Data best practices, any relationships considered necessary in digital aggregates are reused from already published vocabularies and ontologies—logically if they are consistent in their definition with the purposes of the Polymath Virtual Library. For example, to express family relationships or biographical events, we use properties defined in *RELATIONSHIP: A Vocabulary for Describing Relationships Between People*<sup>52</sup> or *BIO: A Vocabulary for Biographical Information*.<sup>53</sup>

It is clear that a relationship like “is influenced by” or “is sibling of” cannot be expressed according to MARC 21 Format, but recent updates open a door to establish other relationships than those previously foreseen for 5XX fields. As MARC 21 says: “When a tracing field contains a relationship designation in subfield \$i, control subfield \$w/0 contains code r (Relationship designation in subfield \$i or \$4). Code r indicates that the generation of a tag related reference instruction phrase in a cross reference display should be suppressed. The content of subfield \$i or \$4 should be used to generate the reference instruction phrase that is used in a cross reference display.”

This definition along with *Discussion Paper No. 2010-DPO2: Encoding URIs for controlled values in MARC Records*<sup>54</sup> is allowing us to experiment with new types of non-MARC relationships, while maintaining the interoperability provided by MARC.

The MARC encoding of influence relationships for Marcelino Menéndez Pelayo is as follows:

```

500 1# $0FILA20120027589$aMilá y Fontanals, Manuel$d1818-
1884$4http://dbpedia.org/ontology/influencedBy$iInfluido
por$wr
500 1# $0POLI20090014992 $aLlorens y Barba, Francisco Xavier $d1820-
1872
$4http://dbpedia.org/ontology/influencedBy $iInfluido por $wi
500 1# $0POLI20090019362 $aLaverde Ruiz, Gumersindo $d1835-1890
$4http://dbpedia.org/ontology/influencedBy $iInfluido por $wr
500 1# $0POLI20090015128 $aUnamuno, Miguel de $d1864-1936
$4http://dbpedia.org/ontology/influenced $iInfluye en $wr
500 1# $0POLI20090015159 $aMenéndez Pidal, Ramón $d1869-1968
$4http://dbpedia.org/ontology/influenced $iInfluye en $wr
500 1# $0FILA20090030435 $aBonilla y San Martín, Adolfo $d1875-1926
$4http://dbpedia.org/ontology/influenced $iInfluye en $wr
500 1# $0FILA20120007154 $aBullón y Fernández, Eloy $cmarqués de
Selva Alegre,
$d1879-1957 $4http://dbpedia.org/ontology/influenced $iInfluye
en $wr
500 1# $0POLI20090015258 $aSáinz Rodríguez, Pedro $d1897-1986
$4http://dbpedia.org/ontology/influenced $iInfluye en $wr
500 1# $0FILA20090011137 $aAgenjo Bullón, Xavier $d1955-
$4http://dbpedia.org/ontology/influenced $iInfluye en $wr
500 1# $0FILA20120030435 $aMenéndez Pelayo, Enrique $d1861-1921
$4http://purl.org/vocab/relationship/siblingOf $iHermano de $wr
510 2# $0FILA20100006634 $iCreador $aBiblioteca Menéndez y Pelayo
$4http://purl.org/dc/terms/creator $wr

```

Obviously, making the visualization of these relationships and links suitable for users depends on programming. Figure 4 shows how the ILS DIGIBIB offers a usable view of relationships coded in MARC 21.

Clearly, the process of acquiring these data manually is very accurate, but it is slow, and the potential for automation was recognized early, weighing the advantages and disadvantages of doing so. Undoubtedly, the number of authors who constitute the Polymath Virtual Library, around 1,000, would allow it to be done manually, but productivity in time and data could be increased with automation.

**Referencia de véase:**

Menéndez Pelayo, Marcelino (1856-1912)  
Menéndez Pelayo, M. (1856-1912)

**Ref. de véase además:**

Creador  
Biblioteca Menéndez y Pelayo

Hermano de  
Menéndez Pelayo, Enrique (1861-1921)

Influido por  
Milá y Fontanals, Manuel (1818-1884)  
Llorens y Barba, Francisco Xavier (1820-1872)  
Laverde Ruiz, Gumersindo (1835-1890)

Influye en  
Unamuno, Miguel de (1864-1936)  
Menéndez Pidal, Ramón (1869-1968)  
Bonilla y San Martín, Adolfo (1875-1926)  
Bullón y Fernández, Eloy, marqués de Selva Alegre, (1879-1957)  
Sáinz Rodríguez, Pedro (1897-1986)  
Agenjo Bullón, Xavier (1955-)

**Más información:**

-  Acceso a Menéndez Pelayo digital: obras completas, epistolario y bibliografía
-  Comentario a la obra de Menéndez Pelayo realizado por el Profesor Emilio Blanco.
-  Proyecto de Filosofía en Español
-  Marcelino Menéndez Pelayo (Hispanismo.org)
-  Usoz y Río, y Wiffen: dos bibliófilos en las Cortes de Isabel II (Protestante Digital)
-  Miguel Serveto en la crítica filosófica de Menéndez Pelayo
-  Marcelino Menendez Pelayo Por Francisco Arias Solis
-  Propugnación de la racionalidad de los brutos de Miguel Pereira de Castro Padrañ
-  Biblioteca Saavedra Fajardo
-  Imagen asociada a la ficha. Retrato de don Marcelino Menéndez Pelayo. Óleo de Joaquín Sorolla (Hispanic Soc

**FIGURE 4** Visualization of Relationships (Color figure available online).

## SKOS: Another Way to Linked Open Data

These types of links have also been carried out with subject headings using Simple Knowledge Organisation System (SKOS), showing that a particular concept is the same as, or very similar to, other concepts in other concept schemas. Through subject headings in bibliographic records, and by linking concepts with other value vocabularies also available in SKOS, one can also get a very wide number of works about an author. In addition, the process of finding information resources can be done automatically, by covering the network of relationships between concepts in different vocabularies and being able to retrieve information resources linked to these concepts in different datasets or databases.

