



New Top Technologies Every Librarian Needs to Know

A LITA Guide

Edited by
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Contents

Preface xi

PART I

Data

- | | | |
|----------|--|----|
| 1 | Linked Open Data in Libraries | 3 |
| | <i>Cliff Landis</i> | |
| 2 | Everything Is Online | 17 |
| | Libraries and the Internet of Things | |
| | <i>Matthew Connolly</i> | |
| 3 | Link Rot, Reference Rot, and Link Resolvers | 29 |
| | <i>Justin M. White</i> | |
| 4 | Engaging Libraries with Web Archives | 43 |
| | <i>Todd Suomela</i> | |

PART II

Services

- | | | |
|----------|---|----|
| 5 | Privacy-Protection Technology Tools | 59 |
| | Libraries and Librarians as Users, Contributors,
and Advocates | |
| | <i>Monica Maceli</i> | |
| 6 | Data for Discovery | 75 |
| | <i>Julia Bauder</i> | |

7 Libraries and Information Visualization	
Application and Value	89
<i>Elizabeth Joan Kelly</i>	

8 Virtual Reality: Out of This World	107
<i>Austin Olney</i>	

PART III

Repositories and Access

9 Digital Exhibits to Digital Humanities	
Expanding the Digital Libraries Portfolio	123
<i>Daniel Johnson and Mark Dehmlow</i>	

10 Digital Repositories	
A Systems Perspective	137
<i>Joshua A. Westgard, Kate Dohe, David Durden, and Joseph Koivisto</i>	

11 Digital Repositories	153
<i>Jessica Wagner Webster</i>	

12 Maximizing Assets and Access through Digital Publishing	
Opportunities and Implications for Special Collections	167
<i>Ellen Engseth and Marguerite Ragnow</i>	

PART IV

Interoperability

13 Impact of International Image Interoperability Framework (IIIF) on Digital Repositories	
	181
<i>Kelli Babcock and Rachel Di Cresce</i>	

14 Embracing Embeddedness with Learning Tools Interoperability (LTI)	
	197
<i>Lauren Magnuson</i>	

15 Bots and the Library

Exploring New Possibilities for Automation
and Engagement

211

Jeanette Claire Sewell

16 Machine Learning for Libraries

223

Alan Darnell

17 Mobile Technology

241

Gordon F. Xu and Jin Xiu Guo

About the Contributors 257

Index 263

Preface

The original *Top Technologies Every Librarian Needs to Know* was published in 2014. Similar to what this volume's authors were asked to do, the authors of the 2014 edition were tasked with thinking about technologies that were relatively new then (either new in general or perhaps somewhat well-established but still novel to libraries) and forecast what libraries would be like in three to five years when that technology had become part of the landscape. Now that we have reached that five-year horizon (2018) from when the first edition's authors were writing (in 2013), it seems a good time to review the predictions from the first set of chapters and, with a different group of authors, take a gaze into 2018's near-term future with a new set.

A LOOK BACK

The original book focused on these broad trends: content and technology convergence, augmented reality, cloud-based library systems, discovery systems, web services, text mining, large-scale digital libraries, and open hardware. Some of these technologies are still being adopted, whereas others have become firmly entrenched in the routine of libraries. For example, text mining, large-scale digital libraries, and cloud-based library systems have become core to what many institutions do. The race to the cloud for many back-end (and user-facing) services continues apace. Discovery layers on top of whatever suite of resources a library offers its clientele are still common; the desire to provide access to the breadth of a library's content is still strong—but with increasing recognition that one-size-fits-all discovery interfaces do not necessarily meet all the needs of all the users.

Other technologies are still on the rise, with potentials constantly being explored. Augmented and virtual reality technologies described in 2014 are now becoming technologically possible as the tools to support them become cheaper. Content and technology convergence, in which users bring their own desires for how they wish to consume the content they seek and libraries can offer multiple formats to meet those needs, is still actively developing. Open hardware and the Internet of Things are still tantalizingly at hand but not quite commonplace.

A LOOK AHEAD

Like the original volume, chapters in *New Top Technologies Every Librarian Needs to Know* are structured around a rough topical outline, but authors were free to adopt a style they wanted. In each of this book's chapters, you will find a description of a technology or trend as it exists in the world in early 2018; how it is being used in libraries, archives, or museums by its early adopters; and what the future will look like if, as the authors envision, the technology is widely adopted in the next three to five years.

