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Connecting RDA and RDF

Linked Data for a Wide World of Connected Possibilities

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Libraries have struggled with connecting a plethora of content and the metadata stored in catalogs to patrons. Adding more value to catalogs, more tools for reference librarians, and enriched patron search, linked data is a means to connect more people with more relevant information. With the recent transition to the Resource Description and Access (RDA) cataloging standard within libraries, linking data in library databases has become a much easier project to tackle, largely because of another standard called Resource Description Framework (RDF). Both focus on resource description and both are components of linked data within the library. Tying them together is the Functional Requirements for Bibliographic Records (FRBR) conceptual framework. Acknowledging that linked data components are most likely new to many librarians, this article seeks to explain what linked data is, how RDA and RDF are connected by FRBR, and how knowledge maps may improve information access.

Introduction

Interest in linked data has been growing. Recently, a search of the abstract databases Scopus, Web of Science, and Google Scholar show “linked data” as a search term an average of 45,633 times from 2010 to July 2015. From January to July 2015 alone, "linked data" was searched an average of 3,573 times. It is therefore no wonder that more people are paying attention to data and how it can be linked to other data. Libraries in particular have started investing resources in linked data. From widely used sources like the Library of Congress Subject Headings and Authorities to more specialized resources like the Getty Vocabularies, linked data has become a popular, if little understood, tool within the library. The basic concept of linked data is at the core of the Semantic Web. Both are synonymous with making things easier to find through multiple access points for a diverse user base. Although it is in the interest of the technical services, metadata, or cataloging librarians to know, linked data can also significantly

help all other librarians- in public, academic, and special libraries -connect more people to more relevant information more efficiently and effectively than current methods. Linked data also has the potential to empower patrons in complex search. This article primarily focuses on linked bibliographic data, but there are other types such as vocabulary and authority linked data as well.

Libraries have struggled with connecting a plethora of content, and the metadata stored in the catalog, for their patrons' use. With the recent transition to the Resource Description and Access (RDA) cataloging standard within libraries, linking data in library databases has become a much easier project to tackle, largely because of another standard called Resource Description Framework (RDF). Tying them together is the Functional Requirements for Bibliographic Records (FRBR) conceptual framework.

Acknowledging that these terms are most likely new to many librarians, this article seeks to highlight recent literature and resources, define and explore RDA, RDF, and FRBR in more detail, expand on how these three topics interconnect, provide a sample teaching aid for library linked data, and bring forth a few examples of linked library data in practice. The purpose throughout is to explore how librarians can harness RDA, RDF, and FRBR for improved information access with linked data.

Literature Review

With recent attention to RDA and RDF respectively, a strong collection of research has emerged. In RDA, librarians are at the forefront with the RDA Toolkit and numerous sites, blogs, videos, and monographs on transitioning to and understanding RDA. A few open access resources include the Association for Library Collections & Technical Services (ALCTS) webinar series (2012), the Tennessee Libraries Association RDA guide (Baskett, Underdown-DuBois, & Busch, 2013), Mark K. Ehlert's RDA brief (2013); and the University of North Florida's RDA training booklet (Veve, 2014). The RDA Toolkit, as well as resources like Mering's (2014) student-focused *RDA Workbook* and Maxwell's (2013) detailed examples of RDA cataloging, are also great resources but are not open access.

A few notable articles on RDA, RDF, and linked data in libraries include Alemu, Stevens, Ross, and Chandler (2012), which supports the use of RDF within the library; Baker, Coyle, and Petiya (2014), which compare FRBR, RDA, and BIBFRAME; Coyle (2010), which expressly maps RDA to RDF fields in a library case study; Panchyshyn and Park (2015), which describe how RDA will enable hybridized cataloging; Tillett (2013), which covers RDA and the linked data environment in libraries; Wacker, Han, and Dartt (2011), which test how RDA can be used in Metadata Object Description Standards (MODS), Encoded Archival Description (EAD), and Dublin Core (DC). Most of these studies include a brief overview of RDA, linked data, or RDF and all describe, at least in brief, why linked data is so important for supporting strong information retrieval and connecting information within libraries.

When reading literature on RDA, linked data, or RDF, a suggested relevancy cutoff date would be no earlier than late 2012 into early 2013. The reason for this cutoff is that RDA and RDF continue to change and reading anything older than 2012 could potentially be outdated. That said, there are a number of blogs one should monitor in order to stay abreast of RDA, like Haider's *RDA* blog (2015) and the *RDA Toolkit* blog (2010), and resources for RDF, like the W3C's RDF primer page (W3C, 2014). A few example resources for FRBR are its use with the various editions and adaptations of Bram Stoker's *Dracula* (City of Mountain View Library, 2010) and Riley's work on interoperable (linking) FRBR-based data (2010). The Linked Library Data Interest Group (2015) (LITA/ALCTS) is also a solid resource to watch. Books such as Coyle's (2012) *Linked Data Tools: Connecting on the Web* as well as *Linked Data for Libraries, Archives and Museums: How to Clean, Link and Publish Your Metadata* (van Hooland and Verborgh, 2014) are also helpful for exploring the opportunities of linked data in the library as well as outlining a few linked data techniques and tools.

There are also a number of general linked data and linked open data (LOD) blogs available to stay abreast of what is going on, such as *Linked Open Data in Libraries Archives and Museums* (LODLAM) (LODLAM, 2015); the LOD2 project blog which seeks to create knowledge out of interlinked data (LOD2, 2015); the W3C blogs for information such as the "Building the Web of Things" blog entry (W3C, 2015); the Association of College and Research Libraries' (ACRL) *TechConnect* blog (2015) which focuses on linked data within the library sphere and Chris Bourg (2015), Director of Libraries at MIT, has a fun and interesting blog that sometimes delves into linked library data called the *Feral Librarian*. These blogs often are also associated with groups working on linked data. A few other groups working with linked data are the W3C Library Linked Data Incubator Group (2012), the LITA Linked Library Data Interest Group (2015), and the Digital Library Federation Linked Open Data interest group (2015).

