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Transforming MARC21 authority records into MADS/RDF: a step-by-step guide

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Abstract

Purpose – During the development of a joint project between the National Library of Catalonia and the University of Barcelona's Faculty of Information and Audiovisual Media, aimed at improving the interoperability and dissemination of the CANTIC authority catalogue through Linked Open Data, a lack of bibliography, experiences and specific tools for transforming MARC21 authority records into MADS/RDF was identified. In response to this need, and as a first phase of the project, an XSLT transformation tool was developed that would be accessible to librarians without advanced IT knowledge. This article aims to present a detailed, step-by-step guide for using and adapting this tool.

Design/methodology/approach – A literature review was conducted to identify similar experiences. The tools found were tested to evaluate their effectiveness. Due to unsatisfactory results, a custom XSLT transformation tool was developed, tailored to the project's needs.

Findings – A detailed guide has been created for the XSLT transformation tool that converts MARC21 records to MADS/RDF, facilitating the integration of the CANTIC catalogue and other similar authority files into the Linked Data ecosystem.

Originality/value – The tool developed represents an advance in the interoperability of authority catalogues and may serve as a gateway for library professionals to engage with emerging technologies. This may encourage their active participation in innovation projects within their work environments.

Keywords Authority files, Linked open data, MARC21 authority, MADS/RDF, Transformation, XSLT

Paper type Technical paper

1. Introduction

In November 2024, the National Library of Catalonia [1] and the University of Barcelona's Faculty of Information and Audiovisual Media launched a joint project to improve the interoperability and dissemination of the *Catalogue of Authority Records of Names and Titles of Catalonia (CANTIC)*[2] through Linked Open Data (LOD). CANTIC, created in 2008 by the National Library of Catalonia (Biblioteca de Catalunya, Consorci de Serveis Universitaris de Catalunya, 2023), is the catalogue of names, titles, and name/title combinations used by most libraries in Catalonia. As of August 4, 2025, CANTIC contains 435,970 authority records created or compatible with RDA and encoded in MARC21.

The project consists of four phases:

(1) Transformation of CANTIC authority records from MARC21 to RDF

(2) Enrichment of records by incorporating data and links obtained from open datasets, especially from resources such as VIAF or Wikidata

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(3) Implementation of a SPARQL query endpoint to enable more precise queries across the entire CANTIC tool, promoting interoperability of the authority file and its reuse in other environments

(4) Evaluation of the transformation and enrichment of authority records, followed by the introduction of improvements

Of these four phases, this article's main objective is to present the experiences, challenges, and lessons learnt during the development of the first phase. From a methodological standpoint, the project began with a search for information and similar experiences in conventional bibliographic databases (*Scopus*, *Web of Science*, *Google Scholar*, and *Dialnet*). Some of the search queries used included:

(1) "Authority files" and "Linked Open Data"

(2) "Authority files" and "interoperability"

(3) "Authority files" and "RDF"

(4) "MARC 21" and "MADS/RDF"

In parallel, searches were conducted of existing applications and previous projects using tools such as Google and GitHub. This initial exploration of the world of authority file transformation revealed the limited amount of literature available on experiences converting MARC21 authority records to RDF. The search for existing transformation tools yielded similarly limited results, and the few tools found did not have clear instructions that would be accessible to librarians without advanced computer knowledge, as is the case of the librarians involved in the project discussed here.

As noted above, there is very little literature on transforming MARC21 authority records to RDF, although the W3C has highlighted the benefits of this practice (W3C Library Linked Data Incubator Group, 2011). Some authors (Fabeiro *et al.*, 2019; Miller, 2022; Pastor Sánchez, 2011; Quílez Mata, 2017; Wang and Yang, 2019; Zeng and Qin, 2022) have pointed out that this transformation contributes to the reduction of information silos, prepares libraries for the semantic enrichment of their collections, and promotes the improvement of data quality and data relationships. However, Fabeiro *et al.* (2019) point out several challenges to implementation, one of the most significant being the very small number of companies dedicated to this type of transformation, which results in many projects being discontinued or having very limited scope. Other factors include the time needed to implement RDA or BIBFRAME, making it difficult to launch related projects (which, like the one discussed here, are quite technically and conceptually complex), as well as the fact that many professionals are unaware of these technologies.

Table 1 presents a summary of some of the most significant projects, which, as can be seen, are usually linked to national libraries or international organizations.