The book is organized into four parts, each looking at a broad swathe of library activity: "Data," "Services," "Repositories and Access," and "Interoperability." Part 1 explores linked open data, the Internet of Things, and the criticality of web archiving for the medium- and long-term preservation of the scholarly record. Part 2 explores ways that libraries are beginning to enhance their offerings to their particular patron base. The chapters cover patron privacy protection, data and data visualization, and virtual reality.

Part 3 explores how the information age will continue to reshape the ways libraries support scholarship. The chapters discuss digital humanities, digital repositories, and digital publishing. Finally, part 4 covers standards (IIIF and LTI), interoperability of content and tools, and the ever-expanding functionality of mobile devices for access.

Kenneth J. Varnum
Ann Arbor, Michigan
January 2019

PART

I

Data

Linked Open Data in Libraries

Cliff Landis

3

Most library users will interact with linked data about your library before they ever interact with the library itself. If a user does a web search on Google for your library's name, they will see a summary of the library's vital information displayed in a "knowledge panel" to the right of their search results. This box displays information pulled from Google's proprietary Knowledge Graph, a specialized database of aggregated facts.

If your user prefers Wikipedia as a starting point, a quick search for the library will pull up a Wikipedia page that includes an "infobox" that again is populated with linked data facts. These were initially pulled to Wikidata, the linked open-data knowledgebase used to tie together facts across Wikimedia projects and languages. Under the menu of every Wikipedia page is a link to the Wikidata item for that page. On that Wikidata page, you can add more details about your library or correct erroneous information (with proper secondary source citations, of course). Unlike

Google's Knowledge Graph (linked proprietary data), Wikidata facts can be edited and reused under a Creative Commons license (linked *open* data).

But linked open data can do much more than display facts in handy little boxes. It also connects content across systems, opens up content for reuse, disambiguates similar concepts, creates relationships among data sets, and makes semantic searching possible. At its most basic, linked open data is a group of technologies and standards that enables

- writing factual statements in a machine-readable format,
- linking those factual statements to one another, and
- publishing those statements on the web with an open license for anyone to access.

For example, we know that *Harry Potter and the Deathly Hallows* is a fantasy book written by J. K. Rowling and published on July 21, 2007. That sentence can be broken up into simple three-part statements, or triples, consisting of a subject, predicate, and object:

Harry Potter and the Deathly Hallows -> has format -> book

Harry Potter and the Deathly Hallows -> has literary genre -> fantasy literature

Harry Potter and the Deathly Hallows -> was written by -> J. K. Rowling

Harry Potter and the Deathly Hallows -> has publication date -> July 21, 2007

Each fact triple describes how two concepts are connected by a relationship. Triples are stored in specialized databases variously called graphs, triplestores, or knowledge bases. But we don't need to limit these facts to bibliographic information; most information can be expressed in this three-part format:

J. K. Rowling -> has place of birth -> Yate

Yate -> has county -> Gloucestershire

Gloucestershire -> has country -> England

J. K. Rowling -> graduated college from -> University of Exeter

With these triples linked together, we can quickly answer very specific questions like "Which fantasy authors born in Gloucestershire County in England went to University of Exeter?" A semantic query like this uses the meaning of relationships between concepts to provide a results list. You can try out your own semantic searches like this one using examples on Wikidata's Query Service (<https://query.wikidata.org>).

The example triples above are human readable, but for them to be machine readable, each part must be represented by a web address (a Uniform Resource Identifier, or URI)—in this case from DBpedia, one of the earliest large-scale triplestores.

Subject	Predicate	Object
<i>Harry Potter and the Deathly Hallows</i>	Has literary genre	Fantasy literature
http://dbpedia.org/page/Harry_Potter_and_the_Deathly_Hallows	http://dbpedia.org/ontology/literaryGenre	http://dbpedia.org/page/Fantasy_literature

The subject and object are both things or concepts (often called entities) represented by their own pages, whereas the predicate is stored in an ontology, a set of definitions for different types of relationships. Collections of these URIs (both entities and ontologies) are called vocabularies. Because each URI stands on its own, you can combine entities and relationships from vocabularies across the web to connect information—that’s what puts the *linked* in linked open data and makes it possible to create meaning across different triple databases. It’s easy to show that an entity in one database is the same as an entity in a different database using the “sameAs” predicate from the Web Ontology Language (OWL) vocabulary.

