

AMS Historica. **A(n imaginary) migration journey**

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Introduction

In this report, I will talk about a possible application of semantics in the migration project of one of the institutional digital repositories of the University of Bologna, *AMS Historica*.

I will start by briefly introducing the context of this repository in the wider framework of "AlmaDL. Alma Digital Library" activities and other repositories, for then analysing in specific the *AMS Historica* repository, its current settings, and the features of the future new tool *Dspace GLAM* where *AMS Historica* will migrate.

Being the project still in its initial steps, I could not analyze the results of the semantic module implementation within the new tool; so, I decided, starting from the actual data in Dublin Core, to try to figure out how it would be possible to draft semantic interconnection among them, in order to ideally help the users in the data searching, exploring and navigation. During this attempt, I realized that the simple translation of the Dublin Core metadata in DCterms relations would not have been completely satisfying. I then tried to use more suitable ontologies to fully express the richness of not-flat relations - within a FRBR model framework - between the physical original copy and its digitized version, the library holding the copy and those in charge of the authorized uses for the digitization. I proposed two rdf turtle serialization samples from *AMS Historica* data: the first based on the "flat DCterms translation", the second based on the enhanced model.

All the original data and their elaborations are available on a Github repository¹.

I have finally drawn some conclusions about the main challenges I could detect.

1. AlmaDL: *AMS Historica* and its siblings

AlmaDL refers to the digital library of the University of Bologna² and the related services³ and it is also the name of the Unit in charge of them⁴: the technical and librarian staff provide

¹ Zani, E. (2022). *AMS Historica. A(n imaginary) migration journey*. https://github.com/enrica/AMSHistorica SDL project_aa2021-22.

² The institutional repositories overseen by *AlmaDL* are currently 5 plus one supervised in the past 2003-2018.

- 1) [AMS Acta](#): the OA institutional repository for research contributions, publications, and underlying data.
- 2) [AMS PhD Theses](#): since 2008 devoted to collect, preserve, and make available the PhD theses.
- 3) [AMS First Cycle Degree Thesis](#): first cycle degree theses collected on Academic board voluntary base.
- 4) [AlmaDL Journals](#): Gold OA journals published by the University of Bologna Departments.
- 5) [AMS Historica](#): digitized items from physical University of Bologna libraries' collections.
- 6) [AMS Campus](#): teaching material (closed repository).

³ AlmaDL Unit, always also provided advanced services: in the mid 2000 they implemented the digital reference service "Ask the Librarian" and the Opac enrichment project with ToC. Recently they are involved in Data Management Plan and Open Access issues as well as supporting scholarly digital edition projects (e.g. Edizione Nazionale delle Opere di Aldo Moro <https://site.unibo.it/edizione-nazionale-moro/it>).

⁴ More information at <https://sba.unibo.it/it/alma dl>.

technical assistance for digital editorial projects; they collect and make available online and long-term preserve, digital collections to support the University goals in teaching, research, and dissemination.

Currently *AlmaDL* oversees 5 institutional repositories covering different material such as scientific publications, datasets, Phd and First cycle degree theses, as well as the digitization of antique or valuable documents owned by the University itself.

The idea of creating a university digital library and its first realizations dates to early 2000.

After 2 years of brainstorming and planning, in 2003 a first version of the institutional archive was launched with *AMS Campus* teaching materials, *AMS Acta* research products and a first selection of items for *AMS Historica*, the repository here analyzed.

In 2006-2007, other 3 fundamental repositories were added to the primary nucleus, thus *AlmaDL* collections received their current physiognomy. At that time indeed, the Master Degrees in *Environmental and Territorial Engineering* and *Civil Engineering*, promoted the *AMS Thesis* project on an experimental basis.

From that experience, also *AMS Tesi di Dottorato* was set up with the dual objective of simplifying the administrative procedures for the theses' management and enhancing the dissemination of the PhDs' scientific production at an international level. A third objective was achieved when, thanks to the electronic legal deposit, the deposit workflow and cataloguing at the *Biblioteca Nazionale Centrale di Firenze (BNCF)* were completely automated and consequently speeded up.

Finally, together with the rise of the Open Access movement⁵, the *AlmaDL Journals* repository based on *OJS (Open Journal Systems)*⁶ platform was implemented for the management and the online publication of Gold OA⁷ scientific journals promoted by the University Departments.

Throughout the years the collections have growth constantly and remained useful for their purposes⁸.

The table below shows the repositories in terms of quantity of items⁹, technology used and life cycle:

⁵ "Open access (OA) is a set of principles and a range of practices through which research outputs are distributed online, free of access charges or other barriers" https://en.wikipedia.org/wiki/Open_access; in the first 2000s several declarations and initiatives in support of OA were signed from institutions all around the world https://en.wikipedia.org/wiki/History_of_open_access.

⁶ "Open Journal Systems (OJS) is an open source software application for managing and publishing scholarly journals. Originally developed and released by PKP in 2001 to improve access to research, it is the most widely used open source journal publishing platform in existence, with over 25,000 journals using it worldwide." <https://pkp.sfu.ca/ojs/>.

⁷ Access types and levels in OA are defined based on a colour scale. "Precious" colours such as gold or platinum/diamond, define the higher level of accessibility to authors and the public. https://en.wikipedia.org/wiki/Open_access#Colour_naming_system.

⁸ Also *AMS Campus* in its evolution knew a big development in terms of integration with other informative systems such as didactic planning, University registry and Unibo Portal. In 2018 it was substituted by a wider Learning Management System based on Moodle <https://en.wikipedia.org/wiki/Moodle>.

⁹ University of Bologna Library System 31th of December 2020 data.

Repository	Typology	Items	Sw ¹⁰	life cycle
AMS Historica	Digitized/Historical material	1.892 bibliographic items 84.236 images	In-house DB	2003-
AMS Acta	Research material	4.896	EPrints	2003-
AMS Tesi	Undergraduate Thesis	18.649	EPrints	2007-
AMS Tesi di dottorato	Phd Thesis	7.522	EPrints	2007-
AlmaDL Journals	OA Academic Journals	8.619 articles 49 Journals	OJS	2007-
AMS Campus	Teaching material	---	EPrints	2003-2018

2. AMS Historica

1. Contents and collections

As already introduced, *AMS Historica* is in charge of collecting the digitizations – and allowing them access and long-term preservation - of books, magazines, maps, drawings, photographs, etc. preserved by libraries, archives or museums of the University of Bologna and chosen for their scientific, historical or cultural interest.

AMS Historica, currently counts 1.875 titles¹¹ organized in 16 collections: here they are just listed but further details can be found in Annex I:

1. Patologia vegetale: malattie degli ortofrutticoli dopo la raccolta <https://amshistorica.unibo.it/patologiavegetale>
2. AMBULO - Manoscritti arabi della Biblioteca Universitaria di Bologna Online - Progetto della Cattedra di studi islamici King 'Abdulaziz - Università di Bologna <https://amshistorica.unibo.it/manoscrittiarabi>
3. IGCyr | GVCyr <https://amshistorica.unibo.it/epigrafi>
4. Rosa Genoni. La moda e la politica in una selezione di suoi scritti (1908-1928) <https://amshistorica.unibo.it/rosagenoni>
5. Manoscritti Greci <https://amshistorica.unibo.it/manoscrittigreci>
6. Papyri Bononienses <https://amshistorica.unibo.it/papiribon>
7. Ulisse Aldrovandi. Manoscritti <https://amshistorica.unibo.it/aldrovandimanoscritti>
8. Ulisse Aldrovandi. Opere a stampa <https://amshistorica.unibo.it/ulissealdrovandi-opereastampa>
9. Architettura <https://amshistorica.unibo.it/architettura>
10. Periodici studenteschi <https://amshistorica.unibo.it/periodicistudenteschi>
11. Fondo Antico di Geografia <https://amshistorica.unibo.it/geografia>
12. Corpus Iuris Civilis <https://amshistorica.unibo.it/176>
13. Il Codice miniato della Divina Commedia <https://amshistorica.unibo.it/divinacommedia>
14. Giovanni Domenico Cassini <https://amshistorica.unibo.it/giovanncassini>
15. Fondo Maestrini <https://amshistorica.unibo.it/fondomaestrini>
16. Letteratura coloniale italiana <https://amshistorica.unibo.it/letteraturacoloniale>

The master images are stored preferably in TIFF format - or JPEG if TIFF was not possible - while they are offered to the final user in two options: JPG and Djvu formats.

¹⁰ Eprints (<https://www.eprints.org/uk/>) and OJS (Open Journal System <https://pkp.sfu.ca/ojs/>) are open-source software devoted to open access institutional repository and journals' publication management.

¹¹ The digitized items are higher in number because for each for each journal title - e.g. Lidel <https://amshistorica.unibo.it/177> - several issues have been digitized.

2. Current back-end and metadata

AMS Historica is in-house hosted, and their servers are managed by the University of Bologna CESIA - Area Sistemi e Servizi Informatici support; its structure is based on a complex and stratified relational database built in the years adding tables when some new metadata were required.

