INLS 720: Metadata Architectures
Fall 2021

Basic information
This is an asynchronous online class.
Class materials will be available through Sakai.

Instructor information
Instructor: Melanie Feinberg
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Student hours: Mondays 3 p.m. to 4 p.m. (in the office) or Mondays 4 p.m. to 4:30 p.m. (via Zoom; link available in Sakai)

Introduction
Information professions both old and new—from librarians to data scientists—rely on the aggregation of data from multiple sources. Just as a library catalog will incorporate records initially created by various institutions, a data scientist will merge datasets created by various research projects.

Aggregation of heterogeneous data can be a challenging prospect. For example, if one system describes authors and titles of resources in a coordinated statement ("Hamlet by William Shakespeare") and another separates authors and titles into distinct elements, then one system's records would need to be mapped to the other system's structure before they could be aggregated.

Aggregation proceeds more smoothly when data is *interoperable:* when data created for one system can seamlessly work in another system. Interoperability increases when datasets have similar structure, syntax, content, and semantics. This data "infrastructure" is sometimes referred to as *metadata.* Metadata *standards* specify parameters for what is described, how it is described, and the format and syntax of description.

In this course, we will review basic concepts central to this metadata infrastructure and survey the many types of standards that attempt to harmonize description across systems. In addition to learning about metadata standards in a general way, we will examine the metadata standards employed in a particular domain: museums. We will examine how the goals of this example domain are expressed through its standards. We will also observe how data from this example domain appears in large aggregation projects.

Concurrently, we will put these concepts into practice through a semester-long project. In this project, we will imagine ourselves as part of a consortium of organizations working to create a Diverse Television and Video Finder (DTV Finder) for children's audiovisual materials (similar in scope to the Diverse Book Finder available at diversebookfinder.org). Taking on the role of a contributing organization to the DTV Finder, we will develop a set of local guidelines to implement the DTV Finder's selected metadata standards. We will then use the guidelines that we have developed to create a class dataset. We will then examine this dataset to understand the extent of its interoperability and to assess its quality. Throughout these explorations, we will seek to understand the inevitable role of human judgment in data creation. How does judgment intersect with interoperability, standards, and quality?

Objectives

At the end of this course, you will be able to:

- Identify and define the fundamental components of metadata: entities, attributes, and relationships.
- Trace the effects of modeling decisions—ways of defining and relating entities and their attributes—on the resulting data.
- Describe how different types of metadata standards work together.
- Explain how metadata standards reflect the goals, stakeholders, and histories of the domains in which they arise.
- Adapt general standards for local uses.
- Analyze a dataset to determine how metadata standards have been implemented in practice.
- Critically examine
    - The human experience of data work, including the role of human judgment in data creation.
    - The relationship between human judgment, metadata standards, interoperability, and quality.

Course structure

This is a remote asynchronous course.

The course is divided into 14 units. Each unit will become available on Wednesday morning. All units will last for one week, except for Unit 14, which is two weeks.

Each unit will incorporate readings, lectures, discussions, and activities. (See the Semester Calendar below for an overview of unit content.)

Material for each unit will have its own tab in Sakai. All the activities for the unit will be documented within that tab. **When the new unit begins, access the unit tab in Sakai and follow the instructions. All readings will be available electronically via the unit page.**

When a unit is over, its page be available in Sakai through the Previous Units tab, so that you can refer to it throughout the semester.

Semester project overview

The semester project provides an opportunity to critically examine the relationship between metadata standards, interoperability, and quality, in the context of local data collection and global aggregation.

This project will adopt the following scenario:

A consortium of organizations—including libraries, schools, community groups, and broadcasters—has decided to sponsor a Diverse Television and Video Finder (DTV Finder) for children's programming, similar to the nonprofit Diverse Book Finder project. Anyone—parents, educators, content providers—will be able to search the database to discover, compare, and differentiate children's programs with diverse characters and associated inclusive themes.