Table 1. Authority data sets in the library domain published as linked open data

LOD service	LOD publication date	Source
Linked Data Service – Library of Congress[a]	2009	Fabeiro *et al.* (2019)
Datos BNE – National Library of Spain[b]	2014	Santos Muñoz (2015)
Data.bnf.fr – National Library of France[c]	2011	Grimaldi (2024)
British National Bibliography – British Library[d]	2011	Burrows *et al.* (2024)
VIAF[e]	2012	Putnam (2022)
ISNI[f]	2012	Armitage *et al.* (2020)

Note(s) [a]https://id.loc.gov/, [b]https://datos.bne.es/inicio.html, [c]https://data.bnf.fr/, [d]https://bl.natbib-lod.org/, [e]https://viaf.org/, [f]https://isni.org/

Many of these projects originated with the ideas presented by Tim Berners-Lee's team in 2007 (Bizer *et al*., 2008) when linked data was experiencing its period of exponential growth, and although they started years ago, this does not mean that they are no longer active. On the contrary, these are projects that are constantly being updated and improved, but that do not share the tools they use—or if they do (some of them are available on GitHub), they are not always sufficiently documented because in most cases their authors have not shared their knowledge and experiences in a detailed and accessible way for librarians without advanced computer knowledge, through academic articles, websites, etc.

The transformation tools identified include:

(1) *MARiMbA* [3] (Vila-Suero; Gómez-Pérez, 2013). This tool was used to convert MARC records (both authority and bibliographic) from the National Library of Spain into RDF. It is well documented, but the tool is no longer maintained and could not be downloaded for testing.

(2) *Semantics.gr* [4] (Georgiadis *et al.*, 2022). This is a well-documented tool with its own website, but it was not possible to test it.

(3) *MARC Authorities to MADS/RDF* RDF/XML [5]. This is a tool designed specifically for Library of Congress records, without instructions to adapt it to other environments. It is available and downloadable on the GitHub platform.

(4) *Catmandu* [6] and *marc2bibframe2marc2bibframe2* [7]. Although both these tools are presented with a tutorial (or at least a brief explanation), it has not been possible to make the transformation work correctly with only basic computer knowledge. Catmandu is hosted with its manual at *LibreCat* [8], while the second tool is also available on GitHub, but its explanations are very brief.

(5) *MarcEdit* [9]. This transformation tool is well known in cataloguing environments, easy to install, and simple to use. However, by experimenting with its conversion options it was found to be unsuitable, as it is designed for transforming bibliographic records rather than authority records.

In view of the above, it was ultimately decided to create a custom tool. XSL transformation technology (XSLT) was chosen because it was used by the Library of Congress to transform MARCXML authority records to MADS (*MARCXML Authorities to MADS 2.1 Stylesheet* [10]). The tool can be downloaded from the Figshare platform by searching for the *MARCXML Authority records to MADS/RDF Authority records* project [11].

Below is a detailed, step-by-step explanation of this tool, with the aim of making it accessible to librarians without advanced computer knowledge. In this way, any professional with basic knowledge of XML and RDF will be able to use this transformation tool properly, adapting it to their needs or creating a new one. Prior to the explanation, however, is a section describing two standards also used in the development of the tool that may not be as well known: MADS/RDF and XSLT.

2. Conversion tool fundamentals

2.1 MADS/RDF

MADS/RDF (Metadata Authority Description Schema in RDF) [12] is a vocabulary developed and maintained by the Library of Congress for the representation of authority records using the *RDF (Resource Description Framework)* model [13]. MADS/RDF records can be serialized (Pastor Sánchez, 2011; W3C – Library Linked Data Incubator Group, 2011) with different encoding standards (JSON, N-Triples, Turtle, etc.), although the most common in the library context is XML. In fact, MADS was created in 2004 in this format and was later adapted to RDF in 2011–2012. As a metadata schema, MADS is complementary to MODS, which

describes bibliographic resources. Its function, however, is the processing of authority data as used by libraries, which means (among other features) that MADS/RDF offers a way of recording MARC 21 authority data in RDF, for use in semantic applications and linked data projects, as is the case with the CANTIC project discussed here.