The structure of the relational database is visible in fig. 1: "Resource" and "Image" tables are dedicated to the image files and the "Biblio" and "biblio_ext" tables are those devoted to the two (first and enhanced) sets of metadata.

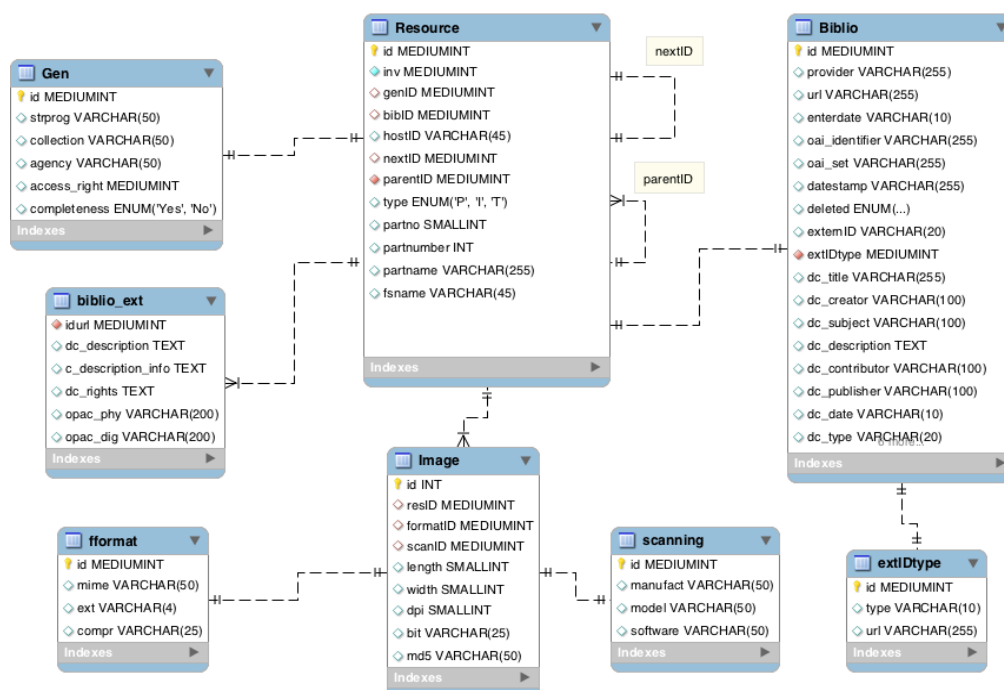


Figure 1. AMS Historica relational database structure.

The ingestion of new metadata records has been done in different ways along the years: a) by providing excel files to IT staff in charge to update the database, b) via an online php form, or c) manually by writing the database itself. The image files were uploaded via ftp: a script uses some data from the file's name in order to build the structural metadata (pages, issues, etc.) and allow the scrolling of pages in the viewer.

Records are described with Dublin Core metadata (dc_title, dc_creator, dc_subject, dc_description, dc_contributor, dc_publisher, dc_date, dc_type, dc_format, dc_identifier, dc_source, dc_language, dc_relation, dc_coverage, dc_rights) and remapped and enhanced with some metadata from the DC PICO Application Profile (pico_chi, pico_cosa, pico_quando)¹². Harvesting of AMS Historica metadata from external services - as AlmaStart

¹² More information about the "DC Application Profile for CulturalItalia (Portale della Cultura Italiana)" at http://www.culturalitalia.it/opencms/documentazione_tecnica_it.jsp.

University of Bologna discovery tool¹³ or *Culturaitalia*¹⁴ - is guaranteed by providing XML DC and DC_pico metadata via the OAI-PMH protocol.

The *Europeana*¹⁵ aggregator is instead populated by taking data directly from *Culturaitalia* that maps and translates the pico-records in EDM (*Europeana Data Model*)¹⁶ records.

<pre><?xml version="1.0" encoding="UTF-8" ?> <OAI-PMH xmlns="http://www.openarchives.org/OAI/2.0/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/ http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd"> <responseDate>2021-10-30T10:49:14Z</responseDate> <request verb="ListRecords" metadataPrefix="oai_dc">https://amshistorica.unibo.it/ <ListRecords> <record> <header> <identifier>oai:amshistorica.unibo.it:1</identifier> <timestamp>2006-10-25</timestamp> <setSpec>comm</setSpec> </header> <metadata> <oai_dc:dc xmlns:oai_dc="http://www.openarchives.org/OAI/2.0/oai_dc/" xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:dcterms="http://purl.org/dc/terms/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/oai_dc/ http://www.openarchives.org/OAI/2.0/oai_dc.xsd"> <dc:title>De Bononiensi Scientiarum et Artium Instituto atque acad <dc:description>De Bononiensi scientiarum et artium Instituto atq <dc:publisher>Bononiae : ex typographia Laelii a Vulpe</dc:publis <dc:date>1731</dc:date> <dc:type>Periodico</dc:type> <dc:format>text/html</dc:format> <dc:identifier>http://amshistorica.unibo.it/1</dc:identifier> <dc:language>lat</dc:language> <dc:relation>http://amshistorica.unibo.it/1</dc:relation> <dc:rights>Università di Bologna</dc:rights> </oai_dc:dc> </metadata> </record></pre>	<pre><?xml version="1.0" encoding="UTF-8" ?> <OAI-PMH xmlns="http://www.openarchives.org/OAI/2.0/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.openarchives.org/OAI/2.0/ http://www.openarchives.org/OAI/2.0/OAI-PMH.xsd"> <responseDate>2021-11-07T18:57:01Z</responseDate> <request verb="ListRecords" metadataPrefix="pico">https://amshistorica.unibo.it <ListRecords> <record> <header> <identifier>oai:amshistorica.unibo.it:1</identifier> <timestamp>2002-01-01</timestamp> <setSpec>comm</setSpec> </header> <metadata> <pico:dc xmlns:pico="http://purl.org/pico/1.0/" xmlns:dc="http://purl.org/dc/elements/1.1/" xmlns:dcterms="http://purl.org/dc/terms/" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://purl.org/pico/1.0/ http://www.culturaitalia.it/opencms/export/sites/culturaitalia/attachment <dc:title>De Bononiensi Scientiarum et Artium Instituto atque academia com <dc:subject xsi:type="pico:Thesaurus">http://culturaitalia.it/pico/thesaur <dc:subject xsi:type="pico:Thesaurus">http://culturaitalia.it/pico/thesaur <dc:subject xsi:type="pico:Thesaurus">http://culturaitalia.it/pico/thesaur <dc:description>De Bononiensi scientiarum et artium Instituto atque academ <dc:publisher>Bononiae : ex typographia Laelii a Vulpe</dc:publisher> <dc:date>1731</dc:date> <dc:format>text/html</dc:format> <dc:rights>The images may be downloaded and printed for individual and pri All other rights are reserved.</dc:rights> <dc:language>lat</dc:language> <pico:language>lat</pico:language> <dc:type xsi:type="dcterms:DCMIType">StillImage</dc:type> <dc:identifier>1</dc:identifier> <dcterms:isReferencedBy xsi:type="pico:Anchor">title=consulta la scheda es <pico:preview xsi:type="dcterms:URI">https://amshistorica.unibo.it/diglib/ </pico:dc> </metadata> </record></pre>
<p>Figure 2A. AMS Historica OAI-PMH dc metadata https://amshistorica.unibo.it/oai/oai2.php?verb=ListRecords&metadataPrefix=oai_dc</p>	<p>Figure 2B. AMS Historica OAI-PMH dc_pico metadata https://amshistorica.unibo.it/oai/oai2.php?verb=ListRecords&metadataPrefix=pico</p>

3. Current public interface and features

AMS Historica intends to offer access through a single access point from. The home page¹⁷ (fig. 3) allows the user to browse highlighted titles and collections or indexes by title or author; there is no search function.

Inside the record it is not possible to navigate through authorities' indexes - such as for authors, or typographers, or places, or subjects - because the metadata are simply strings of text with a maximum enrichment of external hyperlinks (fig. 4).

¹³ www.sba.unibo.it/AlmaStart.

¹⁴ National Italian Cultural Heritage aggregator <http://www.culturaitalia.it/>.

¹⁵ Europeana is the European Cultural Heritage aggregator containing digitized cultural heritage collections of more than 3,000 institutions across Europe. <https://www.europeana.eu/>.

¹⁶ "The Europeana Data Model (EDM) is an interoperable framework that allows us to collect, connect and enrich cultural heritage metadata" from <https://pro.europeana.eu/share-your-data/metadata>. Documentation at <https://pro.europeana.eu/page/edm-documentation>.

¹⁷ Access the AMS Historica home page from <https://amshistorica.unibo.it/>.