As a key element of this initiative, members of the consortium will contribute data to populate the DTV database. Consortium members' local collections might include materials held by the organization (as with the archive of an animation studio that focuses on children's programming) or materials held elsewhere (as with the virtual collection of a school library, which comprises data about freely available Web videos and programs on paid streaming services), or a combination.

To facilitate this data aggregation, consortium members will describe their local collections using an *application profile* that synthesizes elements from
- The PBCore standard for audiovisual content (pbcore.org).
- The Diverse Book Finder project (diversebookfinder.org).

This common metadata schema will be supplemented with several controlled vocabularies to specify allowed values for particular elements. To enable low-cost, efficient aggregation, data will be collected via a widely available technical infrastructure: a Microsoft Excel spreadsheet template.

The project includes four components:
1. Create implementation guidelines for a consortium member to implement the DTV schema for its local collection.
2. Use these local implementation guidelines to create data for eight children's programs (four of your choosing and four common to everyone).
3. Analyze the aggregated dataset created by the class.
4. Reflect on the above activities to develop a professional position statement regarding metadata quality.

The first part of the project (creating local guidelines) will be primarily group work; the other three parts of the project are individual.

Assessment
This class will not employ conventional grades or scores.

To receive a P, you must complete the following fivc course components in line with that component's criteria for success.
- Participation.
- Project #1: Local implementation guidelines for a metadata standard.
- Project #2: Data creation based on standards.
- Project #3: Analysis of aggregated class dataset.
- Project #4: Position paper on metadata quality, interoperability, and standards.

See the Project and Participation tab in Sakai for complete instructions, deliverables, and success criteria.

Project assessment
For each project, you will receive a set of qualitative comments. These comments will be oriented around the project's criteria for success. If a project does not satisfy the success criteria to a minimal proficiency standard, you will be invited to resubmit the project.

Participation assessment
Participation will primarily be assessed through self-reflection. You will submit both a midterm and final self-assessment that considers your participation against the success criteria.

Due dates
All project materials will be submitted via the Assignments tab in Sakai.

Course component	*Due date*
Project 1: Local guidelines	**Wednesday, October 6**
Midterm participation self-assessment	**Wednesday, October 20**
Project 2: Data creation	**Wednesday, October 27**
Project 3: Data analysis	**Wednesday, November 24**

| Project 4: Position paper | **Wednesday, December 8** |
| Final participation self-assessment | **Wednesday, December 8** |

All assignments should be submitted as a PDF document in the Assignments tab of Sakai.

For citation policies and other general requirements for written work, see the Project Details tab in Sakai.

Late work
Late work is accepted without penalty.

If you cannot make a deadline, send an e-mail to inform me when you plan to submit your completed assignment. I appreciate being informed about your intention to submit late work as soon as possible, and ideally well before the scheduled due date. In your e-mail, you just need to tell me when you intend to submit your work. You don't need to explain your circumstances or apologize.

If you don't send me an e-mail and don't turn in a project, I will contact you instead. I won't be angry or anything; I'll just ask you to tell me when you anticipate submitting your assigned work.

The later that projects are submitted, the less time I will have to provide feedback on them, so keep this in mind. **You'll get fewer comments—or potentially no comments—when you turn things in late.** This will be especially true at the end of the semester. Additionally, because UNC has strict deadlines for final grade submission, late final projects may necessitate that you receive an IN (Incomplete) grade.

Project dependencies
Project 2 cannot begin without the submission of local guidelines from Project 1, and Project 3 cannot begin without the submission of data from Project 2. **In other words, it will affect your classmates if you do not submit the Project 1 local guidelines or the Project 2 data on time. That's quite serious! You will mess up everyone else's schedule if you are late with these components. Please do your best to plan accordingly.** (In contrast, if the reflection essays that are also part of these projects are late, no one else is affected.)

Semester calendar
Individual readings or activities for a unit may change slightly as the semester proceeds.

Optional readings are just that: extra stuff that is available if you find a topic particularly interesting.

All course materials will be available through that unit's tab in Sakai.