At present, the Polymath Virtual Library is linking its subject headings to *Lista de Encabezamientos de Materias para Bibliotecas Públicas*<sup>55</sup> (List of Subject Headings for Public Libraries (LEM)) which was set up on July 20, 2011 by the Dirección General de Bellas Artes y Bienes Culturales y de Archivos y Bibliotecas of the Spanish Ministry of Education, Culture and Sport. This *Lista* appeared in the last version of the LOD Cloud of September

2011 and is part of the Library Linked Data Group of the Data Hub.<sup>56</sup> Its first release was linked to the *Library of Congress Subject Headings* (LCSH),<sup>57</sup> and since December 2011 it has also been linked to RAMEAU<sup>58</sup> and to Schlagwortnormdatei (SWD).<sup>59</sup> Such conceptual relationships certainly will not possess a big granularity, but treated and crossed with a determined number of authors could offer a clear network of links between large sets of information significantly.

024 7 # \$ahttp://id.sgcb.mcu.es/Autoridades/LEM201010672/concept\$2uri

024 7 # \$ahttp://id.worldcat.org/fast/1119940\$2uri

024 7 # \$ahttp://id.loc.gov/authorities/subjects/sh85123125\$2uri

035 # # \$aXX526701

080 # # \$a165.72\$2CDU

080 # # \$a17.037\$2CDU

150 # # \$aEscepticismo

It would, therefore, be possible to follow these links from Francisco Sanchez to Skepticism and to all the resources associated with these URIs. Obviously the next step to be taken is to make use of that net of links to build a mash-up of information.

### Time and Space or Space–Time

Two other elements, chronological and geographical data, play an essential role in the aggregation and linking of data relating to an author. Indeed, authors live and die on certain dates; they work and have social relationships with their contemporaries during certain periods and they write books that are published or translated on very specific dates.<sup>60</sup> The possibility of linking authors' data by this new chronological category, not only by name or subject, specifies the work set of an author, although it is certain that scattering or inconsistency will be visible. The codification of time, present in many elements of the authority or bibliographic records, often needs attributes to express probability, inaccuracies, estimations, and so on that are so frequent in descriptions of people and resources, not to mention events. Such data are essential for the generation of timelines or to perform operations and deductions with dates, as can be seen, for example, in WorldCat Identities.<sup>61</sup>

Similar work is being done in aggregating and linking geographic data. In fact, a major initiative for this type of data, GeoNames,<sup>62</sup> exists within LOD that has its parallel in Spain by the transformation of geographic databases from Instituto Geográfico Nacional<sup>63</sup> to RDF. Again, there, the aggregation process can be enlarged. Authors have been born and have died in a particular place, have been associated with their contemporaries in certain places, perhaps schools, universities, religious orders, or military, scientific, and cultural societies, or political groups located or related to a specific location.



Therefore, and through them, it is possible to establish new and appropriate aggregations and links.

The process of linking to GeoLinkedData and GeoNames data was done in an automated way, converting the selected data in a structure valid for its ingestion in DIGIBIB. These data have been mapped to MARC, to automatically update all subfields in 752 and 151. That way, we have obtained not only the names available in these valuable vocabularies, but also the geographic coordinates.

Certainly there must be further manual work to solve problems that may arise to differentiate jurisdictions from geographic locations and geographic locations of old jurisdictions. Similarly, as discussed, it is one thing to manage resources about persons and another to manage resources about names of persons. It is clear that to manage jurisdictions, geographic names and geographic locations are supposed to have different attributes.

The wealth and ambiguity of human language must be translated into a semantic structure carefully so that machines can correctly interpret the context. For example, the name Biblioteca de Menendez Pelayo Library can refer to a building with specific geographic coordinates, to a library collection, and to the institution that manages the collection and library services; this is something very well known. The rules to construct headings are made, among other things, to break up these ambiguities. But in LOD and the Semantic Web disambiguation occurs not only in human readable labels, but also in defining the classes to which this ambiguous name can belong, which means a series of unique and distinguishable attributes. At this time of revision of bibliographic data structures to meet the challenges of the Web of Data it is especially important to note that the human-readable text strings in MARC records undo many ambiguities that would not be possible for software agents if they are not given enough data. Otherwise the spatial representation would be an anachronism.

## Europeana Data Model

We already have mentioned two large-scale projects being undertaken simultaneously, but with different dimensions, that affect the Polymath Virtual Library, not only in its content but also from the point of view of functional requirements. These projects are Hispana<sup>64</sup> and Europeana.<sup>65</sup> About Hispana there are few papers detailing its creation and evolution—which is surprising given the characteristics and dimensions of the project—although there are numerous presentations.<sup>66</sup> As of July 2, 2012, Hispana has collected 3,607,866 digital objects from 172 Spanish repositories. There is obviously much more documentation about Europeana, but for the purpose of this article it is important to note the new data model *Definition of the Europeana Data Model Elements*, version 5.2.3,<sup>67</sup> updated on February 24, 2012

and the *Final Technical and Logical Architecture and Future Work Recommendation*,<sup>68</sup> published on October 31, 2011—both in the Danube phase of Europeana.<sup>69</sup> *Europeana Data Model Primer*<sup>70</sup> updates and summarizes the current state of standardization in relation to the version 5.2.3. In addition, Europeana has produced the Europeana LOD Project.<sup>71</sup>