Brief Review on Access Points and Metadata

Access points are points of information that a patron will use to try and find or access information and materials. Unfortunately access points like subject headings and authority names are generally inconsistent and unreliable. Creating consistent access points- like subject headings, data in MAchine-Readable Cataloging (MARC) fields, and markup standards –is a component of bibliographic control. Bibliographic control is achieved through standards like the Anglo-American Cataloguing Rules (AACR2) and RDA. Standard and consistent information is a key component to linking data. Access points are pieces of information coded into a machine readable format. In libraries, access points are most often recorded in MARC records.

MARC data fields are mentioned in Mering (2014) as containers. Metadata are the data field tags for information- essentially the fields that identify what the information to be entered is supposed to mean. For instance, the information *97831614100* could be an International Standard Book Number (ISBN), a local control code for internal library use, an acquisition number, or any number of other types of information. As soon as the information *97831614100* is entered into an ISBN field, it is immediately recognized, or tagged, as an ISBN in the library database

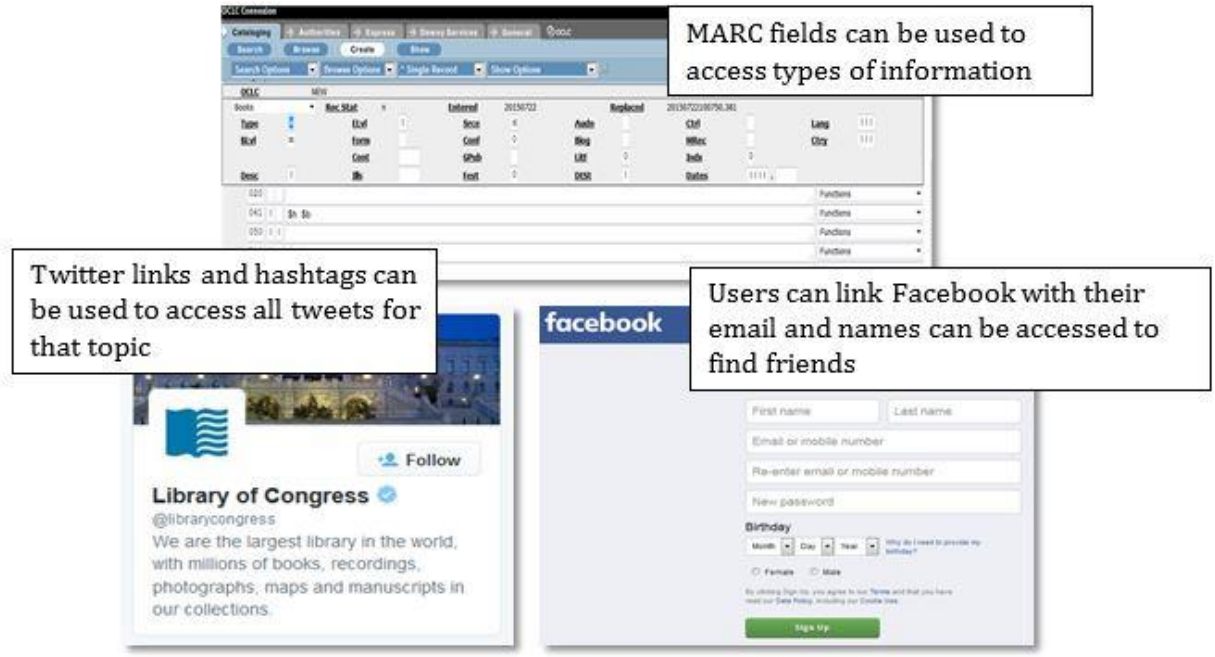


Figure 1

From Top Left to Right- OCLC MARC Record, Twitter, and Facebook Examples

as well as any other database (because an ISBN is a common type of data) that uses an ISBN tag. In linked data these tags are called data elements. ISBN information can be captured with the MARC tag *020* using the RDA standard for describing bibliographic information. In addition to MARC fields, metadata access points can be seen in Twitter, Facebook, and numerous other places (Figure 1).

Brief Review of RDA and FRBR

RDA is the next chapter in library cataloging standards. AACR2 was its predecessor, and both are still in use. In 2013 the Library of Congress, U.S. National Agricultural Library, National Library of Medicine, the British Library, the Library and Archives of Canada, Deutsche Nationalbibliothek, and the National Library of Australia officially switched to using RDA (Wiggins, 2012). RDA is a standard for resource description and access that focuses on better digital representation of information. The RDA guidelines outline the content of the description which can be encoded in MARC records. A new framework for linked data, called Bibliographic Framework Initiative (BIBFRAME), has been proposed to replace MARC, but it has not yet taken hold in many libraries (Gonzales, 2014).

FRBR is a component of the RDA guidelines that helps catalogers identify information for material as well as conceptualize how that content, and its information, connect to the larger collection of content and information in the library. FRBR is not data, a standard, or a best practice. It is most often referred to as a conceptual model:

> A conceptual model serves to define the primary entities and relationships in the information domain at a high level…the conceptual model is a view that can be shared by the database designers and the non-technical users of the data… [and] cannot be directly used as a database design or in programs as many necessary details are not included. (Coyle, 2015, p. 268)

FRBR is different from RDA because it does not specify rules for entering or maintaining bibliographic information and instead frames bibliographic records as a web of connected access points centered on human, rather than machine, understanding. It is more of a mindset than a standard. The FRBR conceptual framework is focused on the idea of information as entities, i.e. data (coded with RDA standards) usually found in MARC fields (the container of the RDA information), and relationships, i.e. the connections between the entities in the MARC fields. The different levels of the FRBR model represent different levels of specificity (Figure 2).