Unit 1: Metadata: an uncertain concept August 18 to August 24		
Content focus	**Things to read**	**Things to do**
• Introduction to the class. • The indeterminacy of metadata.	• Class syllabus • Mayernik, 2020 • Gilliland, 2016 • Zeng, 2016 (optional) • Riley, 2017 (optional) • Greenberg, 2009 (optional) • Furner, 2020 (optional)	• Project 1: submit preferences for project groups and suggestions for common programs.

Unit 2: Entities and identifiers		
August 25 to August 31		
Content focus	**Things to read**	**Things to do**
• What is being described?	• Kent, 1978	• Activity: Entity definitions in practice (terrorist events and bibliographic works).
• How can entities be persistently identified?	• IFLA, 1998	• Project 1: Review instructions.
	• Coyle, 2006	• Project 1: Set a weekly meeting time with your group.
	• Thompson, 2010	• Project 1: Select the four programs that you will describe.
	• Bates, 1986 (optional)	
	• de Fremery and Buckland, 2021 (optional)	

Unit 3: Properties of entities (attributes and values)		
September 1 to September 7		
Content focus	**Things to read**	**Things to do**
• What significant properties distinguish each entity?	• ANSI/NISO Z39.85 (Dublin Core metadata standard)	• Activity: Attributes in practice (race and ethnicity in online dating and the U.S. Census).
• What kinds of values best express these properties?	• CDP Metadata Working Group, 2006	• Project 1: Meet with your group, determine your local context, and decide on a preliminary a work schedule. Submit group status report by September 7.
	• Heery and Patel, 2000	
	• Global Terrorism Database (GTD) codebook (optional)	• Project 2: Submit list of television programs.
	• Armed Conflict Location and Event Data Project (ACLED) codebook (optional)	

Unit 4: Relations between entities (models)		
September 8 to September 14		
Content focus	**Things to read**	**Things to do**
• How are entities and properties related?	• Dublin Core abstract model	• Activity: Comparing the effects of modeling entities differently.
	• Urban, 2014	• Project 1: due October 6. Submit group status report by September 14.
	• IFLA, 1998 (again)	
	• Jett, Sacchi, Lee, and Clarke, 2015	
	• Johnston, 2006 (optional)	
	• Lee, et al, 2020 (optional)	

Unit 5: Types of metadata standards and the work of creating them		
September 15 to September 21		
Content focus	**Things to read**	**Things to do**
• What is interoperability and how do standards facilitate it?	• Zeng and Chan, 2009	• Activity: Creating a metadata crosswalk.
	• Elings and Weibel, 2007	• Project 1: due October 6. Submit status report by September 21.
	• Millerand and Bowker, 2009	
	• Zeng, 2020 (optional)	

Unit 6: Linked data (encoding, linking, and aggregating metadata statements)		
September 22 to September 28		
Content focus	**Things to read**	**Things to do**
• How does linked data provide a technical architecture for encloding, linking, and aggregating metadata?	• Carlson, Lempert, Melvin, and Washington, 2020	• Project 1: due October 6. Submit group status report by September 28.
	• Duval, et al 2002	
	• Miller, 1998	
	• World Wide Web Consortium, 2014 (optional)	