Subject	Predicate	Object
<i>Harry Potter and the Deathly Hallows</i> (in DBpedia)	Is the same as	<i>Harry Potter and the Deathly Hallows</i> (in Wikidata)
http://dbpedia.org/page/Harry_Potter_and_the_Deathly_Hallows	www.w3.org/2002/07/owl#sameAs	www.wikidata.org/wiki/Q46758

These equivalence connections can be made manually by humans (such as editing Wikidata) or matched in large batches automatically using data tools like OpenRefine (<http://openrefine.org>). Either way, connections must be validated by humans because we can differentiate nuances of meaning that are lost on computers. Making these “sameAs” connections between databases makes it possible to connect the same concept across multiple languages and across multiple sites, dissolving information silos among different systems. This decentralized approach to metadata management also means that openly publishing locally rich metadata records can potentially help users accessing completely different systems.

Of course, to break down these metadata silos, the information has to be accessible and free to use—this is why the *open* in linked open data is so important.

By releasing metadata and datasets with open licenses, other users can transform and reuse the data, making new connections possible. Tim Berners-Lee suggests a five-star scheme for linked open data, and it begins with open licensing (<http://5stardata.info/en/>). This orientation toward openness and providing access aligns well with the ethos of libraries and archives.

But as librarians and archivists know, maintaining open access to information isn't a one-shot effort. Records that are enriched with linked open data must be maintained by metadata experts to ensure that the connections persist over time. This is one of the commitments that cultural heritage institutions make when they create persistent online resources of any kind; linked data URIs, just like digital object identifiers (DOIs), need to be maintained to ensure that connections among systems don't break.

One barrier to linked open data adoption by librarians is the alphabet soup of technologies and standards that make it all possible. There are free online glossaries describing the multitude of linked data and semantic web terms, but for the purpose of this chapter, only a few need to be defined. First is the Resource Description Framework (RDF), a set of specifications from the World Wide Web Consortium that explains what a triple is and how triples should be connected and queried. RDF was originally designed as a data model for metadata of web-based resources but has grown to encompass all types of metadata. It is paired with the Extensible Markup Language (XML) to create RDF/XML, the first standard format for writing linked data triples. XML is a versatile language for writing machine-readable content and is used widely in libraries and archives for publishing and exchanging metadata.

Although RDF/XML was the frontrunner for implementing linked data, other ways of expressing RDF triples have been created, including RDFa, N-Triples, N-Quads, Turtle, TriG, and JSON-LD (www.w3.org/TR/rdf11-primer/). Notably, JavaScript Object Notation for Linked Data (JSON-LD) has seen wider adoption in recent years because it is more concise and human readable than RDF/XML. Once linked data is published, it is accessed remotely using the SPARQL query language. (SPARQL is a recursive acronym that means "SPARQL Protocol and RDF Query Language" and is pronounced *sparkle*.) You can see SPARQL in action by using the Wikidata Query Service mentioned above.

Technical jargon aside, it is important to point out that linked data is fundamentally changing how people will access information in the future. To date, users have had to sift through dozens or hundreds of documents retrieved in keyword searches to find the nuggets of information that they need. However, users in

the near future will have rich facets to search and additional context to discover and visualize information. For example, history students studying Renaissance dragomans (diplomatic interpreter-translators) can now browse by the dragomans' languages or professional titles thanks to the linked open data records in the Dragoman Renaissance Research Platform from the University of Toronto Scarborough (<http://dragomans.digitalscholarship.utoronto.ca>). This platform also provides visualizations of the geographic distributions of dragomans and a timeline of their careers, but because the data are openly accessible, users can access the database to create their own visualizations. Although coding visualizations from scratch is too difficult most users, tools are becoming available that allow users to explore linked open data and create their own visualizations with little technical knowledge. For example, RelFinder (www.visualdataweb.org/relfinder.php) shows connections between different linked open data points in DBpedia. A quick search of J. K. Rowling and Stephen King shows that both authors are influenced by author Michael J. Sullivan, while a search for gothic fiction and fantasy literature shows a cluster of books and authors that bridge those genera.