Take for example a patron search for all magazine articles where J. Doe was the primary author in a non-"FRBR-ized" catalog. The search would result in scanning through a huge volume of search results because the relationship *primary author* is not a recognized MARC field- although the name J. Doe can appear in the author or other personal name field (van Ballengooie & Borie, 2014). If the library catalog was realized in the FRBR model, which RDA suggests, a search could harness the relationship *primary author* and limit the search time and increase patron satisfaction. The next step to facilitate such queries is to transition the bibliographic information in the FRBR framework into RDF, a linked data standard used to represent entities (i.e. data) and relationships (i.e. connections between the data).

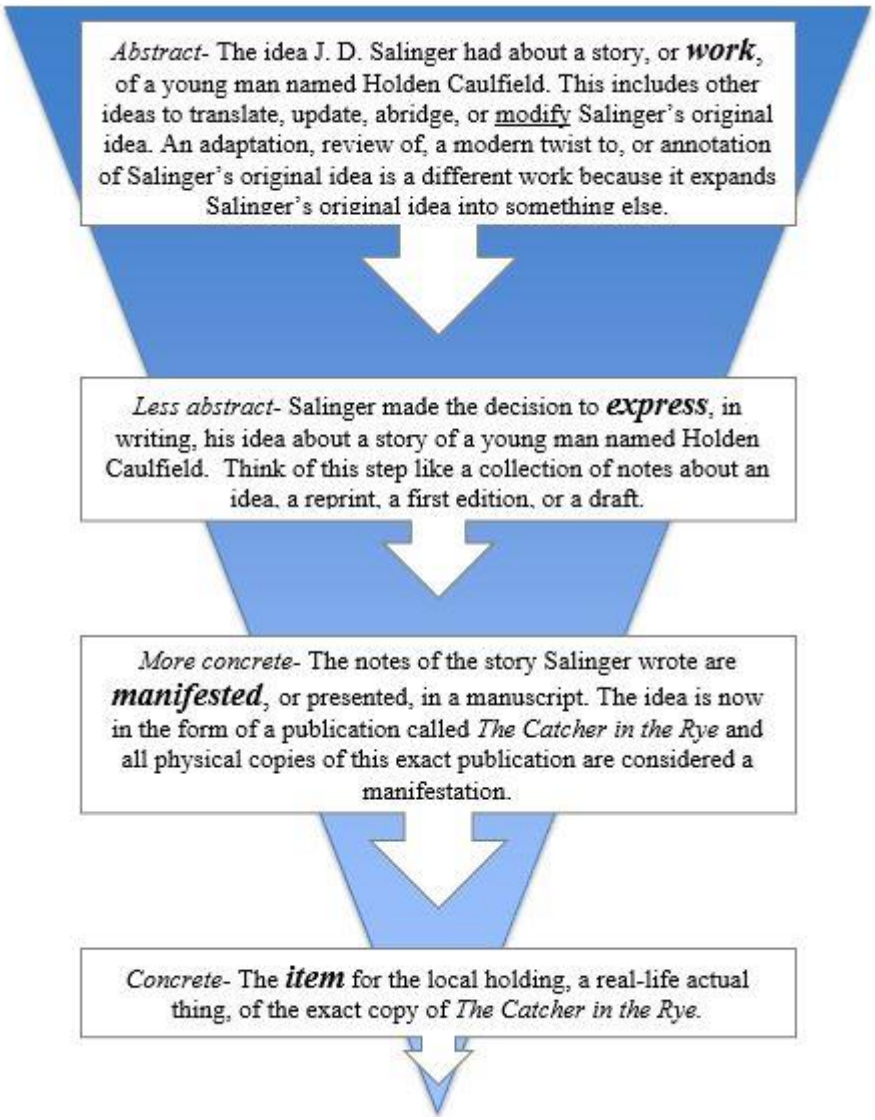


Figure 2

FRBR Conceptual Framework Adapted from Mering (2013) and City of Mountain View Library (2010) examples

FRBR is used for bibliographic information, but it is important to note that the conceptual framework can also be extended to subject and name authority files. Candela, Escobar, Carrasco, and Marco-Such (2015) have visualized the relationships between the entities of the FRBR, the Functional Requirements for Authority Data (FRAD), and the Functional Requirements for Subject Authority Data (FRSAD) models. Like FRBR, FRAD and FRSAD are two conceptual frameworks that RDA supports. They function in a similar way to the FRBR framework outlined in Figure 2. The FRBR, FRAD, and FRSAD relationship model can be found in Figure 3. This model shows the entities in boxes and the relationships along the arrows. All three support linking library entity and relationship data in a consistent way. The benefits of FRBR-izing the library catalog will be further explored in the next section.

Linked Data and FRBR

Linked data can be used, and generated, by anyone. Tim Berners-Lee, father of the Semantic Web, created linked data to connect digital information together (Berners-Lee, 2009). Originally, linking people to information was

not the explicit goal, but this has become the standard way of interpreting linked data in libraries. The ultimate goal of linked data is making things easier to find through multiple access points.

Think for a moment about the following scenario: A patron askes the reference librarian for a copy of *The Catcher in the Rye* without the E. Michael Mitchell cover art. The patron is going to make a timeline of the work's cover art history for class and needs the item the same day as their visit. This kind of detailed request often has librarians consuming hours of research to help the patron or, unable to devote that much time to the request, referring the patron to the catalog or other information tool with some guidance on how to find the material. If the catalog was enhanced with linked data constructed in the FRBR conceptual framework, more information could be used to search the catalog as well as any catalog the library is connected to, thus saving valuable time and resources. FRBR is the connection between the power of linked data and library cataloging with RDA.