Unit 7: Implementation of standards in practice (temporal—and cultural—components of data work) September 29 to October 5		
Content focus	**Things to read**	**Things to do**
• How does our understanding of data infrastructure change over time and across communities of practice?	• Montoya and Morrison, 2019 • Tennis, 2012 *Pick one of the following:* • Ribes, 2017 *Or* • Long, Thompson, Potvin, and Rivero, 2017 • Bowker, 2000 (optional) • Buckland, 2012 (optional)	• Project 1: due October 6.
Unit 8: Implementation of standards in practice (a critical look at metadata quality and assessment) October 6 to October 12		
Content focus	**Things to read**	**Things to do**
• How is a standard implemented in different situations, and what happens when data from different sourcces is aggregated?	• Waigley, Gelches, and Park, 2010 • Lee, Clarke, and Perti, 2015 • Wilkinson, et al, 2016 • Jackson and Barbrow, 2015	• Activity: Comparison of Dublin Core data implementations • Project 2: due October 26.
Unit 9: Implementation of standards in practice (the human labor of data work) October 13 to October 19		
Content focus	**Things to read**	**Things to do**
• What is the lived experience of data creation work? • What is the role of human judgment and skill in data creation?	• Plantin, 2021 • Suchman, 2002	• Project 2: due October 26.
Unit 10: Museum informatics foundations and objectives October 20 to October 26		
Content focus	**Things to read**	**Things to do**
• What are the goals of museum collections data? • What are descriptive practices in museums?	• Marty, Raymond, and Twidale 2003 • Bearman, 2008 • Navarrete and Mackenzie Owen, 2016	• Project 2: due on October 26.
Unit 11: Museum standards October 27 to November 2		
Content focus	**Things to read**	**Things to do**
• What are some content and structure standards for museum metadata? • How do these standards work together, and what are their goals?	• Excerpts from: ○ Cataloging Cultural Objects (CCO). ○ Categories for Description of Works of Art (CDWA). ○ Art and Architecture Thesaurus (AAT) • Coburn et al, 2010	• Project 3: Analysis of class dataset exercise #1. • Project 3: due on November 24.

Unit 12: Museum models November 3 to November 9		
Content focus	**Things to read**	**Things to do**
• What are some models for defining and relating entities and properties in museum metadata?	• Gill, 2004 • Doerr, 2004 • Isaac, 2013	• Activity: Observing modeling decisions in practice. • Project 3: Analysis of class dataset exercise #2: • Project 3: due on November 24.
Unit 13: Integrative infrastructures for cultural heritage data November 10 to November 16		
Content focus	**Things to read**	**Things to do**

• How does standardized metadata enable aggregation of cultural heritage data?	*Cultural heritage data case studies*
	  o Europeana
	  o ArtStor
	  o DIgital Public Library of American (DPLA)
	• Europeana strategy 2020-2025
	• ArtStor metadata policy
	• Capurro and Plets, 2021 (optional)
		• Project 3: Analysis of class dataset exercise #3.

Unit 14: Data work in museum (ish) contexts: human judgments and machine judgments November 17 to December 1		
Content focus	**Things to read**	**Things to do**
• What is the difference between human-generated data and machine-generated data?	• Villaespesa and Crider, 2020 • Pawlowicz and Downum, 2021 • Kahn, 2021 (optional) • Waller and Waller, 2017 (optional)	• Project 3: due on November 24. • Project 4: due on December 8.

Course policies

Asking for help
One of the disadvantages of online courses is that it is difficult for me to know when you are confused. Unfortunately, this means that you will need to proactively ask for help when you don't understand something about course content, expectations, or logistics. It is not a sign of weakness or stupidity to be confused. All questions are welcome. I encourage asking questions in the Sakai discussion forums, which I check regularly; that way, others can also benefit from the exchange.

To consult with me privately, send an e-mail, either to discuss your matter or to set up an individual meeting via Zoom. You can also attend student hours (see below).

No busy work
No one wants to do boring things for no reason, including me! From my perspective, everything that we do in this class has a purpose that requires thinking. If anything seems like busy work, I probably haven't articulated the purpose well. Be sure to ask for help, so that I can better explain what the task is supposed to achieve.

Respectful class environment
Learning requires an atmosphere of respect, care, and empathy for each other. This does not mean that we can't disagree; understanding the nature of our disagreements can help us all grow. But disrespect for any person or their identity will not be tolerated.

Instructor communication
For specific, concrete questions, e-mail is the most reliable means of contact for me. If you do not receive a response after a few days, please follow up. It is always helpful if your e-mail includes a targeted subject line that begins with "INLS 720."

For more complicated questions or help, come to student hours (no appointment necessary) or make an appointment to talk with me at a different time.