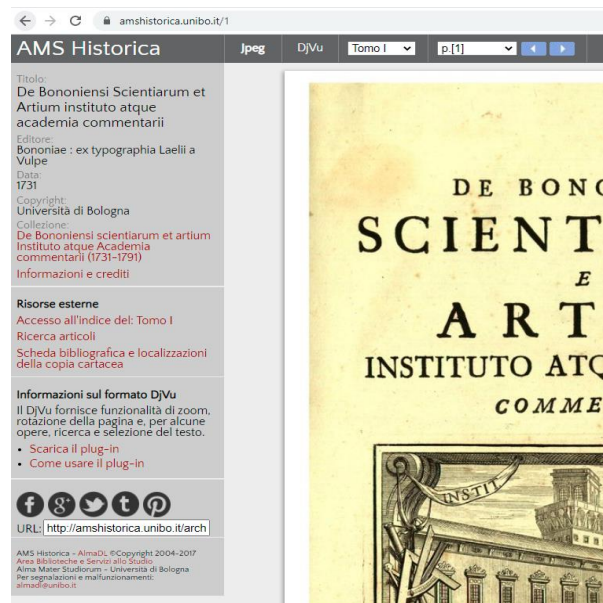
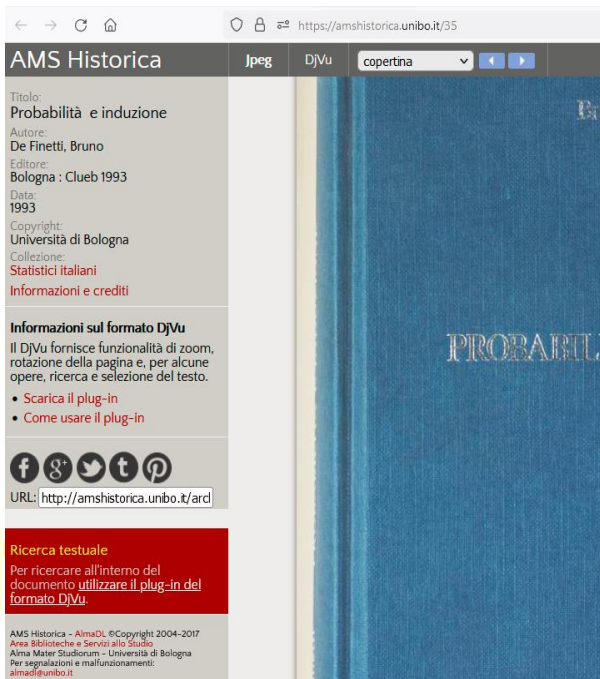
Figure 3. AMS Historica HP <https://amshistorica.unibo.it/>

Figure 4. Result detail

It is possible to scroll page by page the digitised version of the document in Jpeg or DjVu¹⁸ formats. DjVu is now an abandoned format in terms of support, but it was the best option in early 2000s to allow some editing to images - such as zooming, rotating, etc. - and full-text search via a simple a plug-in.



OCR transcription is currently available only for 14 items¹⁹ over the 1862 total: the user cannot filter for them, but, when the transcription is available for an item, an extra label is visible on the left side of the record detail to access the full text search function (fig. 5).

Figure 5. OCR full text search function from detailed record of *Probabilità e induzione*
<http://amshistorica.unibo.it/35>

¹⁸ Before the standardization of PDF in 2008, DjVu was considered higher performative because of smaller files than other formats with similar quality (i.e. 100 kB VS a satisfactory JPEG image typically requires 500 kB) and open source. DjVu can contain an OCR text layer, making it easy to perform copy and paste and text search operations. Its last release dates back in 2005. Cfr. <https://en.wikipedia.org/wiki/DjVu>.

¹⁹ The OCR full text is available for the following items: *Probabilità e induzione* <http://amshistorica.unibo.it/35>, *Statistica e induzione* <http://amshistorica.unibo.it/52>, *La popolazione di Bologna dal secolo XV all'unificazione italiana* <http://amshistorica.unibo.it/159>, *Atlante delle colonie italiane* <http://amshistorica.unibo.it/166>, *La Somalia italiana* <http://amshistorica.unibo.it/167>, *Etiopia: terra, uomini e cose* <http://amshistorica.unibo.it/168>, *Storia economica coloniale: lezioni di storia economica* <http://amshistorica.unibo.it/169>, *Nell'Africa italiana: Impressioni e Ricordi* <http://amshistorica.unibo.it/171>, *L'Omo: viaggio d'esplorazione nell'Africa Orientale* <http://amshistorica.unibo.it/172>.

4. A migration preview towards *DSpace-GLAM*

The last relevant ingestion of contents in *AMS Historica*, dates back to 2019 with two ambitious project such as *Ambulo*²⁰ – trilingual metadata Italian, English and Arabic - and *Patologia Vegetale*²¹ – scientific photographs: the growing complexity of digitized items and descriptive metadata, as well as the need for a higher user experience performance, lead to consider a more structured infrastructure to support the digital library in order to improve both the back-end workflow and the front-end services. After a market and technical analysis, *AlmaDL* adopted *DSpace-GLAM* which combine a highly experienced past on open access digital repositories and their structure on entities and institutions, enhanced with the GLAM extension (Galleries, Libraries, Archives, Museums - fig. 6), with high performative front-end outputs.

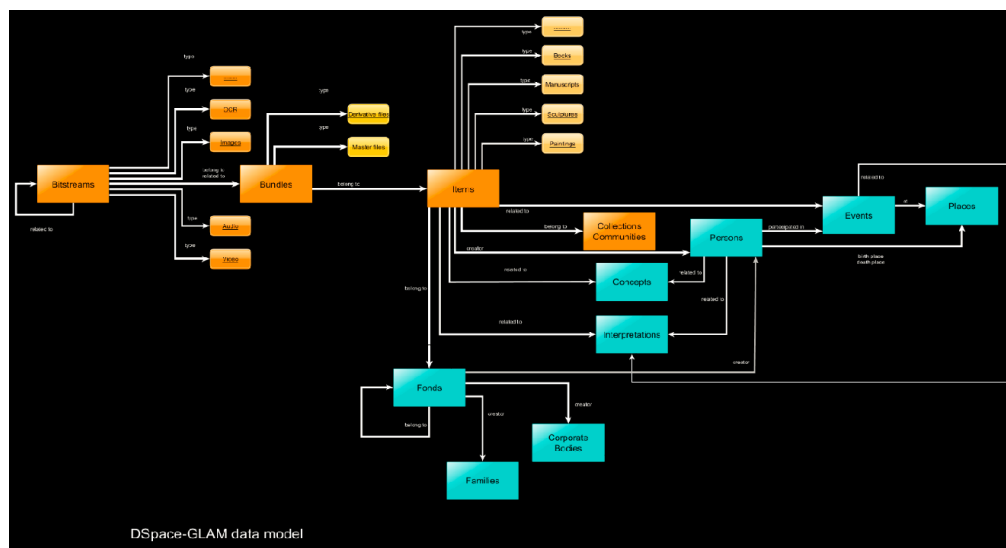


Figure 6. In orange the DSpace data model, in blue the extension of DSpace-GLAM. From 4Science. “[Putting Historical Data in Context: how to use DSpace-GLAM](#)”. SlideShares presentation (slide 74/113).

The back-end workflow is indeed in line with the newer Digital Asset Management²² systems and the *DSpace* entities can be used as authority files for items' metadata, thus also producing lists for Authors, Journals, Events, Projects, Newspapers, Funds, etc²³.

Cronache sociali <http://amshistorica.unibo.it/173>, Kalendarium Archigymnasii Pontificii Bononiensis <http://amshistorica.unibo.it/188>, Annuario della Regia Università di Bologna <http://amshistorica.unibo.it/193>, Annuario dell'anno accademico... - R. Università di Bologna <http://amshistorica.unibo.it/195>, Annuario della Università di Bologna <http://amshistorica.unibo.it/196>.

²⁰ <https://amshistorica.unibo.it/manoscrittitarabi>.

²¹ <https://amshistorica.unibo.it/patologiavegetale>.

²² "Digital Asset Management (DAM) and the implementation of its use as a computer application is required in the collection of digital assets to ensure that the owner, and possibly their delegates, can perform operations on the data files." https://en.wikipedia.org/wiki/Digital_asset_management.

²³ "Le entità DSpace-CRIS/GLAM possono essere utilizzate come authority file per i metadati degli item, producendo così liste gestibili per Autori, Riviste, Eventi, Progetti, Testate, Fondi, ecc". 4Science and Emilia Groppo, Manuale d'uso di DSpace-GLAM (Galleries, Libraries, Archives, Museums): versione italiana Gennaio 2022, p. 62.

From a front-end point of view, DSpace-GLAM offers the “IIIF Image Viewer add-ons” via Mirador³ and Universal viewer²⁴; both the viewers allow multiple images, the option of single-page or double-page view, the option to share the zoom level or the rotation as an URL starting from the current view.