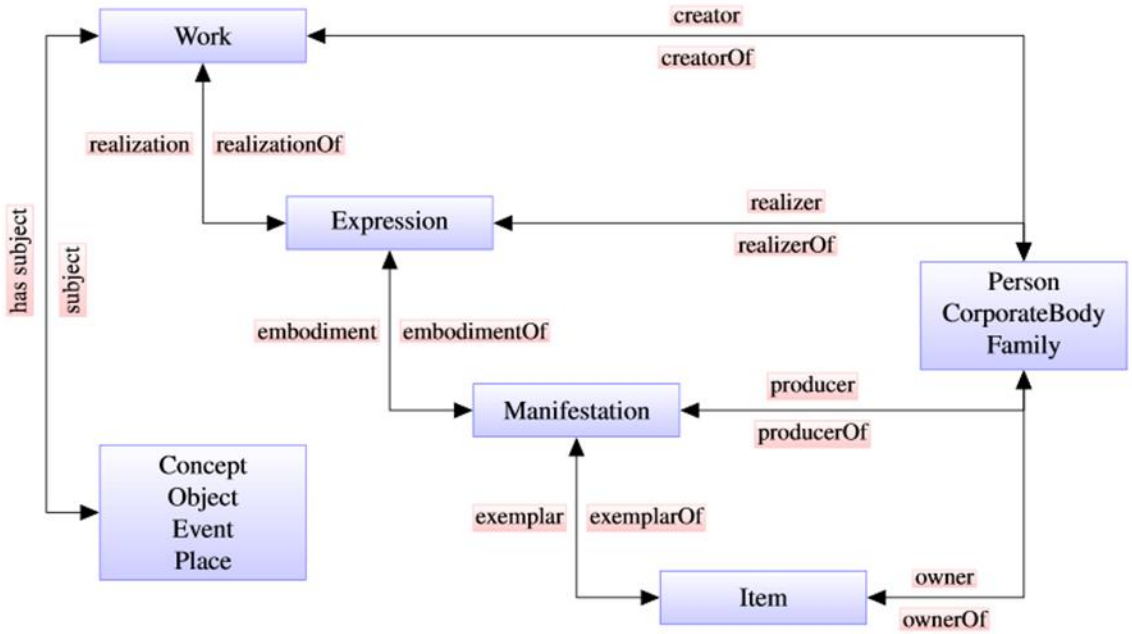


Figure 3

FRBR, FRAD, and FRSAD relationship model reproduced, with permission, from Candela et al. (2015)

Figure 4 illustrates the specific material—or what is called an *item* in FRBR—from the scenario can be found using the following linked data criteria (this is called an *expression* FRBR). Using FRBR-ized RDA within the library search, the following detailed requests could be made:

- Copy of *The Catcher in the Rye* with the cover art by Michael Mitchell
- Copy of *The Catcher in the Rye* with cover art from a different artist
- Copy of *The Catcher in the Rye* with other art from a different artist
- Other works with cover art by E. Michael Mitchell
- Other works with other art by E. Michael Mitchell

Notice the relationship in Figure 4. Relationship connections can be created with RDF. Without RDA and linked data these queries would be difficult to accomplish effectively or efficiently. Even if a librarian has the time and resources to dedicate to these types of search, RDA is also supposed to help empower patrons to search for complex material and information on their own. This will most likely result in future FRBR literacy education for patrons.

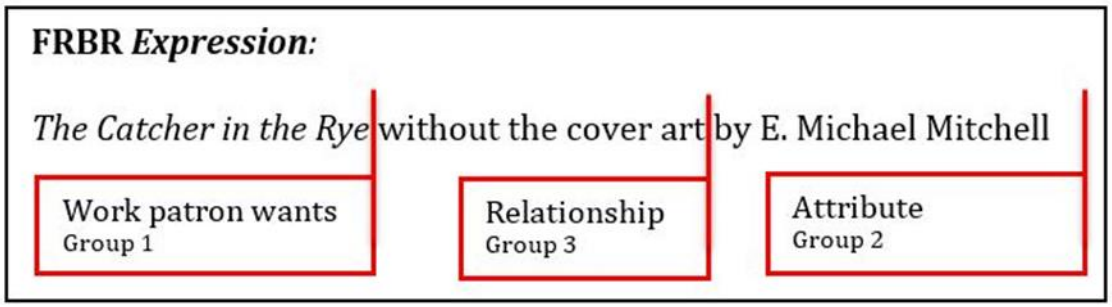


Figure 4
FRBR Expression Search Example

Additional benefits to using linked data include: enabling more content aggregation and repurposing; understanding the patron's information needs and better addressing them; allowing for more serendipitous information discovery; and creating a knowledge graph to help librarians and patrons see the overall themes to the library's collection, connections to other library databases, and what topics might be associated with the search. The essence of linked data is accessibility, and with the help of RDA's introduction of the FRBR framework coupled with RDF, more access points can be established for enhanced library search capabilities.

Overview of Resource Description Framework (RDF) and Linked Knowledge Graphs

The data model or structure for linked data is RDF (Mitchell, 2013). RDF is formatted in 3-tuples or triples, which consist of a subject, predicate, and object. These triples define relationships between two entities like Max *isA* dog and integrate to the structure of a graph. The link in this example is *isA*. RDF relationships help librarians and

Figure 5
RDF Triple Example

patrons understand more about the library collection and how to search more effectively within it. Using the example just mentioned (Figure 5), without having the relationship stated *isA* dog, the patron or librarian might not be able to decipher the information to know whether Max is a human, animal, restaurant name, etc.

In each RDF triple, the relationship and entities are separate pieces of information and are given individual identifiers. The identifiers are coded as Uniform Resource Identifiers (URIs), which is like a URL hyperlink, that can be combined in different ways to link data with other data and repositories (Mitchell, 2013). A URI looks like this: http://id.loc.gov/authorities/subjects/sh85062160. This URI will serve as the identification of the Library of Congress Subject Heading *horses* for anyone using this information for linked data. In this example, the URI is also a URL (hyperlink). The identifier in this example is *sh85062160*. The difference between a URI and a URL is like directions to a house; a URL is the directions to the address and the URI is like the house number of the address. URIs assist in keeping data consistent and reusable.