Linked data promises to unlock information from its container and break it down into interlinked facts, allowing users to discover and interact with resources in new ways. But like all new technologies, linked data will come with its own challenges and problems and will amplify older problems that librarians have always dealt with (e.g., verifiability, contextualization, interpretation, and politicization of information). However, even with these problems, linked data will reshape the landscape of information seeking and retrieval. Thankfully, librarians and archivists are hard at work staying abreast of this change and approaching these challenges head-on.

LARGE-SCALE LINKED DATA IN LIBRARYLAND

Large university libraries, national libraries, and library consortia have been the frontrunners in laying the groundwork for library linked data in two ways: by developing data models and schema for representing resource information as linked data and by publishing and aggregating resource metadata as linked data.

Library resource description is undergoing a dramatic transformation as new models, standards, and schemata are produced. As these tools are being tested in the field, they are evolving to meet the practical needs of the library community. For example, the Bibliographic Framework Initiative (BIBFRAME) from the Library of Congress aims to create a new alternative to the MARC 21 formats

and, more broadly, to expand the way that resource description happens in the networked environment of linked data (www.loc.gov/bibframe/). After its initial pilot in 2015, experiments and community feedback led to further development, resulting in BIBFRAME 2.0 being released in 2016.¹ Experiments with both versions are available to explore, like BIBFRAME 1.0 implemented at the University of Illinois at Urbana–Champaign Library (<http://sif.library.illinois.edu/bibframe/>) and BIBFRAME 2.0 at the US Army Corps of Engineers Research and Development Center Library (<http://engineerradcc.library.link/>). BIBFRAME is building on the momentum created by Resource Description and Access (RDA), the international cataloging standard designed to replace AACR2 (www.rda-rsc.org).² RDA was created with linked data principles in mind and published in 2010, and in 2013 it was adopted by several national libraries. Support for both old and new tools will be needed for years to come, as transitions will happen slowly and carefully.

In both of the above BIBFRAME examples, bibliographic records are enriched with information from external RDF vocabularies. Some of these are smaller vocabularies, such as licenses from Creative Commons Rights Expression Language (<http://creativecommons.org/ns>) and metadata classes from DCMI Metadata Terms (<http://purl.org/dc/terms>). Larger vocabularies are now being provided by national and international organizations, such as authority data from the Virtual International Authority File (<http://viaf.org>) and Library of Congress Linked Data Service (www.dublincore.org/documents/dcmi-terms/). VIAF aims to provide linked data connections among authority records at national libraries, providing a global source for disambiguating person, organization, and place names. While most contributing members are national libraries, you can also find records from other linked data initiatives such as Wikidata and the International Standard Name Identifier International Agency (<http://isni.org>). The connections among these international metadata initiatives mean that a metadata expert can correct an error in one system (such as disambiguating the two Robert W. Woodruff Libraries in Atlanta, Georgia) and see that correction cascade to catalogs around the world as new linked open data connections are made. This type of “long-tail” effort can leverage local knowledge to enrich and repair records on a global scale.

The scope of the Library of Congress Linked Data Service is broader than VIAF, as it encompasses both general authority and subject terms as well as subject-specific terms for areas like children’s literature, art, and music. Additionally, the Library of Congress provides vocabularies for preservation metadata, languages, and formats. This has been no small task, since building the infrastructure for

linked open data requires publishing machine-readable metadata alongside the human-readable metadata that already exists for millions of records.