In addition, Mirador³ makes it possible to compare digital documents contained in the same DSpace-GLAM digital library or in other IIIF compliant digital libraries.

Another add-ons “IIIF OCR & Transcription”²⁵, based on the open-source Tesseract OCR engine²⁶, will furtherly improve the usability of the digital collection thanks to the searchability of the text for the printed materials and the possibility to associate transcriptions for manuscripts.

Specific modules or add-ons for HTR (Handwritten Text Recognition) are not declared in the DSpace-GLAM documentation, even if they state that their OCR engine “can also be instructed with personalized training files to recognize fonts and specific languages”²⁷; the migration project would have to consider how to fill the gap to assure advanced - full text - access to the precious manuscript part²⁸ of the collection. Joining the Transkribus²⁹ Community could be a way to take advantage of the already realized HTR models - and use them to train the OCR DSpace-GLAM engine for treating uniform collections (i.e. the illuminated Dante or the Aldrovandi's manuscripts) - as well as to collaboratively enrich them by providing new images and transcriptions for smaller and peculiar sets (such as the epigraphic or papyri collections).

3. Knowledge Graph experiments

Due to some considerations as the facts that the migration project to the new platform is still in a very early stage and that AMS Historica has not yet usable data from DSpace, but that the AMS Historica metadata had the advantage of being already structured in Dublin Core, I tried to simulate a semantic translation of a subset of AMS Historica records to

²⁴ From 4Science DSpace-GLAM official documentation: <https://www.4science.it/en/iiif-image-viewer/>.

²⁵ From 4Science DSpace-GLAM official documentation: <https://www.4science.it/en/ocr-transcription/>.

²⁶ Tesseract allows to extract text representation in hOCR format for full-text indexing in SOLR. It supports a very large set of languages including: Italian, French, Spanish, German, Arabic, Simplified and Traditional Chinese and many others (<https://github.com/tesseract-ocr/langdata/>). From 4Science DSpace-GLAM official documentation: <https://www.4science.it/en/ocr-transcription/>. More information at: <https://github.com/tesseract-ocr/>.

²⁷ From 4Science DSpace-GLAM official documentation: <https://www.4science.it/en/ocr-transcription/>.

²⁸ AMS Historica counts on 6 manuscripts digitized collections including an illuminated manuscript of the Divine Comedy dated 1350, the 351 volumes of the Aldrovandi's manuscripts as well as precious non-latin alphabets volumes (450 in Arabic and 51 in Greek) and epigraphic and papyrological documentation.

²⁹ “Transkribus is a comprehensive platform for the digitisation, AI-powered text recognition, transcription and searching of historical documents – from any place, any time, and in any language”. More information at: <https://readcoop.eu/transkribus/>.

envisage the possible problems that could have to be faced in using the DC metadata current description in a web semantic context.

I started by using as long as possible a sort of "DCMI translation" but I soon realized that a framework fully describing the complex relationship between the original item and its digitization, required a higher specialized ontology to be expressed.

The steps of this path are explained in the next paragraphs.

1. Sources of data

I started taking the output from the first page of OAI-PMH sorting as seen in fig. 2A and then by converting the OAI-PMH xml in a spreadsheet with 200 items' records³⁰.

I have then used some filters to normalize and select, the "Ulisse Aldrovandi" related items (28) as well as random others (2) to be used for the experiment.

I have later received from *AlmaDL* other spreadsheets³¹ with further details and metadata that have allowed me to enhance the information connected and the complexity of the interconnections (paragraph 4).

2. First Entities

At the first stage I organized the entities URIs by dividing them into agents, items, and places. For naming the first group, further categorizations were applied in order to define the entities as persons - and their roles - or as corporate agents.

Moreover, since in the ancient book field, the search by typographer is a common way to explore collections and build new knowledge, I tried to express the publisher related information in a more semantic way than in the original data, where they were simply string values. I have then created a URI with a `rdfs:label` controlled form for each typographer as a person, domain of the `org:headOf` property which range is a second entity for the "typography corporation" that the typographer created. If available, their VIAF authority records URIs have been used as objects for the `owl:sameAs` property (ex. 1).

³⁰ The url and a copy of the OAI-PMH first page results, as well as its first manipulations are available at Zani, E. (2022). AMS Historica. A(n imaginary) migration journey. https://github.com/enri-ca/AMSHistorica_SDL_project/.

³¹ The new data are available at https://github.com/enri-ca/AMSHistorica_SDL_project/tree/main/0_source_data/2_sources_from_AlmaDL subfolder.

#Agents Typographer

```
<agents/Typographer/DeFranceschi_Francesco> a dcterms:Agent ;
  rdfs:label "De Franceschi, Francesco" ;
  foaf:givenName "Francesco" ;
  foaf:familyName "De Franceschi" ;
  owl:sameAs <http://viaf.org/viaf/136008689> ;
  org:headOf <agents/typography/Francesco_DeFranceschi> .
```

#Agents Typography (corporate)

```
<agents/typography/Francesco_DeFranceschi> a dcterms:Agent ;
  rdfs:label "apud Franciscum de Franciscis Senensem" ;
  org:hasSite <places/City/Bologna> ;
  owl:sameAs <http://viaf.org/viaf/256072202> .
```

Example 1. Creation of Typographer and typography entities and their triples.

3. First Properties

I started by first mapping what could be simply translate from the already structured Dublin Core metadata tag in dcterms properties for an RDF modellization.

I have then used the equivalent properties for almost every initial DC metadata (es. <dc:title> became dcterms:title, <dc:creator> became dcterms:creator etc.) substituting where possible the object with the created URIs for internal entities or with external URI or controlled vocabulary terms: i.e. I used internal URI for dcterms:publisher with VIAF URIs owl:sameAs external connection, I used instead controlled vocabulary URIs for dcterms:format, dcterms:language and the few valorised dcterms:subject (respectively MIME³², ISO639-3³³, and LCSH³⁴).

The dc:rights tag has required a deeper evaluation instead: in fact, according to the definition and comment of the DCMI Metadata Terms for "rights"³⁵, it seems to be not the correct property for the value "Università di Bologna" that fit better the DCMI Metadata Terms definition of "rightsholder"³⁶. I then substituted dc:rights with dcterms:rightsholder instead of with dcterms:rights.

³² <https://www.iana.org/assignments/media-types/media-types.xhtml>

³³ <https://iso639-3.sil.org/>

³⁴ Program for Cooperative Cataloging Task Group on URIs in MARC, "Formulating and Obtaining URIs: A Guide to Commonly Used Vocabularies and Reference Sources," version date 2020-01-15, https://www.loc.gov/aba/pcc/bibframe/TaskGroups/formulate_obtain_URI_guide.pdf.

³⁵ "Definition: Information about rights held in and over the resource. Comment: Typically, rights information includes a statement about various property rights associated with the resource, including intellectual property rights. Recommended practice is to refer to a rights statement with a URI. If this is not possible or feasible, a literal value (name, label, or short text) may be provided. <http://purl.org/dc/terms/rights>.

³⁶ "Definition: A person or organisation owning or managing rights over the resource". <http://purl.org/dc/terms/rightsholder>.

#Items

```

<items/Periodico/1> a dcterms:BibliographicResource ;
  dcterms:title "De Bononiensi Scientiarum et Artium instituto atque academia commentarii" ;
  dcterms:description "De Bononiensi scientiarum et artium Instituto atque academia commentarii. -
  T.1 (1731)-t. 7 (1791). - Bononiae : ex typographia Laelii a Vulpe, 1731-1791. - 28 cm. ((Irregolare." ;
  dcterms:publisher <agents/typograby/ex_Laelii_a_Vulpe> ;
  dcterms:date "1731" ;
  dcterms:type "Periodico" ;
  dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
  dcterms:identifier "http://amshistorica.unibo.it/1" ;
  dcterms:language <https://iso639-3.sil.org/code/lat> ;
  dcterms:relation "http://amshistorica.unibo.it/1" ;
  dcterms:rightsHolders <agents/RightsHolders/Università_di_Bologna> .

```

Example 2. Translation of DC tag in DCTerms properties with `dc:rights` modification in `dcterms:rightsHolders` and use of normalized vocabularies for some objects.

For enriching, I used the `owl:sameAs` property with VIAF³⁷ for agents and GeoNames³⁸ for places.