You are welcome to call me by my first name ("Melanie"). However, you may also use "Dr. Feinberg" or "Professor Feinberg" if that is more comfortable for you.

Student hours
During student hours, I am available to talk with students about anything, without an appointment.

You can use student hours to ask questions, seek help, consult about project work, obtain more information about course topics, or just say hello. You're not bothering me if you attend student hours! I've dedicated this time to talk with students.

If you attend in-person student hours, my office door will be open; simply come in! If I'm talking with someone else, make sure that I know you're there.

If you attend Zoom student hours, and my video is not on, I'm just working in another program. Start talking and I'll switch to Zoom!

Inclusive learning and accessibility
I want everyone to do well in this class. If there are aspects of this course that prevent you from learning or exclude you, please let me know. We'll work together on strategies to meet your needs and satisfy the requirements of the course.

The University of North Carolina at Chapel Hill facilitates the implementation of reasonable accommodations, including resources and services, for students with disabilities, chronic medical conditions, a temporary disability or pregnancy complications resulting in barriers to fully accessing University courses, programs and activities.

Accommodations are determined through the Office of Accessibility Resources and Service (ARS) for individuals with documented qualifying disabilities in accordance with applicable state and federal laws. See the ARS Web site (ars.unc.edu) for details.

Mental health resources
All students have access to counseling and other resources through Counseling and Psychological Services (CAPS). CAPS is strongly committed to addressing the mental health needs of a diverse student body through timely access to consultation and connection to clinically appropriate services, whether for short or long-term needs. Go to caps.unc.edu or visit their facilities on the third floor of the Campus Health Services building.

Basic needs
If you are navigating financial, health, or housing challenges that may have an impact on your ability to thrive at UNC, one resource is the Dean of Students, which also oversees the Dean's Emergency Fund: https://dos.unc.edu/student-support/student-emergency-and-hardship-funds/

If you are struggling with food insecurity and you are in the Chapel Hill area, you can get assisstance through Carolina Cupboard, an on-campus food pantry: http://carolinacupboard.web.unc.edu/

Academic integrity
The UNC Honor Code states that:

It shall be the responsibility of every student enrolled at the University of North Carolina to support the principles of academic integrity and to refrain from all forms of academic dishonesty...

This includes prohibitions against the following:
- Plagiarism.
- Falsification, fabrication, or misrepresentation of data or citations.
- Unauthorized assistance or collaboration.
- Cheating.

All scholarship builds on previous work, and all scholarship is a form of collaboration, even when working independently. Incorporating the work of others, and collaborating with colleagues, is welcomed in academic work. However, the honor code clarifies that you must always acknowledge when you make use of the ideas, words, or assistance of others in your work. This is typically accomplished through practices of reference, quotation, and citation.

If you are not certain what constitutes proper procedures for acknowledging the work of others, please ask the instructor for assistance. It is your responsibility to ensure that the honor code is appropriately followed. (The UNC Office of Student Conduct provides a variety of honor code resources.)

The UNC Libraries has online tutorials on citation practices and plagiarism that you might find helpful.

Bibliography

Armed Conflict and Event Data Project (ACLED). 2019. Codebook. Available at: https://acleddata.com/acleddatanew/wp-content/uploads/dlm_uploads/2019/01/ACLED_Codebook_2019FINAL.docx.pdf

Baca, Murtha, et al. 2006. *Cataloging cultural objects: A guide to describing cultural works and their images.* Chicago: American Library Association. Available at http://vraweb.org/wp-content/uploads/2020/04/CatalogingCulturalObjectsFullv2.pdf (Selections: introduction, Part 2, Elements; Part 2, Chapter 1.)

Baca, Murtha, and Patricia Harpring, editors. 2006, updated 2015. Categories for Description of Works of Art (CDWA). (Selections: Introduction, CDWA and other metadata standards, and Metadata standards crosswalk.)

Bates, Marcia J. What is a reference book: a theoretical and empirical analysis. *RQ* 26 (Fall 1986): 37-57. (Selected excerpts.)