While a detailed description of the structure of this vocabulary is beyond the scope of this article (a breakdown of all its components can be consulted in MADS/RDF (Metadata Authority Description Schema in RDF)) [13], it is worth noting that like any vocabulary that uses the RDF model, it is composed of classes and properties organized hierarchically. There are classes that define resources containing an authorized heading (madsrdf: Authority) or an unauthorized heading (madsrdf:Variant), and classes that define the specific type of heading that is controlled (madsrdf:PersonalName, madsrdf: CorporateName, madsrdf:ConferenceName, etc.). Notable among the properties are those that define the authorized heading (madsrdf:authoritativeLabel), the unauthorized forms of the heading (madsrdf:hasVariant) and the sources consulted for the description of the resource (madsrdf:hasSource).

For example, a simplified authority record for the Catalan writer Víctor Català would be as follows:

```
<?xml version = "1.0" encoding = "UTF-8"?>
<rdf:RDF xmlns:rdf = "http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:madsrdf = "http://www.loc.gov/mads/rdf/v1#">
<madsrdf: PersonalName rdf:about = "http://id.loc.gov/authorities/names/n83014591">
  <rdf:type rdf:resource = "http://www.loc.gov/mads/rdf/v1#Authority"/>
  <madsrdf:authoritativeLabel > Català, Víctor, 1869–1966</madsrdf:authoritativeLabel>
  <madsrdf:hasVariant>
    <madsrdf:PersonalName>
      <rdf:type rdf:resource = "http://www.loc.gov/mads/rdf/v1#Variant"/>
      <madsrdf:variantLabel > Albert y Paradís, Catalina, 1869–1966</madsrdf:
variantLabel>
    </madsrdf:PersonalName>
  </madsrdf:hasVariant>
  <madsrdf:hasSource>
    <madsrdf:Source>
      <madsrdf:citationStatus > found</madsrdf:citationStatus>
      <madsrdf:citationSource > Epistolari de Víctor Català, 2005:</madsrdf:
citationSource>
        <madsrdf:citationNote > v. 1, t.p. (Víctor Català) p. 3 (Caterina Albert Paradís)
</madsrdf:citationNote>
    </madsrdf:Source>
  </madsrdf:hasSource>
</madsrdf: PersonalName>
</rdf:RDF>
```

Optionally, with the <madsrdf:elementList > property, the parts of a heading can be represented in a more granular way:

```
<madsrdf:authoritativeLabel > Català, Víctor, 1869–1966</madsrdf:authoritativeLabel>
<madsrdf:elementList rdf:parseType = “Collection”>
  <madsrdf:FamilyNameElement>
    <madsrdf:elementValue > Català</madsrdf:elementValue>
  </madsrdf:FamilyNameElement>
  <madsrdf:GivenNameElement>
    <madsrdf:elementValue > Víctor</madsrdf:elementValue>
  </madsrdf:GivenNameElement>
  <madsrdf:DateNameElement>
    <madsrdf:elementValue>1869–1966</madsrdf:elementValue>
  </madsrdf:DateNameElement>
</madsrdf:elementList>
```

2.2 XSLT

XSL Transformations (XSLT) is a specific part of XSL (eXtensible Stylesheet Language), a family of W3C recommendations for defining the transformation and presentation of XML documents. XSLT enables the transformation of XML documents into other formats, such as HTML, plain text, or different XML structures.

The transformation is carried out using templates and transformation rules. With XPath expressions [14], specific nodes of the XML document to be transformed (input document) are selected and the corresponding template is applied. With a template, it is possible to associate one or more functions with an element of the input document (<xsl:template match = “”>), insert a literal text into the output document (<xsl:text>), extract the value of an element or attribute of the input document and display it in the output document (<xsl:value-of select = “””>), or define a condition in the input document so that one or more functions are executed (<xsl:if test = “condition”>), among other actions.

For example, if in the following XML input document:

```
<?xml version = “1.0” encoding = “UTF-8”?>
<person>
  <name>John</name>
  <age>25</age>
</person>
```

. . . the following XSLT is applied:

```
<xsl:stylesheet version = “1.0” xmlns:xsl = “http://www.w3.org/1999/XSL/Transform”>
  <xsl:template match = “person”>
    <text>
      <xsl:text>Hello, my name is </xsl:text>
      <xsl:value-of select = “name”/>
```

```
        <xsl:if test = “age >18”> and I am an adult</xsl:if>
      </text>
    </xsl:template>
  </xsl:stylesheet>
```

. . . it will generate the following XML output document:

```
<?xml version = “1.0” encoding = “UTF-8”?>
<text>Hello, my name is John and I am an adult</text>
```

3. Development of the MARC21 to MADS/RDF transformation tool

3.1 First step: creating the XSLT document and defining the namespaces

Using a source code editor (Sublime Text, Phoenix Code, etc.), you need to create an XSL document:

1. <?xml version = “1.0” encoding = “UTF-8”?>
2. <xsl:stylesheet version = “1.0”
3. xmlns:xsl = “http://www.w3.org/1999/XSL/Transform”
4. xmlns:marcxml = “http://www.loc.gov/MARC21/slim”
5. xmlns:rdf = “http://www.w3.org/1999/02/22-rdf-syntax-ns#”
6. xmlns:madsrdf = “http://www.loc.gov/mads/rdf/v1#”>

Line 1 declares that it is an XML document and that the character encoding is UTF-8.