It is not by coincidence that the developments carried out for the Polymath Virtual Library and for the Fundación Ignacio Larramendi are so strongly associated with the functional specifications of Europeana. The reason is this: Spain participates significantly in Europeana through Hispana (with 1,699,229 digital objects as opposed to the Biblioteca Virtual Cervantes<sup>72</sup> that provides only 19,062, although this second project is much more publicized). It happens that both Hispana and most content providers harvested by Hispana<sup>73</sup> are running the ILS DIGIBIB, currently at version 7.0. One should not overlook the fact that the company DIGIBIS<sup>74</sup>—which provides the ILS DIGIBIB, as well as DIGIARCH for archives and an Open Archives Initiative (OAI)-compliant repository called OAsIs—is a company owned by Fundación Ignacio Larramendi, and that the Polymath Virtual Library is systematically used as a testbed for its developments. Therefore (and if so desired by the clients) many of the features described here significantly affect some thirty major Spanish digital libraries, and more than a hundred others if we consider the digital collections collectively gathered by the Biblioteca Virtual de Patrimonio Bibliográfico and the Biblioteca Virtual de Prensa Histórica.<sup>75</sup>

Europeana's new semantic features have been truly decisive to confirm the planned development of a new semantic structure of data for the Polymath Virtual Library. For these features, both Europeana and Hispana are two primary sources of information for the Polymath Virtual Library and two methodological examples providing feedback. One of the main strategic lines of Europeana is the complete adoption of LOD for which it defined the Europeana Data Model (EDM). Basically, EDM is a high-level ontology consisting of proper elements (edm prefix), some of them equivalents to CIDOC-CRM or FRBR, and other elements from different namespaces (Dublin Core, OAI-ORE, SKOS). The first step taken by the Polymath Virtual Library was the adoption of the EDM.

In the process of moving to the new data model, Europeana might be able to treat data more or less automatically in order to transform the information received from content providers to EDM, but considering that these providers already number in the several thousands, working with more than 25 languages and as many vocabularies, makes us believe that this treatment will only affect an undetermined percentage of data, with results that are impossible to verify and with a great risk of making false equivalences and relationships. While such a procedure can be practical and would be able to resolve the linkage between parts of data, it cannot be extended to all, and cannot be enhanced without the intervention of the content providers

themselves. In a typical case, geographical names are often really historical jurisdiction names whose coordinates could not coincide with the geographical coordinates of the current jurisdictions and, thus, matching Castile of the fifteenth century to current Castile is only an approximation. Anyway, the Polymath Virtual Library has begun publishing its data in LOD, through the EDM.

Mapping MARC 21 bibliographic records to Europeana Semantic Elements 3.4<sup>76</sup> and to the Europeana Data Model has a relative difficulty. But, if this process takes place without linking data to external sources or vocabularies, it will be very difficult for Europeana to make an accurate aggregation of data (in the sense of OAI-ORE). Or in other words, one of the ways to establish links between Europeana resources will be through links to external vocabularies. For this DBpedia, VIAF, LCSH, GeoNames, and so on, will be invaluable. For this reason also, authority records become the essence of EDM and LOD.

The methodology of incorporating VIAF or DBpedia URIs into authority records has proved to be very useful since the generation of EDM data can offer a reference to an external source for the class *Agent*. The second linking process was carried out through LCSH available in *id.loc.gov* via the *List of Subject Headings for Public Libraries* (LEM). Thus, the Polymath Virtual Library published its subject headings in SKOS, but linked to LEM, and through LEM, to LCSH, RAMEAU, and SWD. Thus, the property *dc:subject* will be associated with a *skos:Concept*, linked to LCSH, to RAMEAU<sup>77</sup> and SWD,<sup>78</sup> as a minimum; that means subject headings available in a semantic structure and associated with the same heading expressed in English, French, and German. This clearly shows the advantage of linking different datasets to one or more specific value vocabularies.

In addition to this, which is paradoxical, the same procedure may be applicable for interconnecting national data. One effect of using LCSH as one of the main sources to justify the preferred label for subject headings in Spanish libraries is that through this relationship (in field 670) it is possible to link different Spanish subject headings lists in several languages. This is a very beneficial side effect of LOD, even in an indirect way, as it will allow linking data between Spanish library catalogs and authority files that have remained fairly isolated, much more than desirable and comprehensible.