The full turtle serializazion and the related rdf graph realized via RDF Grapher are stored in the Github repository³⁹. A detail view is offered below in fig. 7:

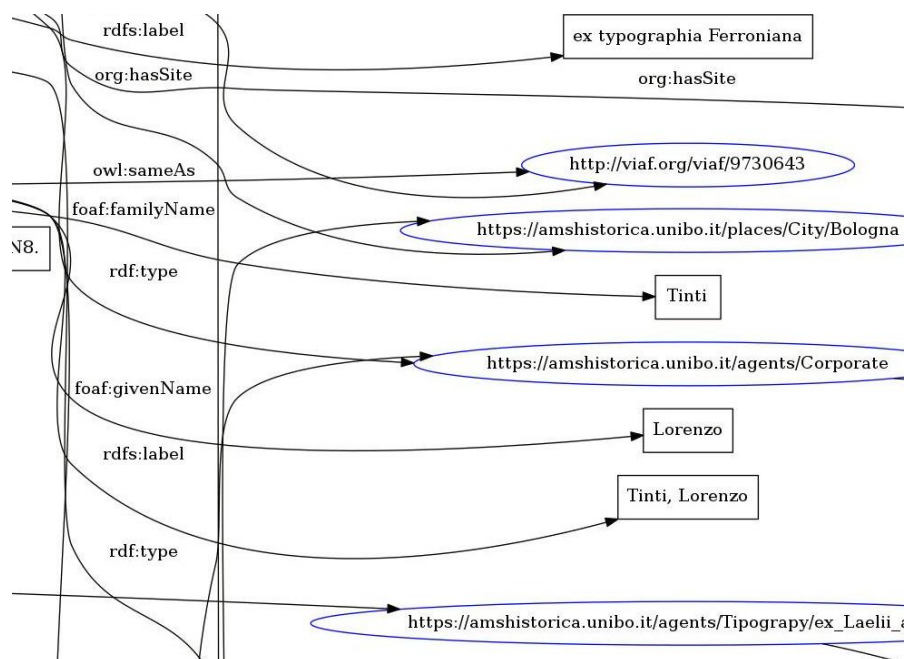


Figure 7. Detail view of the first graph based on `dcterms` and realized with [RDF Grapher](#)

³⁷ "The VIAF (Virtual International Authority File) combines multiple name authority files into a single OCLC-hosted name authority service. The goal of the service is to lower the cost and increase the utility of library authority files by matching and linking widely-used authority files and making that information available on the Web". <http://viaf.org/>.

³⁸ "The GeoNames geographical database covers all countries and contains over eleven million placenames" <https://www.geonames.org/>.

³⁹ Find them in the https://github.com/enri-ca/AMSHistorica_SDL_project/ subfolder Serialization (Historica_rdf_30items_DC.ttl) and Images (sample1).

4. Entities and properties – 2nd step

After these first elaborations on the OAI-PMH data, I received some more organized data from AlmaDL, reporting additional information such as libraries involved, access rights, and link to the original physical copy description in catalogues. This new data allowed to enhance the first URIs organization with the creation of URIs also for the libraries holding the original physical version or for other agents involved with the digitization in other ways. This new data, clarifying some opaque use of DC tags as for the aforementioned dc:rights, has also had some consequences in the ontologies' properties chosen.

To explore the repercussion of this new reflections, I reduced the sample to just 3 items: a journal <http://amshistorica.unibo.it/1>, a printed book <http://amshistorica.unibo.it/17>, and a manuscript <http://amshistorica.unibo.it/197>⁴⁰.

The first challenge of the new data was to translate in triples the relation between the dc:rights metadata tag and its value. This value - e.g. for the <http://amshistorica.unibo.it/1> item - was indeed a text string statement such as:

La scansione è tratta dagli esemplari conservati presso la biblioteca del Dipartimento di Astronomia, Università di Bologna. E' vietato riprodurre o duplicare le immagini consultabili nel sito senza l'autorizzazione scritta delle Biblioteche proprietarie. Il progetto di scansione è stato realizzato in una collaborazione fra il CIB e il Museo di Palazzo Poggi.

The statement reported three important information: 1) where the physical digitized documents are preserved, 2) that the library holding the physical version is also in charge of authorizing the uses of the digitized version, and 3) who realized the digitization.

I then initially enhance the first graph by adding a dcterms:RightsStatement entity about the information 2) and adding it to every item as an object via the dcterms:accessRights property (ex. 3 and 4):

```
<RightsStatement/001> a dcterms:RightsStatement ;
    rdfs:label "E' vietato riprodurre o duplicare le immagini consultabili nel sito senza
    l'autorizzazione scritta delle Biblioteche proprietarie." .
```

Example 3. Rights Statement entity reporting as a label the authorized uses.

```
<items/xxx> a dcterms:BibliographicResource ;
    [...]
    dcterms:accessRights <RightsStatement/001> .
```

Example 4. Rights Statement entity as object of bibliographic resource subject.

⁴⁰ Data are in the https://github.com/enri-ca/AMSHistorica_SDL_project/2_samples subfolder "2_sample2_From_DatiHistoricaeAlmaDL.xlsx" file.

The second step required the creation of new entities for the libraries owning the original document digitized: the entities would have then been connected with the items in order to allow the user to know the library mentioned in the Rights Statement.

I considered to use the URIs available in the *ICCU Anagrafe delle biblioteche italiane (ICCU) open data*⁴¹ to have an authoritative external resource. Unfortunately, especially for the libraries' denominations, the data were not so updated as needed⁴² so, I decided to use a) the ACNP⁴³ code to create new URIs, b) the Cultural-ON (Cultural ONtology)⁴⁴ class `bcco:Library` to define the type of entity, and c) the ACNP name as a literal value for the `rdfs:label` property object. Anyway, I have also used the ICCU URIs as the objects for the `owl:sameAs` property.

```
#Agents Libraries
<agents/Library/BO404> a bcco:Library ;
  rdfs:label "Biblioteca di Matematica, Fisica, Astronomia e Informatica. Sezione di Astronomia
  \"Guido Horn d'Arturo\"";
  owl:sameAs <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0427> ;
  org:hasSite <places/city/Bologna> ;
  foaf:isPrimaryTopicOf <https://acnpsearch.unibo.it/library/BO404> .
```

Example 5. Library entity creation.

At this stage, relating these new entities (the libraries) with the items, and also considering other information available in the new data – specially such as the purl to the bibliographic descriptions of the physical item - the pure use of DCMI started to seem too flat to fully express the multidimensional and multilevel connections between physical and digital items and manifestations and their metadata within a FRBR model.

For example, there was no way to correctly express that the digitized manifestation had been realized starting from a different manifestation (e.g. hypothetically a microfilmed copy of an item) than what described in the purl bibliographic description (the physical in-paper version) and that the three manifestations even if really similar, had different responsible for their creation.

⁴¹ <https://anagrafe.iccu.sbn.it/it/open-data/>.

⁴² There were several discrepancy comparing the name in the ICCU database and in the website of the University of Bologna Library system <https://sba.unibo.it/it/biblioteche?order=descrizione&sort>. E.g. the `rdfs:label` "Dipartimento di Fisica ed Astronomia DIFA. Biblioteca di Astronomia - Alma Mater Studiorum - Università di Bologna" of <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0427.html>, is really different from the correspondent in acnp <https://acnpsearch.unibo.it/library/BO404> "Biblioteca del Navile. Sezione di Astronomia".

⁴³ ACNP: Catalogo Italiano dei Periodici: <https://acnpsearch.unibo.it/librarysearch>.

⁴⁴ Clclcl <http://dati.beniculturali.it/cis/>.

I have then looked at other ontologies specifically devoted to libraries issues and levels, such as FRBRoo, nowadays LRMoo⁴⁵, BibFrame⁴⁶, Fabio⁴⁷, and RDA⁴⁸ to achieve a better modelization.

The best solution in the specific case has seemed the really detailed RDA properties, able to express the case of a manifestation coming from the digitization of a specific item of a previous manifestation: a graphic conceptualization with the digitized manifestation bounded in red is offered below (fig. 8).

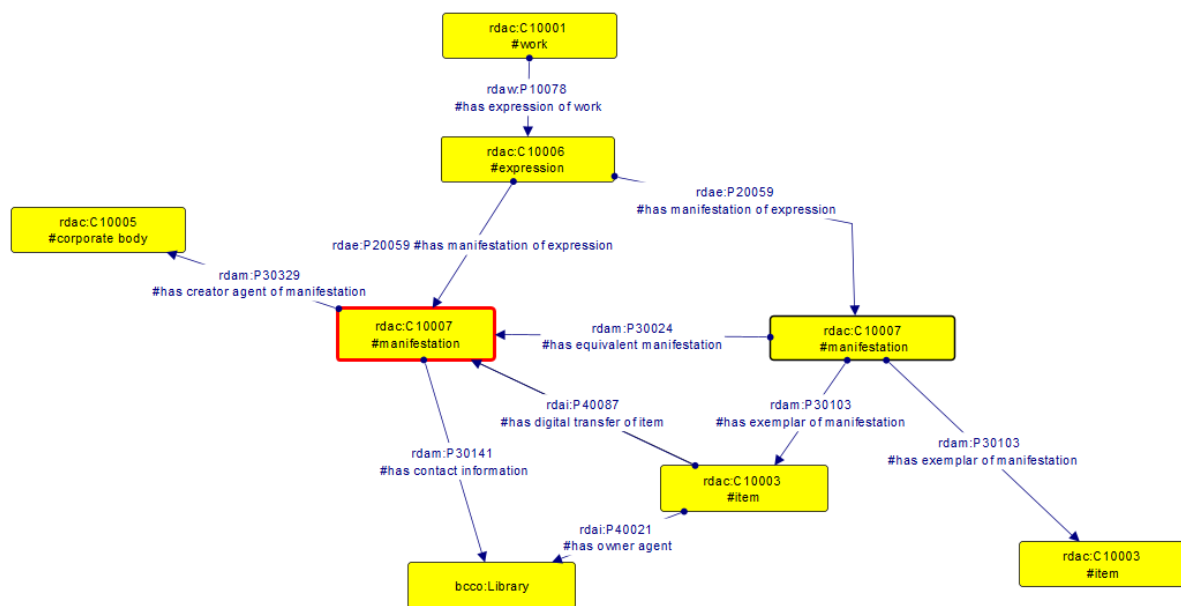


Figure 8. AMS Historica items conceptual model based on RDA classes and properties.