Linked open data is being leveraged to improve access and discovery at national and international scales. Europeana Collections (<http://europeana.eu>) is a search engine portal that aggregates more than fifty-four million metadata records from across Europe. Aggregating this number of records from a variety of sources creates challenges, as the metadata from different libraries needs to be mapped to a central data model (the Europeana Data Model, or EDM). A similar project in the United States, the Digital Public Library of America (<https://dp.la/>) has created its own Metadata Application Profile (MAP) modeled on Europeana's EDM. DPLA and Europeana have also collaborated to create RightsStatements.org, a linked data website with a set of twelve standardized rights statements that can be freely used to declare the copyright and reuse status of digital cultural heritage objects. By mapping these data models to an increasing number of metadata standards, combined with standardized rights statement, Europeana and DPLA are opening the door for a truly global search of cultural heritage resources. However, to take part in this opportunity for increased discovery and access, libraries have to dedicate time and energy to cleaning up resource metadata and making it ready for a global audience. As stated in DPLA's MAP (<http://dp.la/info/map>), "Consider how your data will work in a global context next to the data of thousands of other institutions in DPLA. Will John Brown in Australia understand that your geographic location 'Washington' is different than the State of Washington or Washington County in Wisconsin?" In practice, metadata experts at each institution will need to make sure that their local metadata records align to the larger metadata profile (i.e., the title field contains titles and not dates). Additionally, metadata experts will need to review linked open data URIs in their records (both manually created and automatically generated ones) to ensure that ambiguities are avoided. This extra work will pay off by making the library's records more globally findable, but it will also allow those records to be included in linked open data apps.

Because many users find library resources through public search engines, it is important for libraries and library consortia to create connections to the linked data efforts of large technology companies. Schema.org and the Open Graph protocol (<http://ogp.me>) are two examples of linked data projects initiated by tech giants that have since been released as open source schema. For consortial aggregation like Europeana Collections and DPLA, it is important to have resource metadata mapped to these larger efforts so that search engine results can point to library

resources.³ Otherwise, there is a risk of libraries creating larger collective information silos rather than breaking those silos down.

Unfortunately, large general schemata like Schema.org often do not begin with the depth necessary to fully describe library resource metadata. The Online Computer Library Center (OCLC) addressed this problem by building on the work of Schema.org to create an extension, BiblioGraph.net. This extension included library-centric vocabulary terms such as *agent*, *microform*, *newspaper*, *publicationSeries*, and *thesis*—terms that are more descriptive than “schema:Person” or “schema:CreativeWork.” Schema.org has since added a bibliographic extension into its schemata, which pairs well with OCLC’s larger effort to include linked data on their bibliographic records in WorldCat. Since 2012, users have been able to view linked data in WorldCat by clicking on “Linked Data” at the bottom of each bibliographic record. Meanwhile, machine-readable linked data have been published at the same URI with different formats available at different extensions (i.e., <http://worldcat.org/oclc/155131850.rdf>, <http://worldcat.org/oclc/155131850.jsonld>). This parallel publishing allows for both human- and machine-readable metadata at the same address.⁴ All of these efforts are the latest in the long history of libraries working to improve access by normalizing, enhancing, and connecting library resource metadata. Although the medium of cataloging has changed from print catalogs to cards, to electronic records to linked open data, the aim has been the same—namely, to make information accessible to users. Linked open data takes this to a new level by publishing individual components of a bibliographic record in a machine-readable format, making new forms of user discovery and collection analysis possible.

EXTRA-SPECIAL COLLECTIONS

In the information ecosystem, bibliographic metadata is just the tip of the iceberg. Having copies of the same book in multiple libraries means that metadata about that book could be shared to improve access. But what happens when resources are truly unique? How do we make cultural heritage materials more discoverable? Archivists are familiar with this barrier to access, but experiments with linked open data in archives and special collections are showing the potential for new methods of discovery—ones that shine light on the relationships and contexts implicit within archival materials.

At the University of Nevada, Las Vegas (UNLV), Cory Lampert and Silvia Southwick led a team to add linked data to the UNLV University Libraries’ Southern Nevada Jewish Heritage Project. This linked data initiative led to the creation of the

Jewish Heritage Project Navigator, a pilot search and browse interface (<http://lod.library.unlv.edu/nav/jhp/>). By using external relationship vocabularies to connect people, organizations, subjects, and materials, the UNLV team was able to create an interface that allows users to browse the collections in a nonlinear way. For example, connections between family and community members are described using predicates like “parentOf,” “childOf,” “neighborOf,” and so on. This is in turn connected to materials, creating a rich context for users to explore the project’s digital collection. This type of exploratory interface will become much more common in the next five years as libraries and archives seek to enhance their collections. To date, relevance-ranked keyword searches were the best researchers could hope for. But with the advent of linked open data in libraries and archives, researchers will have immediate access to additional contexts that can save both time and energy when exploring digital collections.