Here again we must point out another benefit of Europeana in improving the information systems of a country. The Spanish Ministry of Education, Culture and Sport that maintains Hispana is also in the process of adapting to EDM and one of their first activities has been the conversion of the List of Subject Headings for Public Libraries (LEM) to SKOS, linking entries, when possible, with LCSH, RAMEAU, and SWD. Logically, the Polymath Virtual Library links its subject headings with LEM. It is hoped that through the LEM dataset other Spanish subject headings lists, in Galician, Catalan, Valencian, and Basque, could be linked. In addition, other digital libraries,

```

- <rdf:RDF xsi:schemaLocation="http://www.w3.org/1999/02/22-rdf-syntax-ns# http://europeanlabs.eu/svn/europeana/trunk/ROOT/src/main/webapp/schemas/edm/EDM.xsd">
  - <edm:Agent rdf:about="http://www.larramendi.es/aut/POLI20090012677">
    <skos:prefLabel xml:lang="es">Mariana, Juan de (1536-1624)</skos:prefLabel>
    <owl:sameAs rdf:resource="http://dbpedia.org/resource/Juan_de_Mariana"/>
    <skos:altLabel xml:lang="es">Mariana, Padre (1536-1624)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Juan de, (S.I.) (1536-1623)</skos:altLabel>
    <skos:altLabel xml:lang="es">De Mariana, Juan (1535-1624)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, J. de (Juan) (1535-1624)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Ioannes (1535-1624)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Juan de (1535-1624.)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Juan de (1536-1624.)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Juan de (1535-1624)</skos:altLabel>
    <skos:altLabel xml:lang="es">Mariana, Juan de</skos:altLabel>
  - <skos:note xml:lang="es">
    "Bibliotecas Virtuales FHL. Edición 2008". Madrid : Fundación Ignacio Larramendi , 2008 , p. 166
  </skos:note>
  - <skos:note xml:lang="es">
    Catálogo de Autoridades de la Biblioteca Nacional de España (BNE19900416146). Visitado el 23 de marzo de 2010
  </skos:note>
  - <skos:note xml:lang="es">
    VIAF - ID:89794074. - http://www.viaf.org/viaf/89794074/
  </skos:note>
  - <skos:note xml:lang="es">
    Diccionario Biográfico Español de la Real Academia de la Historia. Visitado el 22 de septiembre de 2010
  </skos:note>
  - <skos:note xml:lang="es">
    Library of Congress Authorities. LC Control Number: n 81099091
  </skos:note>
  - <skos:note xml:lang="es">
    Díaz Díaz, Gonzalo. Hombres y Documentos de la Filosofía Española. Tomo V. Pp. 170-183
  </skos:note>
  - <skos:note xml:lang="es">
    Teólogo y escritorista sin parangón, realizó sus estudios en Alcalá de Henares y el noviciado en el colegio jesuita de Simancas. Enseñó en Alcalá de Henares, Roma, Sicilia y París, hasta que por problemas de salud, en 1573, fija su residencia en Toledo. Su trabajo más difundido es la Historia de España, escrito primero en la lengua franca del momento, el latín, para mejor divulgar su contenido, bajo el título de Historiae de rebus Hispaniae libri XXI; fue publicado en 1592 y traducido por el propio Mariana al castellano entre 1601 y 1615. Es un tratado histórico que ha sido que ha sido frecuentado en España por todas las clases sociales desde su publicación y que se convirtió en el más conferenciado hasta el siglo XXV del imperio colonial español. Mencionarame
  </skos:note>

```

**FIGURE 5** A MARC Authority Record in EDM. <http://www.larramendi.es/aut/POLI2009-0012677.rdf> (Color figure available online).

implemented in DIGIBIB, are already able to provide metadata in EDM 5.2.3, e.g., Biblioteca Virtual de Patrimonio Bibliográfico, Biblioteca Virtual de Prensa Histórica, Biblioteca Virtual del Principado de Asturias, Biblioteca Digital de Castilla y León, Biblioteca Valenciana Digital, and Biblioteca Virtual de Defensa among others.

These processes have converged both in the full implementation of EDM and in the publication of the Polymath Virtual Library, which already supports content negotiation, as a datasets<sup>79</sup> in LOD. In fact the Polymath Virtual Library is one of the case studies for its implementation of EDM (see Figure 5).<sup>80</sup>

In this sense, the publication of such data as LOD should be slow, corresponding with the progress of the bibliographic plan so that only data well established, with a reasonable degree of liability, and sufficiently linked<sup>81</sup> are published. Just as the bibliographical project of the Polymath Virtual Library involves a critical selection of sources, its publication as LOD implies a similar selection of datasets. Metadata element sets, vocabularies, or ontology mappings and alignment should not make us lose sight of the library forest, that is of the bibliographical objectives of datasets that are going to be published in LOD.

## USING LINKED OPEN DATA, SEMI-AUTOMATIC PROCESSES

The Polymath Virtual Library is taking steps again to take advantage of certain library data that it is pouring into the form of LOD datasets,<sup>82</sup> and is doing so from the consumer's as well as the producer's point of view.

VIAF can be queried and results can be obtained in MARC XML or RDF, among others. Through its API<sup>83</sup> VIAF can be searched via SRU and OpenSearch, and results can be downloaded in MARC XML, RDF, and a variety of formats and schemas. VIAF<sup>84</sup> is also available as LOD. Following the recommendation to publish data in LOD,<sup>85</sup> accessing and querying datasets is often done through SPARQL Endpoint<sup>86</sup> or SPARQL clients<sup>87</sup> that can be used to query RDF files. This means that DBpedia<sup>88</sup> or VIAF can be searched via SPARQL<sup>89</sup> and therefore queries can make a logical sweep against data and retrieve much more related information. Also, with SPARQL it is possible to define a more complex search. One example that can be done in DBpedia, but not in VIAF, is "philosophers influenced by Maimonides."

```
select * where {
?x a <http://dbpedia.org/ontology/Philosopher>.
?x <http://dbpedia.org/property/influences>?y
FILTER (regex(?y, "Maimonides"))
}
```

DBpedia exemplifies here a dataset about, among other things, persons while VIAF is about the names of persons and their works; the Polymath Virtual Library wants to reach both functionalities.

As a consumer of information, Polymath Virtual Library is developing various applications for data capture, integration, and dissemination. We already mentioned data reuse from GeoNames or LEM. Furthermore, at the time of this writing, other applications are being designed to capture LOD datasets using semi-automated procedures. This process may involve capturing some or all triples associated with one or more authors, or obtaining only the URI of the resource. This data is stored in an intermediate repository on which search, selection, and updating operations can be performed. That way, once the data has been verified it can be ingested into the bibliographic database or the authority file, and it is thus possible to choose all the attributes of a resource or only its URI, and update database records.

The same procedure will be carried out with bibliographic descriptions. This process will start soon since it has the added problem of the correct identification of works. If the identification of names of persons in authority files has inherited a number of problems such as lack of enough data for contextualization, in the case of works that lack of data may be even greater. So the absence of uniform titles and author-uniform title entries, or of relationships between the titles of works and their translations made automated or semi-automated processes especially inefficient. Moreover, not

all sources of authority or bibliographic data are available on LOD, although this is changing every day.