The network of linked data concepts and relationships form knowledge graphs that help librarians and patrons find more relevant information. A popular example of a knowledge graph can be found on Google search, which was introduced in 2012. When a search is conducted, linked data is assembled to the right of the search results (Figure 6).

Libraries can use linked data to create their own knowledge graphs, although the distinction between knowledge and information needs clarification. Information is the raw cataloging data and the knowledge is the relationships librarians create and the tagging (as in MARC fields) that add value to data. RDA and RDF leverage the information and knowledge of the library for everyone.

To illustrate how RDF can be leveraged from RDA, think of a standard 9-dot puzzle exercise (Figure 7). The goal is to connect all the dots without lifting the pen from the paper. Linked data is similar to this puzzle. Assuming the dots are MARC fields, each dot can be considered an access point (Figure 8). Figure 9 shows the knowledge graph that can be created by adding in RDA-FRBR enhanced relationships.

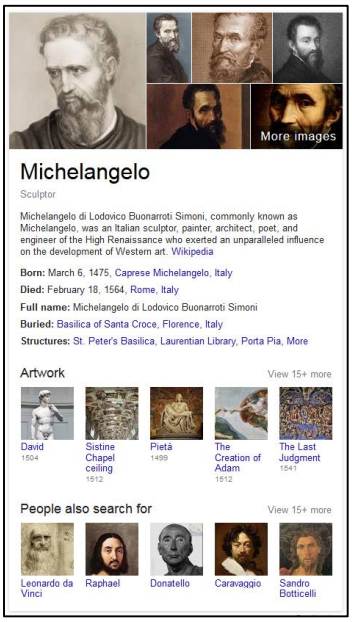


Figure 6

Google Knowledge Graph Display on Michelangelo (retrieved July 22, 2015)

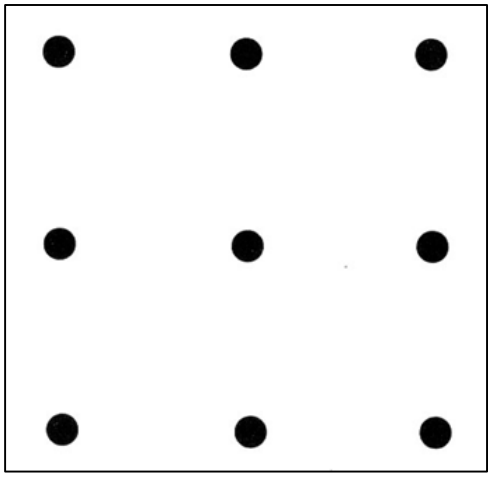


Figure 7

9 Dot Puzzle

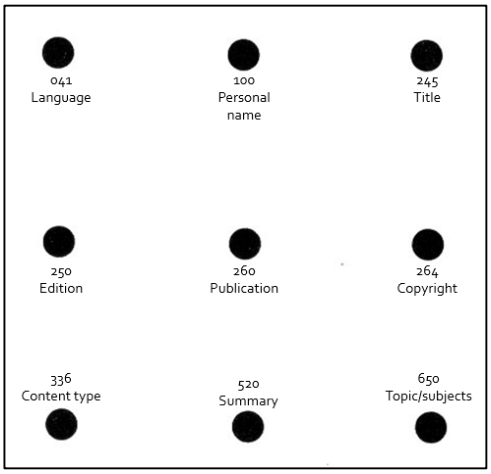
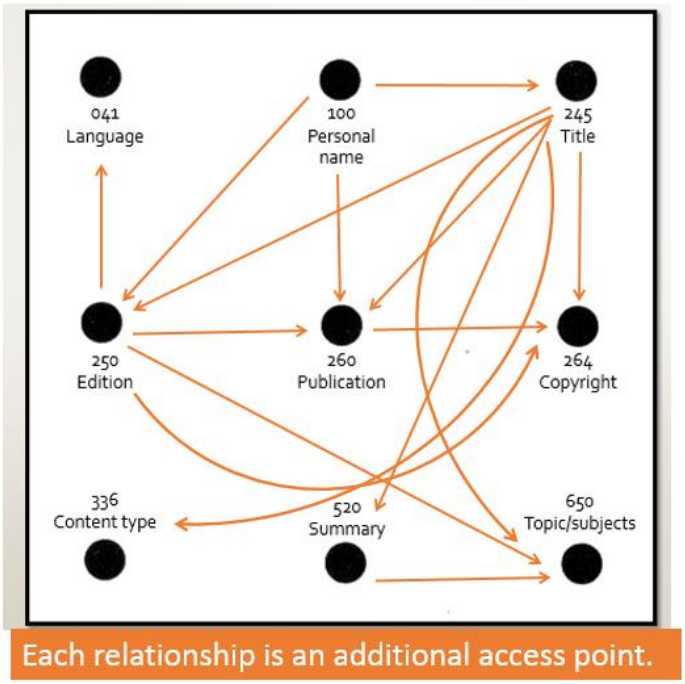


Figure 8

9 Dot Puzzle with MARC Access Points

Using the information links gathered from the list in Figure 9, the knowledge graph in Figure 10 can be created. In order to make connections between data, RDF needs to be encoded or written out. JavaScript Object Notation (JSON), Notation3 (N3), Terse RDF Triple Language (Turtle), and Extensible Markup Language (XML) are standard ways to capture RDF. RDF/XML is a popular machine readable format that is generally defined by the identifier *rdf:*, very similar to the number identifiers for MARC fields (Mitchell, 2013). An example is used with *dc:title*, where *dc* signifies the Dublin Core syntax and *title* is the element tag. If MARC was a namespace, we could think of the 245 title field as *marc:title*.