Line 2 defines the document as an XSL stylesheet (version 1.0) and lines 3–6 declare the namespaces necessary to develop the tool. In this case, the namespaces are XSLT, MARCXML, RDF and MADS/RDF.

3.2 Second step: definition of the output document format

Next, the output document of the XSLT transformation, the MADS/RDF document, is defined as being in XML format, which is the option chosen in the project discussed here.

7. <xsl:output method = “xml” indent = “yes” encoding = “UTF-8”/>

3.3 Third step: definition of the main template

The first template is applied to the root of the MARCXML input document (match = “/”), and this creates the root element <rdf:RDF> in the MADS/RDF output document (lines 9 and 11).

8. <xsl:template match = “/”>
9. <rdf:RDF>
10. <xsl:apply-templates select = “//marcxml:record”/>
11. </rdf:RDF>
12. </xsl:template>

Once the root element has been created, line 10 establishes that whenever an authority record (<record>) is found in the MARCXML input document, specific templates for each field (100, 110, 130, 400, 670, etc.) will be applied to its content. These specific templates are defined throughout the transformation file.

3.4 Fourth step: definition of specific templates per field

Since the structure of the template is almost the same for all fields, an explanation of all the templates is not offered here. Instead, the template for field 100 (Personal name) is detailed below, because the rest are either equivalent to or a subset of it.

```
13. <xsl:template match = "marcxml:record[marcxml:datafield[@tag = '100']]">
14.   <madsrdf:PersonalName>
15.     <xsl:attribute name = "rdf:about">
16.       <xsl:text>https://cantic.bnc.cat/registre/</xsl:text>
17.       <xsl:value-of select = "marcxml:controlfield[@tag = '001']"/>
18.     </xsl:attribute>
20.     <rdf:type rdf:resource = "http://www.loc.gov/mads/rdf/v1#Authority"/>
22.     <madsrdf:authoritativeLabel>
23.       <xsl:value-of select = "marcxml:datafield[@tag = '100']/marcxml:subfield
          [@code = 'a']"/>
24.       <xsl:if test = "marcxml:datafield[@tag = '100']/marcxml:subfield
          [@code = 'd']">
25.         <xsl:text>, </xsl:text>
26.         <xsl:value-of select = "marcxml:datafield[@tag = '100']/marcxml:subfield
            [@code = 'd']"/>
27.       </xsl:if>
28.     </madsrdf:authoritativeLabel>
30.     <xsl:apply-templates select = "marcxml:datafield[@tag = '400']"/>
32.     <xsl:apply-templates select = "marcxml:datafield[@tag = '670']"/>
34.   </madsrdf:PersonalName>
35. </xsl:template>
```

The template starts (line 13) by using the match = attribute to define which field of the MARCXML input document it will be applied to. In this case, it is established that the template will be applied when a <datafield> element is found with an attribute equal to tag = '100'.

Since this is a personal name authority record, line 14 creates the <madsrdf: PersonalName > element in the MADS/RDF output document, which is closed on line 34.

To uniquely identify the personal name with a URI, line 15 creates the rdf:about attribute (closed on line 18). In the case of this project, since CANTIC records do not have a URI, it was determined to define the attribute value as the text https://cantic.bnc.cat/registre/ (line 16) followed by the value of the <controlfield tag = "001"> element of the MARCXML input document (line 17).

Line 20 creates the rdf:type element in the MADS/RDF output document to indicate the type of class to which the field value belongs. In this case, since it is field 100, the class is Authority (if it were a field 400 the class would be Variant).