In this way I could also easily expressed that the library, holding the physical items digitized, is the same to be contacted for asking about authorized uses of the digital manifestation even if the “creator agent of manifestation” (the digitized one) is not the library itself. In fact, thanks to the rdam:P30329 property (#has creator agent of manifestation), it is possible to assign the entity <agents/RightsHolders/Università_di_Bologna> to the digital manifestation without mixing these specific creation responsibilities with those of the printed manifestation (ex. 6).

⁴⁵ <http://www.cidoc-crm.org/frbroo/ModelVersion/lrmoo-f.k.g.-frbroo-v.0.7.>

⁴⁶ <https://www.loc.gov/bibframe/docs/bibframe2-model.html>.

⁴⁷ <https://sparontologies.github.io/fabio/current/fabio.html>.

⁴⁸ <http://www.rdaregistry.info/>.

```

<items/Monografia/17> a rdac:C10007; #manifestation
dcterms:title "De piscibus libri 5. et De cetis lib. vnus. Ioannes Cornelius Vteruerius ... collegit.
Hieronymus Tamburinus in lucem edidit ... Cum indice copiosissimo" ;
dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
dcterms:identifier "http://amshistorica.unibo.it/17" ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation _:m17 ;
dcterms:accessRights <RightsStatement/001> ;
rdam:P30141 <agents/Library/BO404> ; #has contact information
dcterms:rightsHolders <agents/RightsHolders/Università_di_Bologna> ;
rdam:P30117 <agents/RightsHolders/Università_di_Bologna> . #has statement of responsibility

```

Example 6. RDA properties for the digitized item.

I have then expressed the relations according to this more sophisticated model in the RDF serialization for the 3 mentioned items: for each of them, I used some blank nodes for the entities related to work, expressions, manifestations, and items not yet identified in the domain but anyway needed to complete the structure (ex. 7).

#17 Book: starting from W level

```

_:w17 a rdac:C10001 ; #work
rdaw:P10065 <agents/Author/Aldrovandi_Ulisse> ; #has creator agent of work
rdaw:P10078 _:e17 . #has expression of work

_:e17 a rdac:C10006 ; #expression
rdae:P20059 _:m17 , <items/Monografia/17> . #manifestations

_:m17 a rdac:C10007; #print manifestation
dcterms:title "De piscibus libri 5. et De cetis lib. vnus. Ioannes Cornelius Vteruerius ... collegit.
Hieronymus Tamburinus in lucem edidit ... Cum indice copiosissimo" ;
dcterms:description "Vlysis [...]"
[...]
dcterms:relation "http://amshistorica.unibo.it/17" ;
rdam:P30005 <https://sol.unibo.it/SebinaOpac/resource/UBO2845920>; #has preferred citation
rdam:P30005 <http://id.sbn.it/bid/TO00182608>; #has preferred citation
rdam:P30103 _:i17.

_:i17 a rdac:C10003 ; #item of print manifestation
rdai:P40021 <agents/Library/BO402> ; #has owner agent
rdai:P40001 "ZOV 822" ; #has identifier for item
rdai:P40087 <items/Monografia/17>. #has digital transfer of item

```

Example 7. Item modellization on FRBR levels.

The full 3 items serialization is in Annex II as well as in the Github repository.

5. Conclusion

This project started with the aim of analyzing from a technical viewpoint, the migration of a digital library from an in-house system to a new commercial platform. Due to few information about the old system and the really early stage of the migration that did not allow to have enough information about the new platform, I have briefly illustrated the key points of the future digital library platform to then concentrate on a simulated semantic translation of a sample of records to envisage the possible problems that could have to be faced in using the DC metadata current description in a semantic web context.

For the migration project, the core challenge will be to efficiently cover the technological and computer sciences 20-last-years advances and be able to exploit the precious – now silent - contents of the digitized material through OCR and transcriptions campaigns, text extraction and automated content analysis applications and IIIF API use.

The metadata rdf modelization will surely improve the navigation across the entities and will favour access to new, external knowledge. Although, a key point to take in consideration is to evaluate the use of a more complex model than DCterms in order to allow the maximum level of expressivity for the FRBR relations that a digitalization process entails.

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ANNEX I – AMS Historica Collections

Patologia vegetale: malattie degli ortofrutticoli dopo la raccolta. Plant pathology: fruit and vegetable diseases after harvesting

photographic material collected in the research activity of the CRIOF (Center for the conservation and processing of fruit and vegetables of the University of Bologna 1970-1990) about fruit and vegetable samples affected by microbiological and physiological alterations after harvesting, during storage and marketing.

AMBULO - Manoscritti arabi della Biblioteca Universitaria di Bologna Online - Progetto della Cattedra di studi islamici King 'Abdulaziz - Università di Bologna. Biblioteca Universitaria di Bologna Arabic manuscripts Online

450 digitized manuscripts from the Arabic books collection of Luigi Ferdinando Marsili (1658-1730) collected from 1679 to 1692, during travels to Turkey and the siege of Buda (1684).

Most of the texts are in Arabic with some of them in Turkish, dating from the thirteenth century to the second half of the seventeenth (A.D.). Several manuscripts are miscellaneous and they treat astronomy, religion, law, grammar, lexicography, metrics, geography, medicine, biographical dictionaries, and Korans.

The metadata description is trilingual available: Italian, English and Arabic.

IGCyr | GVCyr

iconographic resource on the Greek epigraphy of Cyrenaica (Greek Cyrenaica 7th-1st century BC and Greek metric inscriptions from Cyrenaica), the collection collects iconographic images of *Inscriptions of Greek Cyrenaica* e *Greek Verse Inscriptions of Cyrenaica* epigraphic corpora.

The images comes from "Center de recherches sur la Libye antique" of the Université Paris IV Sorbonne, the personal archive of the corpora editor Catherine Dobias-Lalou, the archives of the University of Macerata, the archives of the Department of Antiquities of Libya, the archives of the IRCyr project in London and in some other institutions. Some reproductions of images already published in paper epigraphic editions complete the collection.

Rosa Genoni. La moda e la politica in una selezione di suoi scritti (1908-1928). Rosa Genoni. Fashion and politics in a selection of her writings (1908-1928)

books and articles published between 1908 and 1928 by Rosa Genoni (1867-1954), collected as part of a research project on fashion.

Inspired by Italian medieval and Renaissance art, Genoni gave life to a production of models now recognized as the basis of the "made in Italy" phenomenon. Her fervent political commitment, documented by numerous writings and publications, ranged from female education to civil rights defence.

Manoscritti Greci. Greek manuscripts

Digitization of the Biblioteca Universitaria di Bologna Greek codices fund (51), formed by the Marsili's book collection, then enriched by the transferred library of "monastero dei canonici regolari del SS. Salvatore", and other donations.

Papyri Bononienses. Papyri Bononienses

Complete digitization of the collection of papyri in Greek and Latin of the Ptolemaic, Roman and Byzantine periods, contains in 1930 by an antiquarian in Cairo preserved at the University Library of the University of Bologna.

Ulisse Aldrovandi. Manoscritti. Ulisse Aldrovandi. Manuscripts

The collections of Ulisse Aldrovandi, left by testament to the Municipality of Bologna and kept in the Palazzo Pubblico until 1742, were on that date transferred by the will of Benedict XIV to the Institute of Sciences, located in Palazzo Poggi. The manuscript collection, made up of 153 codices divided into 363 volumes, includes letters, scientific works, annotations, catalogs of natural objects, partly autographed by the scientist, partly written by copyists in his service. The collection also includes the famous volumes of watercolor paintings (10 of plants, 7 of animals and one mixed) made by Aldrovandi to various painters specialized in naturalistic representation.

Ulisse Aldrovandi. Opere a stampa. Ulisse Aldrovandi. Printed works

complete digitization of the printed works, with hand-colored xylographic tables, by the seventeenth-century naturalist Ulisse Aldrovandi (1522-1605), preserved at the University Library of Bologna and the Department of Evolutionary Biology of the University of Bologna. The digitization was carried out on the occasion of the celebrations of the fourth centenary of the death of the Bolognese scholar.