Bearman, David. 2008. Representing museum knowledge. In *Museum informatics,* edited by Paul Marty and Katherine Burton-Jones, 35-57. New York: Taylor and Francis.

Buckland, Michael. 2012. Obsolescence in subject description. *Journal of Documentation* 68(2): 154-161.

Bowker, Geoffrey. 2000. Biodiversity datadiversity. *Social Studies of Science* 30, 5: 643-683.

Carlson, Scott, Cory Lempert, Darnelle Melvin, and Anne Washington. 2020. *Linked data for the perplexed librarian.* Chicago: ALA Press. (Chapters 1-3.)

Capurro, Carlotta, and Gertjan Plets. 2021. Europeana, EDM, and the Europeanisation of cultural heritage institutions. *Digital Culture and Society* 6(2): 164-189.

Coburn, Erin, Elisa Lanzi, Elizabeth O'Keefe, Regine Stein, and Ann Whiteside. 2010. The Cataloging Cultural Objects experience: codifying practice for the cultural heritage community. *IFLA Journal* 36(16): 16-29.

Collaborative Digitization Program (CDP) Metadata Working Group. 2006. Dublin Core Metadata Best Practices version 2.1.1.

Coyle, Karen. 2006. Identifiers: unique, persistent, global. *The Journal of Academic Librarianship* 32(4): 428-431.

de Fremery, Wayne, and Michael Buckland. 2021. Copy theory. *Journal of the Association for Information Science and Technology.* Available at: https://doi.org/10.1002/asi.24558

Doerr, Martin. 2004. The CIDOC conceptual reference model: an ontological approach to semantic interoperability of metadata. *AI Magazine* 24(3): 75-92.

Duval, Eric, Wayne Hodgins, Stuart Sutton, and Stu Weibel. 2002. Metadata principles and practicalities. *D-Lib.* Available at: http://dlib.org/dlib/april02/weibel/04weibel.html

Elings, Mary, and Gunter Weibel. 2007. Metadata for all: descriptive standards and metadata sharing across libraries, archives, and museums. *First Monday* 12(3). Available at: http://firstmonday.org/article/view/1628/1543

Europeana data model primer. (2013) Available at: http://pro.europeana.eu/files/Europeana_Professional/Share_your_data/Technical_requirements/EDM_Documentation/EDM_Primer_130714.pdf

Europeana strategy 2020-2025: empowering digital change. Available at: https://pro.europeana.eu/files/Europeana_Professional/Publications/EU2020StrategyDigital_May2020.pdf

Furner, Jonathan. 2020. Definitions of metadata: a brief survey of international standards. *Journal of the Association for Information Science and Technology* 71(6): E33-E42.

Getty Research Institute. (Patricia Harpring, editor.) About the Art and Architecture Thesaurus. Available at: http://www.getty.edu/research/tools/vocabularies/aat/about.html

Gilliland, Anne. 2016. Setting the stage. In *Introduction to Metadata.* 3rd ed (online edition). Edited by Murtha Baca. Available at: http://www.getty.edu/publications/intrometadata/setting-the-stage/

Gill, Tony. 2004. Building semantic bridges between museums, libraries, and archives: the CIDOC conceptual reference model. *First Monday* 9(5). Available at: http://firstmonday.org/ojs/index.php/fm/article/view/1145/1065

Global Terrorism Database (GTD). 2019. Codebook. Available at: https://www.start.umd.edu/gtd/downloads/Codebook.pdf

IFLA. Functional Requirements for Bibliographic Records final report. Available at: http://www.ifla.org/VII/s13/frbr/frbr.pdf (Selections: Sections 3.1-3.11 and 4.1-4.4.)

Isaac, Antoine. 2013. Europeana data model primer. Available at: http://pro.europeana.eu/files/Europeana_Professional/Share_your_data/Technical_requirements/EDM_Documentation/EDM_Primer_130714.pdf (Selections: pp. 1-19.)