The Linked Jazz project (<http://linkedjazz.org>) takes this same work a step further by using linked open data to connect the relationships in the jazz community described in oral histories. These relationships come alive in the Linked Jazz Network Visualization Tool, where users can explore how various jazz artists, producers, and educators connect (<http://linkedjazz.org/network/>). This visualization is possible because Cristina Pattuelli and her team of researchers took transcripts from fifty-four oral histories and identified more than nine thousand entity names through automated and human analysis. This list of names was then connected to other linked open data vocabularies like DBpedia, VIAF, and MusicBrainz (<http://musicbrainz.org>). However, because some of the people mentioned in the oral histories were not in any of the other vocabularies, the Linked Jazz team had to publish (a.k.a. “mint”) their own linked open data URIs to represent those people.⁵ As more archival institutions mint their own URIs and connect them, it will become possible to see relationships within collections, across collections, and even across archival institutions.

This last kind of connection is particularly needed, as researchers often have difficulty locating materials about the same person or organization held at separate archives. The Social Networks and Archival Context (SNAC) Cooperative aims to help solve this problem through its website (<http://n2t.net/ark:/99166/w6gk06z2>). For example, 318 different library collections have materials about the influential and prolific activist W. E. B. Du Bois (<http://snaccooperative.org/view/67874817>). By harvesting metadata records at archival institutions, the SNAC website makes it possible to identify records connected to Du Bois. Like libraries, linked open data in archives and special collections is made possible because of metadata standards and schemata. Archives have been using XML to create Encoded Archival

Description (EAD) finding aids since 1998, and more recent creations like SNAC make use of the Encoded Archival Context—Corporate Bodies, Persons and Families (EAC-CPF) standard.⁶ By publishing standardized authority records for entities, new linked open data connections—and therefore new methods of discovery—become possible.

THE FUTURE: MOVING FROM CODE TO TOOLS

Publishing and integrating linked open data is the future trend for cultural heritage organizations, but until recently, taking advantage of these standards required planning a discrete project and hiring programmers to do the coding. But library vendors have also been paying attention to emerging standards and schemata, so tools are now being designed with linked data standards in mind. It will take the availability of both open source and proprietary linked open data library tools before broad adoption can happen.

Archives and special collections have seen the popular digital exhibit tool Omeka launch a new, completely rewritten version of the tool in late 2017 dubbed Omeka S (<http://omeka.org/s>). This version includes the ability to integrate with external vocabularies, create custom vocabularies, publish linked data URIs, and use templates designed to work with DPLA's MAP data model. There is a plug-in for an International Image Interoperability Framework (IIIF) server to assist in processing and sharing images (see chapter 13 for more on this framework). Additionally, Omeka S administrators can install plug-ins to connect to other popular tools like Fedora 4 and DSpace.

Institutional repositories had a linked data overhaul in 2015, when DSpace version 5 came out with linked data capabilities, and that trend has continued with version 6 (<http://dspace.org>). It is important for scholars, researchers, and academic librarians to make research and its associated metadata as widely available as possible. By including RDF metadata and a SPARQL endpoint, DSpace provides researchers with the ability to increase the findability and impact of their research while also opening up repositories for large-scale data analysis.

Digital repository vendors are also adding linked data capabilities to their tools. Since Fedora is the backbone of several digital repository programs, its inclusion of linked data capabilities with the Fedora 4 release had a large impact on future development of tools like Islandora (<http://islandora.ca/CLAW>) and Samvera

(<http://samvera.org>). Fedora 4 also supports the Portland Common Data Model (PCDM), a model for sharing content in digital repositories and institutional repositories (<http://pcdm.org>).⁷

The standards and technologies at the core of linked open data are being integrated into an increasing number of library schemata and software; as these tools become more available, the entire landscape of information seeking and retrieval will change.

SCI-FI SEARCH

Through the early research into linked open data by the projects mentioned earlier, we're already beginning to see how linked open data will impact libraries. The discovery and contextualization of information are being reshaped, and new possibilities for research are becoming broadly available.