Architettura. Architecture

Also presented are some digitized volumes of the historical collection of the Library of the Department of Architecture and Territorial Planning, today the Michelucci Library. In particular, some folders of unbound

tables, A3 format, with drawings and photographs both in black and white and in color, mainly from the early twentieth century, were selected. The tables reproduce facades, perspectives and floor plans of buildings in various Italian and European cities, together with wrought iron, elevators, stairs, buildings in Buenos Ayres, projects for competitions, villas and small villas". The three volumes of the Ossatura Murale are also worthy of note. del Milani (I, II, III), the work of Giuseppe Sommaruga and Otto Wagner's Einige Skizzen (1, 2, 3).

Periodici studenteschi. Student zines

The collection of periodicals from the European Student Museum of the University of Bologna offers an overview of the varied student world, from the first post-war period to the protest of the 1960s. There are student magazines, politicians, nationalists, fascists and anarchists. They are expressions of Italian student associations (from goliardic associations to communist ones, from fascist to anarchist ones): their innovative graphics, often irreverent, offer evidence of a world full of ideas, contrasts, dreams and contradictions.'

Fondo Antico di Geografia. Ancient Geography Fund

At the end of the 14th century, the Byzantine monks who left Constantinople brought some important Greek codes of the classical tradition to Europe. Fundamental is the arrival in Florence of Ptolemy's Geography, the summa of the geographic thought of antiquity, which becomes a sort of atlas for Renaissance scholars. The digitization of some works from the Ancient Geography Fund offers an overview of that period of rebirth of geographic and cartographic thought, proposing four Renaissance editions of Ptolemy's Geography (1540, 1562, 1598, 1599), together with the Descriptions of all countries Bassi by Lodovico Guicciardini, in Italian, and the History of the Gentiles and the Nature of Northern Things by Bishop Olao Magno.

Il Codice miniato della Divina Commedia. The Illuminated Code of the Divine Comedy

The illuminated manuscript of the Divine Comedy, known to the international scientific community as "Phillipps 9589", owes its fame to the fact that it is the only Dante's program. Preserves, in the scriptio superior, one of the oldest witnesses of that branch of the manuscript tradition called "tradition a", the so-called "ancient vulgata". The original parchment is kept in the Library of the Dante Center of the Friars Minor Conventual in Ravenna.

Corpus Iuris Civilis

The Corpus Iuris Civilis presented here is a splendid folio, printed in Lyon, for the types of Hugues de la Porte, in the years 1558 and 1560, enriched by the vast apparatus of the Glossa Accursiana. This edition is characterized, in compliance with the graphic-textual models established in the humanistic age, by the fact of incorporating various texts of particular interest compared to other editions of the Corpus Iuris Civilis, in particular an updated version of the Digest with respect to the traditional Bolognese Vulgate, the Novellae Constitutiones, both in the version of the Authenticum (divided into 9 collationes) and in that of the Epitome Iuliani (the version in Latin paraphrase of the Justinian Novellae), the Brachylogus iuris civilis (also known as Corpus legum), and a version of the Institutions of Gaius.

Giovanni Domenico Cassini

In 2005 the "Cassinian year" was celebrated, in memory of the 350th anniversary of the sundial of San Petronio and the importance of the work of Giovanni Domenico Cassini. The writings relating to the sundial have been digitized, including: some flying sheets printed on the occasion of the inauguration of the sundial and the first results obtained, in addition to the invitation made for Queen Christina of Sweden; Cassini's work with the description of the sundial, the observations and the results; Cassini's work, with an appendix by Guglielmini, created for the control of the stability of the sundial and the new observations of 1695; Zanotti's work created in 1779 on the occasion of a new inspection, which also reports the observations made over the course of a century.

Fondo Maestrini. Maestrini Fund

The digitization of the Maestrini Fund brings to light some ancient works of veterinary and farriery, including William Cavendish's La methode et invention nouvelle, On the way to know the nature of the cavalli and the medicines belonging to them, by Agostino Columbre, and Dissertatio historica de bovilla peste, by Giovanni Maria Lancisi.

Letteratura coloniale italiana. Italian colonial literature

Founded in 1937, when the fascist colonial expansion was at its peak, the "Walter Bigiavi" Library of the Faculty of Economics was able to collect numerous and interesting materials focused on the African experience of Italy, documents brought to light today by AMS Historica. The materials presented here were part of the exhibition "Italians good people? Italy and the Empire", proposed during June 2008.

ANNEX II – 3 items Turtle RDF serialization

```
@base <https://amshistorica.unibo.it/> .
@prefix dcterms: <http://purl.org/dc/terms/> .
@prefix owl: <http://www.w3.org/2002/07/owl#> .
@prefix pro: <http://purl.org/spar/pro/> .
@prefix org: <http://www.w3.org/ns/org#> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix rdfs: <http://www.w3.org/2000/01/rdf-schema#> .
@prefix foaf: <http://xmlns.com/foaf/spec/> .
@prefix lrmoo: <http://www.cidoc-crm.org/frbroo/ModelVersion/lrmoo-f.k.a.-frbroo-v.0.7> . # 7.1.1 jun 2021
@prefix bcco: <http://dati.beniculturali.it/cis/> . # Cultural-ON (Cultural ONtology)
@prefix rdac: <http://rdaregistry.info/Elements/c/> .
@prefix rdaw: <http://rdaregistry.info/Elements/w/> .
@prefix rdae: <http://rdaregistry.info/Elements/e/> .
@prefix rdam: <http://rdaregistry.info/Elements/m/> .
@prefix rdai: <http://rdaregistry.info/Elements/i/> .
@prefix bf: <http://id.loc.gov/ontologies/bibframe/> .
```

#Authors

```
<agents/Author/Aldrovandi_Ulisse> a rdac:C10004 ; #person
    rdfs:label "Aldrovandi, Ulisse" ;
    foaf:givenName "Ulisse" ;
    foaf:familyName "Aldrovandi" ;
    owl:sameAs <http://viaf.org/viaf/100190422>, <https://lccn.loc.gov/n50035572> .

<agents/Author/Uterverio_GiovanniCornelio> a rdac:C10004 ; #person
    rdfs:label "Uterverio, Giovanni Cornelio 1592-1619" ;
    foaf:givenName "Giovanni Cornelio" ;
    foaf:familyName "Uterverio" ;
    owl:sameAs <http://viaf.org/viaf/9730643> .
```

#Agents Typographer

```
<agents/Typographer/Tamburini_Girolamo> a rdac:C10004 ; #person
    rdfs:label "Tamburini, Girolamo" ;
    foaf:givenName "Girolamo" ;
    foaf:familyName "Tamburini" ;
    owl:sameAs <http://viaf.org/viaf/72323243> ;
    org:headOf <agents/typography/Girolamo_Tamburini> .

<agents/Typographer/Bellagamba_GiovanniBattista> a rdac:C10004 ; #person
    rdfs:label "Bellagamba, Giovanni Battista" ;
    foaf:givenName "Giovanni Battista" ;
    foaf:familyName "Bellagamba" ;
    owl:sameAs <http://viaf.org/viaf/97661849> ;
    org:headOf <agents/typography/GiovanniBattista_Bellagamba> .
```

#Agents Typography (corporate)

```
<agents/typography/ex_Laelii_a_Vulpe> a rdac:C10005 ; #corporate body
    rdfs:label "ex typographia Laelii a Vulpe" ;
    org:hasSite <places/city/Bologna> .

<agents/typography/GiovanniBattista_Bellagamba> a rdac:C10005 ; #corporate body
    rdfs:label "apud Ioannem Baptistam Bellagambam" ;
    org:hasSite <places/city/Bologna> ;
    owl:sameAs <http://viaf.org/viaf/2120145857132522922329> .

<agents/typography/Girolamo_Tamburini> a rdac:C10005 ; #corporate body
    rdfs:label "Hieronymi Tamburini" ;
    org:hasSite <places/city/Bologna> .
```

#Agents Rights Holders

```
<agents/RightsHolders/Università_di_Bologna> a rdac:C10005 ; #corporate body
    rdfs:label "Alma Mater Studiorum – Università di Bologna" ;
    org:hasSite <places/City/Bologna> ;
    owl:sameAs <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0427> ;
    lrmoo:R4 <items/Periodico/1> , <items/Monografia/17> , <items/Monografia/197> .
```