Some example free-text (i.e. not coded) links within a MARC document record:

- The 4th edition is in Spanish
- Maria Luguio wrote the book
- Maria Luguio wrote the books current edition
- Mario Luguio worked with the publisher XIX
- The title is in its 4th edition
- The title was published by XIX Inc.
- The title is under this copyright
- The title is a textual content type
- The title is about the summary (abstract)
- The 4th edition was produced in Italy
- XIX Inc. filed and received copyright
- The 4th edition was produced and in copyright by 1980
- The book is about horses
- The edition is about horse healthcare
- The summary describes horses

Figure 9

Example Library Knowledge Graph Using Linked Data

In Figure 10, Dublin Core elements in an RDF/XML framework, as well as an open source linked data mapping tool called Protégé, were used to model and visualize a set of RDF triples. Protégé is just one example of the tools available for knowledge map creation. Notice the highlighted arrow and label in Figure 10. Knowledge maps are usually interactive and display the relationships between information. The example in Figure 10 is simplified to one book. If this one book were connected to all other information within the library, this would become a very powerful tool for browsing linked data information because it gives a clear visual of the data. Not only do knowledge maps present information in a visual format, but they also can link to other concepts in interactive content like video. Knowledge maps can be used to present linked data for patron use. The linked data stack, which comprises the layered components of linked data, will help librarians walk through the linked data creation process.

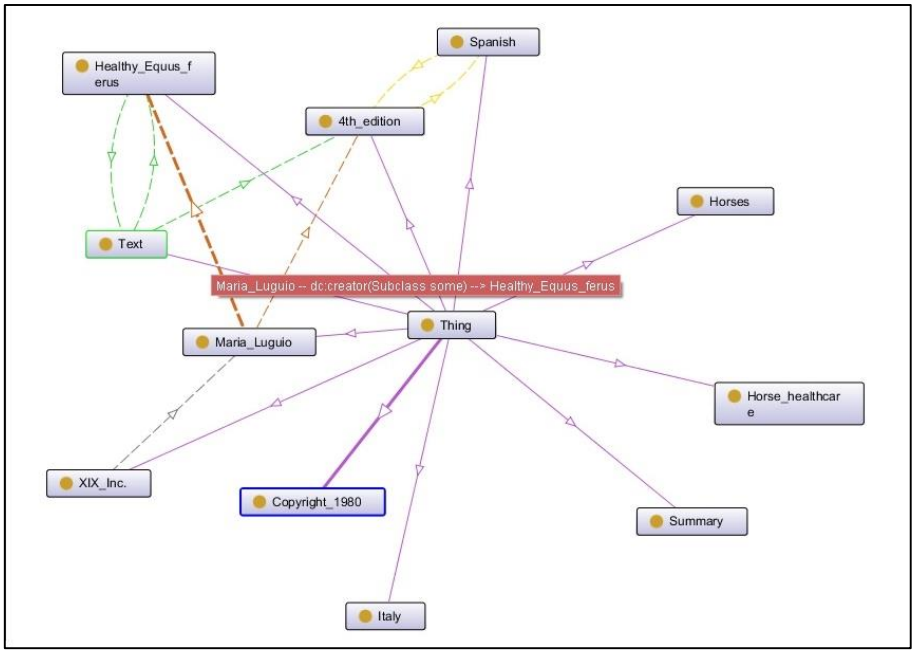


Figure 10
Knowledge Map Example

The Linked Data Stack

The examples from Figures 7-10 can be used to teach librarians about linking FRBR-ized RDA and RDF although further work is needed to establish a curriculum on teaching linked data concepts and searching techniques to patrons. When teaching librarians about RDF, RDA, and linked data, it is helpful to sketch out all the layers of the linked data stack of processes and standards.

RDF by itself does not directly tag information like MARC tags. There are three levels of information in linked data as shown in Figure 11. The first layer is the machine readable format in which the rest of the stack will be written. Linked data is most often written in XML, but RDF can also be expressed in HTML using RDFa. The second level is the information container, or abstraction layer. In the library field, abstraction is a short summary of content; linked data abstraction is no different. Abstraction takes place when a model of information is created. In the library linked data, information modeling means to represent the structure of the catalog and how the materials within the library relate to one another. RDF, as well as the Web Ontology Language (2004), are examples of abstraction models. RDF is used in combination with other data element standards like DC, Friend of a Friend (2005), and the Bibliographic Ontology (2009). This is the third level of the linked data stack. These often have tag lists, or vocabularies, for librarians to consult when cataloging or retrieving information. Many of the elements and schemas can be found on the Linked Open Vocabularies (LOV) portal (Linked Open Vocabularies, 2015).

The general linked data stack can be built upon to include more conceptual information for information retrieval and librarian use. By building on the general linked data stack, RDA and FRBR are introduced to leverage library data into linked data (Figure 12). The transition to cataloging with RDA is especially needed to leverage library data into linked data because it eliminates many abbreviations and other problematic grammar rules, as well as adding in the FRBR concept for capturing knowledge.