The Polymath Virtual Library makes use of SRU servers on which specific search profiles can be launched, a process that acts also as test to incorporate the knowledge already in the database (authority records) into metadata being ingested. The advantage of the design is that the results can be stored in an OAI repository that performs regular harvesting of metadata from SRU servers. We are aware of the great possibilities that this system can provide to create a national or even an international harvester. The tremendous progress of Europeana to date has been based on OAI metadata harvesting and a similar system, which could be called *Americanae*, can be initiated.

The main advantage of this procedure would be the selective metadata harvesting and we have obtained very good results in both Hispana and Europeana. For now, Europeana has released an API<sup>90</sup> based on OpenSearch that can be integrated within a Web site search and display records retrieved from Europeana. This API, which works very effectively and has been incorporated already into the Web interface of the Polymath Virtual Library, automatically launches a search from an initial query in the Europeana database. That is, the same query on a database of several thousand records is also run on the Europeana database, which had around 23 million records in July 2012.

The Europeana API not only complements search results on the Web site of the Polymath Virtual Library<sup>91</sup> with the results of Europeana, but also allows those records to be downloaded. This process may be also performed on other SRU servers, as is the case of Hispana,<sup>92</sup> which provides a mechanism to reuse records from different sources. Thus, DIGIBIB has in its version 8.0 a tool for semi-automatic cataloging that launches searches against SRU servers and through the corresponding mapping, ingests these records in bulk. Search profiles can be configured to be launched periodically, or occasionally, in one or more SRU servers. In that way it is possible to get a large amount of metadata and digital objects that, once revised or modified, become part of the database. Clearly, in the current Web lots of metadata and digital objects that may be of interest to a particular project are available. Then, the work process is more about obtaining metadata and digital objects instead of scanning. That is, it makes no sense to scan what already exists on the Web, and it makes sense to develop applications that will capture these data in bulk. The next step (already being prepared) is to obtain these data from available LOD datasets, either through RDF dumps or SPARQL Endpoint. In addition, once tools were designed and developed, they could be incorporated as specific features to DIGIBIB. The next version, DIGIBIB 8.0, incorporates a tool for semi-automated cataloging in order to ingest bulk metadata retrieved through SRU servers, and soon through RDF datasets and SPARQL Endpoint or SRU servers.

Another rich source of information, analogous to Europeana, will no doubt be the Digital Public Library of America, founded in December 2010 and with an interoperability model very similar to Europeana.

Summarizing, we see that the authors in the Polymath Virtual Library, authors of several thousand works, which had been located in many libraries, are now interconnected and aggregated spatially and chronologically, forming a network easily visible. This was accomplished by linking works with other authors through VIAF, and later on, by establishing virtual navigation among the subjects of these books, using vocabularies or lists of headings such as LEM, LCSH, RAMEU, or SWD. A wide network of relationship has been made, especially metadata to persons; there is no doubt that corporate bodies can be treated as persons. We will now be able to add works because—in the majority of cases—works through their expressions will be manifested thanks to printers, editors, and booksellers (and libraries where items are kept or digitized). Thus, following the Escuela de Salamanca, we will see how the Convento de San Esteban (40° 57' 38''N – 5° 39' 47'' O) played a key role for teachers and students, and even did editorial and printing work, which certainly continues to the present. That term from the time of Library Science Schools, invisible colleges, has become clearly visible.

## CONCLUSIONS

### MARC 21 and Linked Open Data

This model has shifted from authority records for *personal names* to the records for *persons*, which is not a nominal but a long-range issue. In fact, some of the cataloging problems to be solved in the near future will be the combination of persons' attributes with *personal names*' attributes. A look at some ontologies and datasets such as VIAF or DBpedia show different definitions of classes and attributes that are involved in the establishment of persons' names.

If the center of the LOD cloud diagram is DBpedia, that is Wikipedia, it would seem normal that our encyclopedic authority records have a similar structure to that of Wikipedia, but using the MARC format as a basis. To disregard the huge number of MARC records in the world would be absurd, given also the great versatility and granularity of MARC 21 that could easily be converted to XML structures. Additionally, the MARC format is expected to last for a few more years until the *Bibliographic Framework Transition Initiative*<sup>93</sup> or other initiatives report their results. It is possible, of course, that any system could get data from any dataset available in LOD, but this is not only about linking data, but also about maintaining and updating them. In this sense, structures from DBpedia, VIAF, MADS, MARC 21, and EAC-CPF can be arranged to mash up information, but this may be insufficient, since

it could lead to uncontrollable mistakes, inaccuracies, or redundancies. We need a new data structure for *persons* and *names of persons* that can support management and maintenance of data, of LOD.

The structure of authority records may be a combination of schemes based on the MARC format, which also would share the analysis of MADS/RDF, EAC-CPF,<sup>94</sup> and include some of the attributes of DBpedia.<sup>95</sup> It is very possible that the influence being exerted by DBpedia makes it necessary to expand the number of attributes that define a person. A glance at the DBpedia ontology shows some properties of the class person of real interest to the Polymath Virtual Library as *Influence*, *influencedBy*, or *philosophicalSchool* among others.

### Redefining ILS Functionalities

The possibilities of providing linked data will lead to a complete redefinition of the functions of the ILS, namely DIGIBIB. First, to incorporate data elements or attributes not found in the MARC format for its updating, management, and publication as LOD. Second, to ingest complete or selected datasets; this means having the ability to update all or parts of a record. Third, to modify query interfaces allowing discovery and online mash up from other sources through APIs based on SRU/OpenSearch or even in a combination with SPARQL. At the bottom of this (not exhaustive) list, it should be possible to manage other types of information not widely used such as the descriptions of the LOD datasets as a whole, within which we must mention archive finding aids and museum records.