#Agents Libraries

```
<agents/Library/BO404> a bcco:Library ;
    rdfs:label "Biblioteca di Matematica, Fisica, Astronomia e Informatica. Sezione di Astronomia \"Guido Horn d'Arturo\"";
    owl:sameAs <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0427> ;
    foaf:isPrimaryTopicOf <https://acnpsearch.unibo.it/library/BO404> .
```

```

<agents/Library/BO402> a bcco:Library ;
  rdfs:label "Biblioteca del Dipartimento di Scienze biologiche, geologiche e ambientali - BiGeA" ;
  owl:sameAs <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0429> ;
  foaf:isPrimaryTopicOf <https://acnpsearch.unibo.it/library/BO402> .

<agents/Library/BO001> a bcco:Library ;
  rdfs:label "Biblioteca Universitaria di Bologna" ;
  owl:sameAs <https://dati.beniculturali.it/iccu/anagrafe/resource/Library/IT-BO0098> ;
  foaf:isPrimaryTopicOf <https://acnpsearch.unibo.it/library/BO001> .

#Places

<places/city/Bologna> a dcterms:Location ;
  rdfs:label "Bologna"@it ;
  owl:sameAs <https://www.geonames.org/6541998/bologna.html> .

#RightsStatement

<RightsStatement/001> a dcterms:RightsStatement ;
  rdfs:label "E' vietato riprodurre o duplicare le immagini consultabili nel sito senza l'autorizzazione scritta delle Biblioteche proprietarie." .

#Collections

<items/Collezione/comm> a dcterms:BibliographicResource ;
  rdfs:label "De Bononiensi scientiarum et artium Instituto atque Academia commentarii (1731-1791)" ;
  dcterms:hasPart <items/Periodico/1> .

<items/Collezione/alrovandimanoscritti> a dcterms:BibliographicResource ;
  rdfs:label "Ulisse Aldrovandi Manoscritti" ;
  dcterms:hasPart <items/Monografia/197>, <items/Monografia/198>, <items/Monografia/199>.

<items/Collezione/aldr:stamp> a dcterms:BibliographicResource ;
  rdfs:label "Ulisse Aldrovandi, opere a stampa" ;
  dcterms:hasPart <items/Monografia/17>, <items/Monografia/26> .

#Expressions, manifestations, items

#1 Journal: starting from E level

_e1 a rdac:C10006 ; #expression
  rdae:P20059 _m1 , <items/Periodico/1>.

_m1 a rdac:C10007; # "manifestation"
  dcterms:title "De Bononiensi Scientiarum et Artium instituto atque academia commentarii" ;
  dcterms:description "De Bononiensi scientiarum et artium Instituto atque academia commentarii. - T.1 (1731)-t. 7 (1791). - Bononiae : ex typographia Laelii a Vulpe, 1731-1791. - 28 cm. ([Irregolare.];" ;
  dcterms:publisher <agents/typograpy/ex_Laelii_a_Vulpe> ;
  dcterms:date "1731" ;
  dcterms:type "Periodico" ;
  dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
  dcterms:identifier "1122-4150" ; #issn
  dcterms:language <https://iso639-3.sil.org/code/lat> ;
  dcterms:relation "http://amshistorica.unibo.it/1" ;
  rdam:P30005 <https://acnpsearch.unibo.it/journal/34096>; #has preferred citation
  rdam:P30005 <https://sol.unibo.it/SebinaOpac/resource/UBO2846137>; #has preferred citation
  rdam:P30005 <http://id.sbn.it/bid/TO00182608>; #has preferred citation
  rdam:P30103 _i1. #

_i1 a rdac:C10003 ; #item
  rdai:P40021 <agents/Library/BO404> ; #has owner agent
  rdai:P40001 "MUSEO.ANT CC. 0006" ; #has identifier for item
  rdai:P40087 <items/Periodico/1>. #has digital transfer of item

#17 Book: starting from W level

_w17 a rdac:C10001 ; #work
  rdaw:P10065 <agents/Author/Aldrovandi_Ulisse> ; #has creator agent of work
  rdaw:P10078 _e17 . #has expression of work

_e17 a rdac:C10006 ; #expression
  rdae:P20059 _m17 , <items/Monografia/17> .

_m17 a rdac:C10007; # "manifestation"
  dcterms:title "De piscibus libri 5. et De cetis lib. vnus. Ioannes Cornelius Vteruerius ... collegit. Hieronymus Tamburinus in lucem edidit ... Cum indice copiosissimo" ;
  dcterms:description "Vlyssis Aldrouandi ... *De piscibus libri 5. et De cetis lib. vnus. Ioannes Cornelius Vteruerius ... collegit. Hieronymus Tamburinus in lucem edidit ... Cum indice copiosissimo. - Bononiae : apud Bellagambam : [Girolamo Tamburini], 1613 (Bononiae : apud Ioannem Baptistam Bellagambam : sumptibus Hieronymi Tamburini, 1612). - [8], 372 [i.e. 732], [28] p. : ill. ; fol. ((Nel tit. 5. espresso V. - Front. calcogr. con stemma del dedicatario, cardinale Marco Sittico Altemps. - Marca (V5) in fine. - Cors. ; gr. ; rom. - Segn.: pi greco4 A-3Q6 3R8." ;
  dcterms:publisher <agents/typography/Girolamo_Tamburini> , <agents/typography/GiovanniBattista_Bellagamba> ;
  dcterms:contributor <agents/Author/Uterverio_GiovanniCornelio> ;
  dcterms:date "1613" ;
  dcterms:type "monografia" ;

```

```

dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation "http://amshistorica.unibo.it/17" ;
rdam:P30005 <https://sol.unibo.it/SebinaOpac/resource/UBO2845920>; #has preferred citation
#rdam:P30005 <http://id.sbn.it/bid/TO00182608>; #has preferred citation
rdam:P30103 _i17. #

_i17 a rdac:C10003 ; #item
rdai:P40021 <agents/Library/BO402> ; #has owner agent
rdai:P40001 "ZOV 822" ; #has identifier for item
rdai:P40087 <items/Monografia/17>. #has digital transfer of item

#197 Manuscript: starting from W level, M and I level merged

_w197 a rdac:C10001 ; #work
rdaw:P10065 <agents/Author/Aldrovandi_Ulisse> ; #has creator agent of work
dcterms:subject <http://id.loc.gov/authorities/subjects/sh85015976> ;
rdaw:P10078 _e197 . #has expression of work

_e197 a rdac:C10006 ; #expression
rdac:P20059 _m197 , <items/Monografia/197>.

_m197 a rdac:C10007, rdac:C10003, bf:Manuscript; #manifestation, item, manuscript
dcterms:title "Bologna, Biblioteca Universitaria, ms. Aldrovandi 112" ;
dcterms:creator <agents/Author/Aldrovandi_Ulisse> ;
dcterms:description "http://manus.iccu.sbn.it//opac_SchedaScheda.php?ID=197826" ;
dcterms:date "1550-1605" ;
dcterms:type "monografia" ;
dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
dcterms:identifier "http://amshistorica.unibo.it/197" ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation "http://amshistorica.unibo.it/197" ;
rdam:P30005 <https://sol.unibo.it/SebinaOpac/resource/UBO2845920>; #has preferred citation
rdai:P40021 <agents/Library/BO001> ; #has owner agent
rdai:P40001 "ID:197826" ; #has identifier for item
rdai:P40087 <items/Monografia/197>. #has digital transfer of item

#Items

<items/Periodico/1> a rdac:C10007 ; #manifestation
dcterms:title "De Bononiensi Scientiarum et Artium instituto atque academia commentarii" ;
dcterms:format <https://www.iana.org/assignments/media-types/text/html> ; #cambiare
dcterms:identifier "http://amshistorica.unibo.it/1" ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation _m1 ;
dcterms:accessRights <RightsStatement/001> ;
rdam:P30141 <agents/Library/BO404> ; #has contact information
dcterms:rightsHolders <agents/RightsHolders/Università_di_Bologna> ;
rdam:P30117 <agents/RightsHolders/Università_di_Bologna> . #has statement of responsibility

<items/Monografia/17> a rdac:C10007; #manifestation
dcterms:title "De piscibus libri 5. et De cetis lib. vnus. Ioannes Cornelius Vteruerius ... collegit. Hieronymus Tamburinus in lucem edidit ... Cum indice copiosissimo" ;
dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
dcterms:identifier "http://amshistorica.unibo.it/17" ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation _m17 ;
dcterms:accessRights <RightsStatement/001> ;
rdam:P30141 <agents/Library/BO404> ; #has contact information
dcterms:rightsHolders <agents/RightsHolders/Università_di_Bologna> ;
rdam:P30117 <agents/RightsHolders/Università_di_Bologna> . #has statement of responsibility

<items/Monografia/197> a rdac:C10007; #manifestation
dcterms:title "Bologna, Biblioteca Universitaria, ms. Aldrovandi 112" ;
dcterms:format <https://www.iana.org/assignments/media-types/text/html> ;
dcterms:identifier "http://amshistorica.unibo.it/197" ;
dcterms:language <https://iso639-3.sil.org/code/lat> ;
dcterms:relation _m197 ;
dcterms:accessRights <RightsStatement/001> ;
rdam:P30141 <agents/Library/BO001> ; #has contact information
dcterms:rightsHolders <agents/RightsHolders/Università_di_Bologna> ;
rdam:P30117 <agents/RightsHolders/Università_di_Bologna> . #has statement of responsibility

```