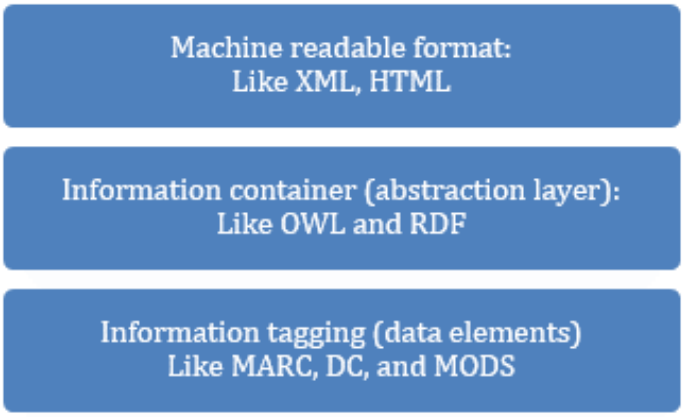


Figure 11
General Linked Data Stack

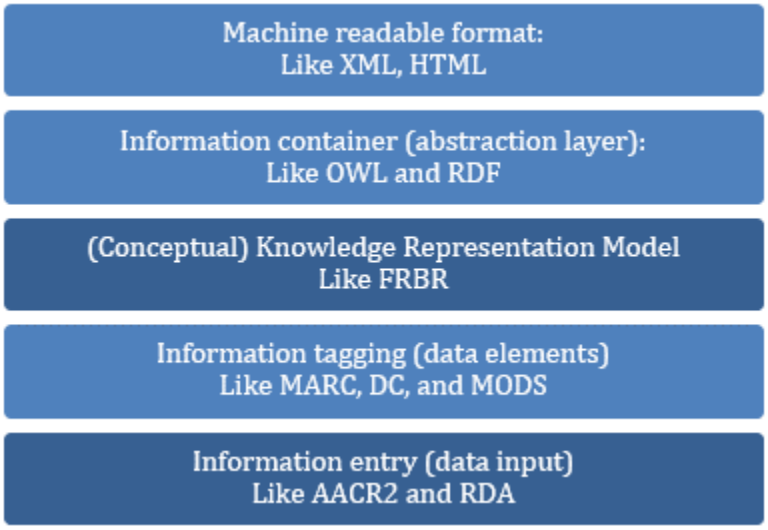


Figure 12
Linked Data Stack, Conceptual Information for Information Retrieval and Librarian Use Included

Linked Data in Practice

By utilizing the data models, vocabularies, and query methods, structured data can be linked and accessed for a variety of purposes. While there are many linked data projects underway, a few notable projects include BabelNet (Navigli, 2015), DBpedia (Bizer, 2015), Getty Linked Data Vocabularies (Getty Research Institute, 2015), Library of Congress Subject Headings (LCSH) (Library of Congress, 2015b), LivePlasma (Vavrille, 2015), MeLOD (Giovanni, 2015), and the NASA Thesaurus (NASA, 2013). These projects are either leveraging their data into linked data, like the Getty, the LCSH, and NASA, or they are aggregating linked data into a platform for user search and knowledge browsing, like BabelNet, DBpedia, LivePlasma, and MeLOD. Structures and vocabularies like BIBFRAME (Library of Congress, 2015a) and Dublin Core (Dublin Core Metadata Initiative, 2015) are also examples of linked data in the library and information community. A few libraries and repositories that have incorporated RDA into

their catalog are Biblioteca Virtual Miguel de Cervantes, Bibliothèque nationale de France, British National Bibliography Linked Data Platform, German National Library, and the Library of Congress (Candela et al., 2015).

Conclusions

With libraries being inundated with digital information and electronic materials, it can be argued that a better method of describing and leveraging library data and materials is needed. Through linked data processes and standards mapped to the data model, vocabulary, and query languages described in Figures 7-10, libraries can start to form action plans and roadmaps to make their libraries linked data compatible as well as leveraging their own catalogs into linked data.

Adding more value to catalogs through linked data relationships paints a more comprehensive picture of the library catalog and may help connect libraries to the outer world wide web of information. Harnessing RDF and FRBR relationships, reference librarians will be able to tackle more specific requests with less resource demand. Additionally, patrons can be empowered with more diverse, serendipitous browsing and more robust search options through linked data.

Linked data is a means to connect more people with more relevant information. Linking data in library databases has become a much easier project to tackle because of RDF and the linked data stack. Transitioning linked data into a knowledge map interface is one way linked data can be presented for patron use. Keeping linked data in mind when transitioning to RDA and the FRBR mindset will help libraries leverage their information into linked data that much easier. Additionally, using the ever-growing suite of linked data projects, libraries may adopt processes and learn how other libraries and organizations are sharing their knowledge resources with the world at large. Linking data for more relevant and empowered search helps open libraries to a wider world of connected possibilities.

References

Alemu, G., Stevens, B., Ross, P., & Chandler, J. (2012). Linked data for libraries: Benefits of a conceptual shift from library-specific record structures to RDF-based data models. *New Library World, 113*(11/12), 549-570. doi:10.1108/03074801211282920

American Library Association, Canadian Library Association, & Chartered Institute of Library and Information Professionals (CILIP). (2010). *RDA Toolkit*. Retrieved from http://www.rdatoolkit.org

Association of College & Research Libraries. (2015). *About ACRL TechConnect Blog*. Retrieved from http://acrl.ala.org/techconnect/about-techconnect

Association for Library Collections and Technical Services (ALCTS). (2012). *RDA series webinars*. Retrieved from https://www.youtube.com/watch?v=DRQGZgtof_w&list=PL1AAFB573158DC4A1&index=28

Baker, T., Coyle, K., & Petiya, S. (2014). Multi-entity models of resource description in the semantic web: A comparison of FRBR, RDA and BIBFRAME. *Library Hi Tech, 32*(4), 562-582. doi:10.1108/LHT-08-2014-0081

Baskett, G., Underdown-DuBois C., & Busch, H. (2013). RDA for catalogers: A guide to using the cataloging rules created to be relevant to today's materials. *Tennessee Libraries, 63*(3) Retrieved from http://www.tnla.org/general/custom.asp?page=564

Berners-Lee, T. (2009). *Tim Berners-Lee: The next web*. TedTalk. Retrieved from http://www.ted.com/talks/tim_berners_lee_on_the_next_web#t-13122

Bibliographic Ontology. (2009). *Bibliographic Ontology Specification (BIBO)*. Retrieved from http://bibliontology.com

Bizer, C. (2015). *About DBpedia*. University of Mannheim. Retrieved from http://dbpedia.org/About

Bourg, Chris. (2015). *Feral Librarian*. Retrieved from https://chrisbourg.wordpress.com

Candela, G., Escobar, P., Carrasco, R., & Marco-Such, M. (2015). Transformation of a library catalogue into (RDA) linked open data. In *Research and advanced technology for digital libraries-:19th International Conference on Theory and Practice of Digital Libraries (TPDL) 2015 Proceedings* (pp. 321-325).