Lines 22–28 are used to transform all the MARCXML subfields of field 100 into MADS/RDF. First (line 22), the <madsrdf:authoritativeLabel > element that will contain all the transformed subfields is created (closed on line 28). The values of mandatory subfields are selected with xsl:value-of select = "". This is the case of subfield a of field 100 (line 23). In the case of optional subfields, since it is not certain that they will appear in the MARCXML input document, it is necessary to define an xsl:if conditional control element that allows a portion of

code to be executed only if a specific condition (test) is met. In this case, for example, a conditional has been created for subfield d corresponding to dates associated with the personal name (line 24). If a subfield d is found in the input document, then lines 25 and 26 are executed, i.e. a comma and a blank space are added in the output document after the personal name (line 25) and then the value of subfield d is given (line 26).

Finally, if the <record> of the MARCXML input document contains other fields besides field 100, a call is made to apply the corresponding template. This is the case of the call to the template for field 400 (line 30) and field 670 (line 32). These templates are defined later, in the same XSL file, following in whole or in part the structure explained for field 100.

4. Running the XSLT transformation file

To apply the XSLT file to a MARCXML input document and obtain a MADS/RDF output document, in this project it was decided to create a very simple PHP file [15] that:

(1) Loads the MARCXML input document

(2) Loads the file containing the XSLT transformation rules for converting MARCXML to MADS/RDF

(3) Applies the XSLT transformation to the MARCXML input document

(4) Saves the MADS/RDF output document to an XML file

(5) Displays a message confirming that the transformation has been completed

PHP was chosen because the team had some experience with this programming language, but a script with the same functions can be made with other languages, such as Python.

Finally, it should be noted that to run the XSLT file with PHP it is necessary to have a web server with support for this language, such as Apache [16]. It can also be run on a personal computer using the free software package XAMPP [17], which contains Apache and the PHP interpreter and is very easy to install.

5. Conclusions

Librarians need to play an active role in the technological aspect of the Semantic Web and linked data. Without seeking to replace IT specialists, librarians must be able to go beyond theoretical approaches, develop small technological projects and participate in tandem with IT specialists on larger projects.

Among the elements needed to achieve this objective are publications in the field of information and documentation that publicize projects and technologies related to the Semantic Web and linked data in a clear and accessible way for librarians without advanced IT knowledge. This is the purpose behind the joint project of the Library of Catalonia and the University of Barcelona's Faculty of Information and Audiovisual Media, which was launched with the aim of improving interoperability and dissemination through open linked data from the CANTIC authority catalogue.

This first phase of the project has consisted of transforming MARC21 authority records into RDF using a proprietary tool developed with XSL technology (XSLT). In order to encourage other libraries and institutions to undertake similar projects related to the Semantic Web and linked data, this article has provided a fairly detailed explanation of the tool, in language accessible to librarians without advanced computer knowledge. It is hoped that any librarian with basic knowledge of XML and RDF will be able to use the transformation tool properly, adapting it to their needs or creating a new one.

Knowledge of these and other emerging technologies should allow librarians to participate in advanced technological projects and, ultimately, become active agents in an increasingly digital and innovative professional context.

Notes

1. "The BC is the national library of Catalonia, with almost five million documents of all types (books, magazines, audio, videos, maps, drawings, engravings, ancient and modern manuscripts, scores, posters, etc.). It is a leading cultural centre specializing in the collection, conservation, promotion and dissemination of Catalonia's written, musical, audio, audiovisual, graphic and editorial heritage, both in the analogue and digital contexts." (Biblioteca de Catalunya, 2025, our translation)
2. https://cantic.bnc.cat/
3. https://oeg.fi.upm.es/index.php/es/technologies/228-marimba/index.html
4. https://www.semantics.gr/authorities/?language=en
5. https://github.com/lcnetdev/marcauth-to-madsrdf
6. https://librecatproject.wordpress.com/
7. https://github.com/lcnetdev/marc2bibframe2
8. https://librecat.org/
9. https://marcedit.reeset.net/downloads
10. https://www.loc.gov/standards/mads/rdf/
11. https://figshare.com/articles/software/MARCXML_Authority_records_to_MADS_RDF_Authority_records/28554335
12. https://id.loc.gov/ontologies/madsrdf/v1.html
13. https://www.w3.org/TR/rdf12-primer/
14. XPath (XML Path Language) is a language that allows you to build expressions that traverse and process an XML document. XPath allows you to search and select taking into account the hierarchical structure of XML. XPath was defined by the W3C consortium. Specifications about XPath can be found at https://www.w3.org/TR/xpath/
15. PHP (https://www.php.net/) is an interpreted programming language that runs on the server side using a PHP interpreter.
16. httpd.apache.org/
17. https://www.apachefriends.org/es/index.html

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