### Availability of Datasets

It should be noted that besides the availability of the datasets, the critical selection of these datasets, which ultimately are nothing but bibliographic information resources with a new structure, is, and always has been, very important. Critical analysis of the quality of data from the intellectual and theoretical points of view remains fundamental. Apart of what is required to register datasets according to The Data Hub<sup>96</sup> or, more precisely, VoID,<sup>97</sup> there is clearly a need for information about, not only the ontology or data structure, but also the number of entries and relationships, the frequency of updates, the way that updates are managed, and the sources used in any data merging. We can say that probably the most immediate experience of linking data from external sources, as indeed is already well known by librarians and bibliographers, is in the range of assertions about the same thing, sometimes inaccurate, sometimes erroneous, redundant, and in other occasions the source is not reliable.



The Semantic Web and LOD propose greater accuracy in navigation, but it can be seen, despite having few sources now available in LOD, that it is easy to find things defined in different ways, with very different attributes and that linking per se is not sufficient to improve the accuracy of navigation. The need to transform a huge amount of high quality bibliographic sources into LOD datasets that remain in paper, unstructured as they are not in the public domain must be noted. We believe this is a responsibility that libraries and librarians must assume without delay, although mass digitization projects that converge in Europeana and Hispana are making a good progress. *Das Ding im sich, das Ding am sich und das Ding bei sich*, as elucidated by nineteenth-century German idealism.

All work described here has gravitated around two projects that are still open. On the one hand, the implementation of the EDM has just begun. On the other hand, the implementation of RDA is postponed until 2013. If we add the conclusions of the W3C Library Linked Data Incubator Group, it is obvious that our results are just a set of actions in parallel with the development and implementation of this new paradigm. Perhaps there lies the greatest interest of our contribution, since the Polymath Virtual Library has taken steps similar to the implementation of RDA and participates actively in Europeana and is an EDM case study. So our actual work, accessible and available through the Web for those who want to see it, can be considered as an additional contribution to achieve that information (and not only bibliographic information) reaches maximum accessibility and, above all, meets the objectives proposed by Tim Berners-Lee in his theory of LOD. This is the ultimate meaning of this article.

## NOTES

1. <http://www.larramendi.es/i18n/estaticos/contenido.cmd?pagina=estaticos/bibliotecaLL>

2. To review the state of the art of this project see Xavier Agenjo Bullón and Francisca Hernández Carrascal, "La Biblioteca Virtual Larramendi: fuente de información bibliográfica para el pensamiento iberoamericano en la Web 3.0," in *Jornadas Virtuales Iberoamericanas de Bibliotecología*, <http://goo.gl/Vbwtn>. These pages were written in autumn 2010, and some important changes have been implemented since then. Some of them can be seen in: Xavier Agenjo and Francisca Hernández, "La Biblioteca Virtual Ignacio Larramendi desde la perspectiva LOD y EDM," which was presented at the *I Seminario Internacional de la Biblioteca de Galicia*, [http://issuu.com/bibliotecasdixitais/docs/xavier\\_agenjo\\_-\\_francisca\\_hernandez](http://issuu.com/bibliotecasdixitais/docs/xavier_agenjo_-_francisca_hernandez)

3. As may be recalled, Toynbee, in his *A Study of History*, could determine up to 21 different civilizations and although this information may seem outdated and even the application of the concept of civilization by Huntington in his famous book (and for our purposes in that one that followed after) the fact is that there seems to be isolated compartments between cultures that undoubtedly the exchange of information should solve, especially as raised in Tim Berners-Lee in his seminal *Design Issues: Linked Data*, <http://www.w3.org/DesignIssues/LinkedData>

4. <http://hispana.mcu.es/>

5. <http://www.openarchives.org/ore/>

6. [http://www.ifla.org/files/cataloguing/frad/frad\\_2009-es.pdf](http://www.ifla.org/files/cataloguing/frad/frad_2009-es.pdf)