Kahn, Rebecca. 2021. Man, woman, child: Ethical aspects of metadata at the Pitt Rivers Museum. *Digital Culture and Society* 6(2): 63-85.

Kent, William. 1978. *Data and reality: basic assumptions in data processing reconsidered.* Amsterdam: North Holland Press. (Selections: Chapter 1.)

Heery, Rachel, and Manjula Patel. 2000. Application profiles: mixing and matching metadata schemas. *Ariadne* 25. Available at: http://www.ariadne.ac.uk/issue/25/app-profiles/

Jackson, Steven, and Sarah Barbrow. 2015. Standards and/as innovation: protocols, creativity, and interactive systems development in ecology. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems* (CHI '15)

Jett, Jacob, Simone Sacchi, Jin Ha Lee, and Rachel Clarke. 2015. A conceptual model for video games and interactive media. *Journal of the Association of Information Science and Technology (JASIST),* doi: 10.1002/asi.23409

Johnston, Pete. 2006. Why an abstract model for Dublin Core metadata? eFoundations blog. Available at: http://efoundations.typepad.com/efoundations/2006/11/why_an_abstract.html

Lee, Jin Ha, Rachel Clarke, and Andrew Perti. 2015. Empirical evaluation of metadata for video games and interactive media. *Journal for the Association of Information Science and Technology (JASIST).*

Lee, Jin Ha, Andrew Perti, Rachel Clarke, Travis Windleharth, and Marc Schmalz. 2020. UW/SIMM Video Game Metadata Schema Version 4.1. Available at: http://gamer.ischool.uw.edu/official_release/

Long, Kara, Santi Thompson, Sarah Potvin, and Monica Rivero. 2017. The wicked problem of neutral description: a documentation perspective to metadata standards. *Cataloging and Classification Quarterly* 55(3): 107-128.

Marty, Paul., W. Boyd Rayward, and Michael Twidale. 2003. Museum informatics. In *Annual Review of Information Science and Technology.* Blaise Cronin, ed.. 259–294. Medford, NJ: Information Today.

Mayernik, Matthew. 2020. Metadata. In *Encylopedia of Knowledge Organization,* edited by Birger Hjørland and Claudio Gnoli. https://www.isko.org/cyclo/metadata#col.

Miller, Eric. 1998. An introduction to the Resource Description Framework. *D-Lib* Available at: http://dlib.org/dlib/may98/miller/05miller.html

Millerand, Florence, and Geoffrey Bowker. 2009. Metadata standards: trajectories and enactment in the life of an ontology. In *Formalizing Practices: Reckoning with Standards, Numbers and Models in Science and Everyday Life,* edited by Susan Leigh Star and Martha Lampland.

Montoya, Robert and Katherine Morrison. 2019. Document and data continuity at the Glenn A. Black Laboratory of Archaeology. *Journal of Documentation* 75(5): 1035-1055.

Navarrete, Trilce, and John Mackenzie Owen. 2016. The museum as information space: metadata and documentation. In *Cultural Heritage in a Changing World,* edited by Karol Jan Borowiecki, Neil Forbes, and Antonella Fresa, 111-123.

National Information Standards Organization (NISO). 2013. ANSI/NISO Z39.85-2012 Dublin Core Metadata Element Set. Available at: https://groups.niso.org/apps/group_public/download.php/10258/Z39-85-2012_dublin_core.pdf

Pawlowicz, Lescek, and Christian Downum. 2021. Applications of deep learning to decorated ceramic typology and classification: A case study using Tusayan White Ware from Northeast Arizona. *Journal of Archeological Science* 130. Available at: https://doi.org/10.1016/j.jas.2021.105375

Plantin, Jean-Christophe. 2021. The data archive as factory: alienation and resistance of data processors. *Big Data and Society* 8(1). Available at: https://doi.org/10.1177/20539517211007510

Ribes, David. 2017. Notes on the concept of data interoperability: cases from an ecology of AIDS research infrastructures. *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing 2017*, 1514-1526.