City of Mountain View Library. (2010). *FRBR group 1 entities: A short PPT presentation explaining FRBR Group 1 entities using Bram Stoker's Dracula* [PowerPoint slides]. Retrieved http://www.slideshare.net/librarygeeky/frbr-group

Coyle, K. (2010). RDA in RDF. *Library Technology Reports, 46*(2), 26-36.

Coyle, K. (2012). *Linked data tools: Connecting on the web*. Chicago: ALA TechSource.

Coyle, K. (2015). FRBR, Twenty Years On. *Cataloging & Classification Quarterly, 53*(3/4), 265-285. doi:10.1080/01639374.2014.943446

Digital Library Federation Linked Open Data interest group. (2015). Retrieved from http://www.diglib.org/community/groups/linkeddata

Dublin Core Metadata Initiative. (2015). *Dublin Core (DC)*. Retrieved from http://dublincore.org/documents/dces

Ehlert. M. K. (2013). *RDA in Brief – The Body of the Record*. Retrieved from https://docs.google.com/file/d/0B17huW4VEcKeUjJTMnc4WWN1LTg/edit?pli=1

Friend of a Friend. (2015). *Friend of a Friend (FOAF): An experimental linked information system*. Retrieved from http://www.foaf-project.org

Getty Research Institute. (2015). *Getty vocabularies as linked open data*. Retrieved from http://www.getty.edu/research/tools/vocabularies/lod

Giovanni, T. (2015). *MeLOD: Mobile environment for learning with linked open data*. Italian National Research Council. Retrieved from http://melod.pa.itd.cnr.it

Gonzales, B. (2014). Linking libraries to the Web: Linked data and the future of the bibliographic record. *Information Technology and Libraries, 33*(4), 10-22. doi:10.6017/ital.v33i4.5631

Haider, S. (2010). *RDA Blog*. Retrieved from http://resourcedescriptionandaccess.blogspot.com

Library of Congress. (2015a). *Bibliographic framework initiative*. Retrieved from http://www.loc.gov/bibframe

Library of Congress. (2015b). *Library of Congress Subject Headings*. Retrieved form http://id.loc.gov/authorities/subjects.html

Linked Open Vocabularies (LOV). (2015). Retrieved from http://lov.okfn.org/dataset/lov

LITA Linked Library Data Interest Group. (2015). Retrieved from http://www.ala.org/lita/about/igs/linked/lit-iglld

LOD2. (2015). Retrieved from http://planet.lod2.eu

LODLOM. (2015). Retrieved from http://lodlam.net

Maxwell, R. L. (2013). *Maxwell's handbook for RDA: Resource description & access: Explaining and illustrating RDA: Resource description and access using MARC21.* Chicago: ALA.

Mering, M. V. (2014). The RDA workbook: Learning the basics of Resource Description and Access. CA: Libraries Unlimited.

Mitchell, E. T. (2013). Building blocks of linked open data in libraries. *Library Technology Reports, 49*(5), 11-25.

NASA. (2013). NASA thesaurus data files. Retrieved from http://www.sti.nasa.gov/thesaurus-datafiles/#.VbJGeflGxkk

Navigli, R. (2015). About. *BabelNet*. European Research Council. Retrieved from http://babelnet.org/about

Panchyshyn, R. S., & Park, A. L. (2015). Resource Description and Access (RDA) database enrichment: The path to a hybridized catalog. *Cataloging & Classification Quarterly, 53*(2), 214-233. doi:10.1080/01639374.2014.946574

Riley, J. (2010, October). Enhancing interoperability of FRBR-based metadata. In Diane I. Hillmann & Michael Lauruhn (Eds.), *Proceedings of the 2010 International Conference on Dublin Core and Metadata Applications* (DCMI '10), Dublin Core Metadata Initiative, 31-43.

Tillett, B. (2013). RDA and the semantic web, linked data environment. *Italian Journal of Library & Information Science, 4*(1), 139-145. doi:10.4403/jlis.it-6303

van Ballegooie, M., & Borie, J. (2014). From record-bound to boundless: FRBR, linked data, and new possibilities for serials cataloging. *Serials Librarian, 66*(1-4), 76–87. doi:10.1080/0361526X.2014.879527

van Hooland, S., & Verborgh, R. (2014). *Linked data for libraries, archives and museums: How to clean, link and publish your metadata.* Chicago: Neal-Schuman.

Vavrille, F. (2015). *Liveplasma*. Retrieved from www.liveplasma.com

Veve, M. RDA workshop I: Cataloging books (print and electronic). (2014). *University of North Florida Digital Commons*. Retrieved from http://digitalcommons.unf.edu/library_facpub/13

Wacker, M., Han, M., & Dartt, J. (2011). Testing resource description and access (RDA) with non-MARC metadata standards. *Cataloging & Classification Quarterly, 49*(7), 655-675. doi:10.1080/01639374.2011.616451

W3C Library Linked Data Incubator Group. (2012). Retrieved from http://www.w3.org/2005/Incubator/lld

W3C. (2014). Latest "RDF Primer" versions. Retrieved from http://www.w3.org/TR/rdf-primer

W3C. (2015). *Building the web of things*. Retrieved from https://www.w3.org/blog/2015/05/building-the-web-of-things

Web Ontology Language. (2004). *OWL web ontology language*. Retrieved from http://www.w3.org/TR/owl-features

Wiggins, B. (2012, March 2). Library of Congress announces its long-range RDA training plan. Retrieved from http://www.loc.gov/catdir/cpso/news_rda_implementation_date.html