7. <http://www.loc.gov/marc/marbi/2001/2001-dp05.html>

8. <http://www.loc.gov/marc/transition/>

9. MADS/RDF Primer. Final Public Review Document, <http://www.loc.gov/standards/mads/rdf>
10. <http://www.digibis.com/software/digibib.html>
11. <http://www.larramendi.es/aut/POLI20090013193.rdf>
12. Xavier Agenjo Bullón and Pilar Palá Gasós, "El fichero de autoridades del Catálogo Colectivo del Patrimonio Bibliográfico," in *Boletín de la ANABAD*, Tomo 37, No. 4 (1987), 593–606, <http://dialnet.unirioja.es/servlet/articulo?codigo=801041>
13. <http://www.loc.gov/marc/RDAinMARC29.html>
14. MARC Discussion Paper No. 2011-DP03, "Identifying Work, Expression, and Manifestation records in the MARC 21 Bibliographic, Authority, and Holdings Formats," <http://www.loc.gov/marc/marbi/2011/2011-dp03.html>
15. See Trove from the National Library of Australia, <http://trove.nla.gov.au/>
16. [http://clip.jcm.es/archivo\\_de\\_la\\_imagen/es/micrositios/inicio.cmd](http://clip.jcm.es/archivo_de_la_imagen/es/micrositios/inicio.cmd)
17. Ibid.
18. [http://socialarchive.iath.virginia.edu/NAAC\\_index.html](http://socialarchive.iath.virginia.edu/NAAC_index.html)
19. In fact, it was an ancestor of Ignacio de Larramendi y Montiano (1921–2001), founder, among many other initiatives, of the Larramendi Virtual Libraries or DIGIBIS. See also, Hernando de Larramendi, Ignacio. Mecenazgo cultural de Ignacio Hernando de Larramendi y Montiano: crónica y testimonios, <http://www.larramendi.es/i18n/consulta/registro.cmd?id=954>
20. <http://europeana.eu/>
21. <http://hispana.mcu.es/>
22. Martin Doerr, Stefan Gradmann, Steffen Hennicke, Antoine Isaac, Carlo Meghini, and Herbert van de Sompele, "The Europeana Data Model (EDM)," in *76th IFLA General Conference and Assembly*, August 10–15, 2010, Gothenburg, Sweden, <http://www.ifla.org/files/hq/papers/ifla76/149-doerr-en.pdf>
23. <http://www.w3.org/wiki/SweoIG/TaskForces/CommunityProjects/LinkingOpenData>
24. <http://ckan.net/package/viaf/>
25. <http://dbpedia.org/About/>
26. <http://www.w3.org/2005/Incubator/ld/>
27. <http://www.w3.org/2005/Incubator/ld/XGR-ld-20111025/>. See the Spanish translation at <http://www.larramendi.es/LAM/Incubator/ld/XGR-ld-20111025.html>
28. <http://www.w3.org/2005/Incubator/ld/XGR-ld-usecase-20111025/>. See the Spanish translation at <http://www.w3.org/2005/Incubator/ld/XGR-ld-usecase-20111025/>
29. <http://www.w3.org/2005/Incubator/ld/XGR-ld-vocabdataset-20111025/>. See the Spanish translation at <http://www.larramendi.es/LAM/Incubator/ld/XGR-ld-vocabdataset.html>
30. <http://thedatahub.org/group/ld/>
31. [http://www.w3.org/2005/Incubator/ld/wiki/Use\\_Case\\_Polymath\\_Virtual\\_Library](http://www.w3.org/2005/Incubator/ld/wiki/Use_Case_Polymath_Virtual_Library)
32. <http://www.w3.org/TR/2007/WD-cooluris-20071217/>
33. <http://www.w3.org/wiki/SemanticWebTools>
34. [http://www.larramendi.es/francisco\\_sanchez/i18n/micrositios/inicio.cmd](http://www.larramendi.es/francisco_sanchez/i18n/micrositios/inicio.cmd)
35. <http://www.larramendi.es/aut/FILA20120004030.rdf>
36. <http://www.larramendi.es/aut/FILA20120003101.rdf>
37. [http://dbpedia.org/page/Michel\\_de\\_Montaigne](http://dbpedia.org/page/Michel_de_Montaigne) and <http://www.larramendi.es/aut/FILA20120002876.rdf>
38. <http://viaf.org/viaf/41838958/> and <http://www.larramendi.es/aut/FILA20120003132.rdf>
39. <http://www.larramendi.es/aut/POLI20090013650.rdf>
40. <http://goo.gl/Jcb77>
41. Xavier Agenjo Bullón, Francisca Hernández Carrascal and Patricia Juez García, "La Escuela de Salamanca considerada desde el punto de vista de la Web semántica y la información en la red." Paper given on April 14, 2011, in *X Jornadas de la Asociación de Hispanismo Filosófico: Crisis de la modernidad y filosofías ibéricas*, held in Santiago de Compostela, April 13–15, 2011, <http://goo.gl/uFrXx>
42. Joseph A. Schumpeter, *History of Economic Analysis* (New York: Oxford University Press, 1954).
43. Marjorie Grice-Hutchinson, *The School of Salamanca: Readings in Spanish Monetary Theory, 1544–1605* (Oxford: Clarendon Press, 1952).
44. Ibn Maymun, Musà or, much more familiar to the orthodox Jews, Rambam.
45. Not included yet in VIAF.
46. Particularly interesting is the access to the Library and Archives in Canada (<http://www.collectionscanada.gc.ca/>) through VIAF, although for the purposes and objectives of the Polymath Virtual

Library none of the authors who form part of the project has been found, at least for the moment, but it would be possible if the methodology is extended.

47. <http://wiki.dbpedia.org/Ontology?v=181z>

48. <http://metadataregistry.org/schema/show/id/24.html>

49. Ibid.

50. <http://metadataregistry.org/schema/show/id/1.html>

51. <http://metadataregistry.org/schema/show/id/13.html>

52. <http://vocab.org/relationship/.html>

53. <http://vocab.org/bio/0.1/.html>

54. <http://www.loc.gov/marc/marbi/2010/2010-dp02.html>

55. <http://id.sgcb.mcu.es/>

56. <http://thedatahub.org/dataset/lista-encabezamientos-materia>

57. <http://id.loc.gov/>

58. <http://www.cs.vu.nl/STITCH/rameau/>

59. <http://www.d-nb.de/standardisierung/normdateien/swd.htm>

60. There is now a new format that will attempt to standardize the many different ways in which different chronologies have been established and even numbers with those that have been represented, if not through the alphabet, the Latin alphabet, the Arabic alphabet, and so on. Extended Time/Date Format ETDF, <http://www.loc.gov/standards/datetime/>

61. <http://www.worldcat.org/identities/>

62. <http://www.geonames.org/ontology/documentation.html>

63. GeoLinkedData has been launched with the publication of various information sources from the Instituto Geográfico Nacional, making it available as RDF knowledge bases according to the principles of Linked Data, <http://thedatahub.org/dataset/geolinkeddata>