Sanger-Katz, Margot. 2016. Is terrorism getting worse? In the West, yes. In the world, no. *New York Times,* August 16, 2016.

Suchman, Lucy. 2002. Located accountabilities in technology production. *Scandinavian Journal of Information Systems* 14(2): 91-105.

Tennis, Joseph T. 2012. The strange case of eugenics: a subject's ontogeny in a long-lived classification scheme and the question of collocative integrity. *Journal of the American Society for Information Science and Technology* 63(7): 1350-1359.

Thompson, Henry. 2010. What is a URI and why does it matter? Available at: http://www.ltg.ed.ac.uk/~ht/WhatAreURIs/

Urban, Richard. 2014. The 1:1 principle in the age of linked data. *Proceedings of the International Conference on Dublin Core and Metadata Applications 2014,* 119-128.

Villaespesa, Elena, and Seth Crider. 2021. A critical comparison analysis between human and machine-generated tags for the Metropolitan Museum of Art's collection. *Journal of Documentation.*

Waller, Helen, and David Waller. 2017. Opera costumes and the value of object biographies. *Journal of Documentation* 74(6): 1162-1174.

Weagley, Julie, Ellen Gelches, and Jung-Ran Park. 2010. Interoperability and metadata quality in digital video repositories: a study of Dublin Core. *Journal of Library Metadata* 10(1): 37-57.

Wilkinson, Mark, et al. 2016. The FAIR guiding principles for scientific data management and stewardship. *Scientific Data* 3, 160018. Available at: https://doi.org/10.1038/sdata.2016.18

World Wide Web Consortium (W3C). 2014. RDF Primer 1.1. Available at: https://www.w3.org/TR/rdf11-primer/

Zeng, Marcia. 2020. Interoperability. In *Encylopedia of Knowledge Organization,* edited by Birger Hjørland and Claudio Gnoli. https://www.isko.org/cyclo/interoperability.htm

Zeng, Marcia Lei, and Lois Mai Chan. 2009. Semantic interoperability. In *Encyclopedia of Library and Information Sciences,* edited by Marcia Bates and Mary Niles Maack. 3rd ed. CRC Press.

Resources and references
These are not assigned, but you may find them helpful.

Metadata fundamentals
Marcia Lei Zeng. (2016) Metadata Basics tutorial. Available at: http://metadataetc.org/metadatabasics/

Marcia Lei Zeng and Jian Qin. (2021) *Metadata.* 3rd ed. New York: Neal-Schuman.
Web site to accompany the book is available here:
http://metadataetc.org/book-website2nd/

David Haynes. 2017. *Metadata for Information Management and Retrieval.* 2nd ed. London: Facet Publishing.

Jenn Riley. 2017. *Understanding metadata: what is it, and what is it for?* A primer publication of the National Information Standards Organization (NISO). Available at:
http://www.niso.org/publications/understanding-metadata-2017

Richard Gartner. 2016. *Metadata: Shaping Knowledge from Antiquity to the Semantic Web.* Springer.

Jeffrey Pomerantz. 2015. *Metadata.* MIT Press.

Jane Greenberg. 2009. Metadata and digital information. In *Encyclopedia of Library and Information Sciences,* edited by Marcia Bates and Mary Niles Maack.. 3rd ed. CRC Press.

Paul Miller. (1996) Metadata for the masses. *Ariadne* (5) Available at:
http://www.ariadne.ac.uk/issue5/metadata-masses/

Metadata standards
List of (primarily structural) standards from Metadata book Web site by Zeng and Qin:
http://www.metadataetc.org/book-website/readings/appendixaschemas.htm

Linked data, Semantic Web, RDF
Linked Data Tools. Semantic Web Primer. Available at: http://www.linkeddatatools.com/semantic-web-basics

Tom Heath and Christian Bizer. (2011) *Linked data: evolving the Web into a global data space.* Available at: http://linkeddatabook.com/