64. <http://hispana.mcu.es/>

65. <http://europeana.eu/>

66. María Antonio Carrato Mena, "Hispana y las iniciativas del Ministerio de Cultura," in *Jornada de Difusión de EuropeaanaLocal*, November 17, 2010, <http://hdl.handle.net/10421/4765>. María Luisa Martínez-Conde, "La aplicación del Modelo de Datos de Europeaana a la Biblioteca Virtual de Patrimonio Bibliográfico: bvpb.mcu.es," in *Jornada de Difusión de EuropeaanaLocal*, November 17, 2010, <http://hdl.handle.net/10421/4783>. More recent: María Antonia Carrato, "Hispana," in *I Seminario Internacional de la Biblioteca de Galicia*, 2011, [http://issuu.com/bibliotecasdixitais/docs/maria\\_antonia\\_carrato](http://issuu.com/bibliotecasdixitais/docs/maria_antonia_carrato)

67. <http://pro.europeana.eu/documents/900548/bb6b51df-ad11-4a78-8d8a-44cc41810f22>

68. [http://pro.europeana.eu/documents/10602/370691/D3\\_4+final.pdf](http://pro.europeana.eu/documents/10602/370691/D3_4+final.pdf)

69. [http://pro.europeana.eu/documents/844813/851994/D3\\_2\\_Final.pdf](http://pro.europeana.eu/documents/844813/851994/D3_2_Final.pdf)

70. <http://pro.europeana.eu/documents/900548/770bdb58-c60e-4beb-a687-874639312ba5>

71. <http://pro.europeana.eu/web/guest/linked-open-data>

72. <http://www.cervantesvirtual.com/>

73. Biblioteca Virtual de Prensa Histórica, Galiciana: Biblioteca Digital de Galicia, Biblioteca Virtual de Andalucía, Gredos (Universidad de Salamanca, Spain), Biblioteca Digital de Madrid, Biblioteca Digital de Castilla-La Mancha, Centro de Documentación de Fundación MAPFRE, Biblioteca Digital de Castilla y León, Biblioteca Virtual del Patrimonio Bibliográfico, Biblioteca Virtual de Derecho Aragonés, Biblioteca Digital Real Academia de la Historia, Catálogo Colectivo de la Red de Bibliotecas de los Archivos Estatales, Biblioteca Virtual del Principado de Asturias, Archivo de la Imagen de Castilla-La Mancha, Biblioteca Valenciana Digital, Biblioteca Virtual de Aragón, Fundación Sancho el Sabio, Biblioteca Regional de Murcia, Biblioteca Digital de Aranjuez, Universidad de La Laguna, Biblioteca Virtual de la Diputación de Zaragoza, Biblioteca Virtual de La Rioja, Fundación Ignacio Larramendi, Biblioteca Virtual de la Real Academia Nacional de Farmacia.

74. <http://www.digibis.com/>

75. This can be seen especially in Biblioteca Virtual de Patrimonio Bibliográfico subdomain Iberoamérica en las colecciones de la BVPB, <http://goo.gl/8Jyfa>. Also, it can be useful in the full text search in Biblioteca Virtual de Prensa Histórica, <http://prensahistorica.mcu.es>

76. <http://pro.europeana.eu/web/guest/technical-requirements>

77. <http://thedatahub.org/dataset/stitch-rameau>

78. <http://thedatahub.org/dataset/dnb-gemeinsame-normdatei>

79. <http://thedatahub.org/dataset/polymath-virtual-library>

80. <http://pro.europeana.eu/polymath-edm>

81. Stuart Weibel, "Principles of Linked Data Recast," *Weibel Lines*, <http://goo.gl/SYSDe>
82. <http://thedatahub.org/dataset>. See also the compilation done by the LLD, <http://thedatahub.org/group/lld> or DOIs as Linked Data, <http://inkdroid.org/journal/2011/04/25/doi-as-linked-data/>, or Linked Periodicals Data, <http://periodicals.dataincubator.org/.html>
83. <http://www.oclc.org/developer/documentation/virtual-international-authority-file-viaf/using-api>
84. <http://thedatahub.org/dataset/viaf>
85. How to Publish Linked Data on the Web, <http://www4.wiwiw.fu-berlin.de/bizer/pub/LinkedDataTutorial/> and Best Practice Recipes for Publishing RDF Vocabularies. W3C Working Group Note 28, August 2008, <http://www.w3.org/TR/swbp-vocab-pub/>
86. <http://www.w3.org/wiki/SparqlEndpoints>
87. <http://www.w3.org/wiki/SparqlImplementations>
88. <http://ckan.net/package/dbpedia>
89. SPARQL Query Language for RDF, <http://www.w3.org/TR/rdf-sparql-query/>. Now W3C is working in SPARQL 1.1 Federated Query. This specification defines the syntax and semantics of a SPARQL 1.1 Federated Query extension for executing queries distributed over different SPARQL endpoints, <http://www.w3.org/2009/sparql/docs/fed/service>
90. <http://pro.europeana.eu/web/guest/api>
91. <http://pro.europeana.eu/web/guest/api-implementation>
92. <http://hispana.mcu.es/es/estaticos/contenido.cmd?pagina=estaticos/sru>
93. <http://www.loc.gov/marc/transition/news/minutes-alamw-2012.html>
94. Although it has been not mentioned throughout this communication, we have to cite CIDOC-ICOM Linked Open Data Recommendation for Museums, [http://www.cidoc-crm.org/URIs\\_and\\_Linked\\_Open\\_Data.html](http://www.cidoc-crm.org/URIs_and_Linked_Open_Data.html)
95. <http://mappings.dbpedia.org/server/ontology/classes/Person>
96. <http://thedatahub.org/>
97. *Describing Linked Datasets with the VoID Vocabulary*, <http://www.w3.org/TR/void/>