In the near future, resource discovery will take on new dimensions for users and researchers alike. Context clues will be scattered throughout bibliographic records as libraries pull in biographical information from public databases to tell students about the backgrounds of authors. Underrepresented populations will get new levels of exposure, as users will be able to narrow down authors and subjects by new facets enabled by richer metadata provided through linked open data, like with Stacy Allison-Cassin and Dan Scott's pilot project to improve visibility for Canadian musicians.⁸ We can imagine other examples where students will be able to limit search results by an author's gender, allowing women's studies and queer studies students to quickly locate research by women or nonbinary authors. With large sets of archival metadata online, historians will be able to study changes in the patterns of human communication and behavior as publications, correspondence, and photography open for analysis in aggregate.

For public domain materials, there is no need to limit linked open data to bibliographic records. Text mining and machine learning can be put to work to unlock tabular data from old books and archival manuscripts and publish them online as linked open data. Further in the future, we could see historical weather patterns published from the daily diaries of manuscript collections, helping us study the direction of climate change. Social justice advocates could query historical demographic information en masse, revealing patterns of disenfranchisement that have previously been hidden from view in scattered tables and maps. Special collections and archives will be publishing their own locally controlled vocabularies

and ontologies and connecting them across institutions. This work will require metadata experts to wrangle messy data sets, connect them, and maintain those connections over time. But because of this effort, the lives of historical figures who have previously been passed over will find new light as authority records are connected across the world.

The next five years will be both exciting and a tad chaotic for libraries. Linked open data has slowly matured over the seventeen years since the concept was first introduced. But now that linked data is entering mainstream use in libraries, we will need to contend with larger problems that have been easy to overlook in the past. Disambiguation will require renewed urgency and care as information professionals connect resources together. The importance of metadata standardization will only increase as we link our data together, and gray areas of interpretation and bias in description will need refreshed scrutiny. As libraries start minting new URIs to represent resources, we must make a long-term commitment to preventing link rot (see chapter 3 for more). The library community will need to balance data models that describe library resources in depth while also connecting to outside search engines; we must accept that some tools will work and others will go the way of dodo birds and Betamax tapes. Within all these challenges, however, are opportunities to further express our core value of helping people connect with the information they need.

Experiments with linked open data in libraries are giving us glimpses of a tantalizing future where users have increased access and context for interacting with information. But even more, building the infrastructure of library linked open data will make information available for remixing and reusing in ways that we can't yet imagine. Those new uses will be discovered not only by librarians and archivists but by the users we serve, making linked open data a top technology that every librarian needs to know.

NOTES

1. Sally H. McCallum, "BIBFRAME Development," *JLIS.it* 8 (September 2017): 71–85, <https://doi.org/10.4403/jlis.it-12415>.
2. Karen Coyle, "Mistakes Have Been Made," filmed November 24, 2015, at Semantic Web in Libraries, Hamburg, Germany, www.youtube.com/watch?v=d0CMuxZsAIY, 37:30.
3. Richard Wallis, Antoine Isaac, Valentine Charles, and Hugo Manguinhas, "Recommendations for the Application of Schema.Org to Aggregated Cultural Heritage Metadata to Increase Relevance and Visibility to Search Engines: The

- Case of Europeana,” *Code4Lib Journal* 36 (April 2017), <http://journal.code4lib.org/articles/12330>.
4. Carol Jean Godby, Shenghui Wang, and Jeffrey K. Mixer, *Library Linked Data in the Cloud: OCLC's Experiments with New Models of Resource Description*, Synthesis Lectures on the Semantic Web: Theory and Technology, vol. 4, no. 5 (Williston, VT: Morgan & Claypool, 2015), <https://doi.org/10.2200/S00620ED1V01Y201412WBE012>.
 5. M. Cristina Pattuelli, Karen Hwang, and Matthew Miller, “Accidental Discovery, Intentional Inquiry: Leveraging Linked Data to Uncover the Women of Jazz,” *Digital Scholarship in the Humanities* 32, no. 4 (2017): 918–24, <https://doi.org/10.1093/lc/fqw047>.
 6. Hilary K. Thorsen and M. Cristina Pattuelli, “Linked Open Data and the Cultural Heritage Landscape,” in *Linked Data for Cultural Heritage*, ed. Ed Jones and Michele Seikel (Chicago: ALA Editions, 2016), 5.
 7. Erik T. Mitchell, “Library Linked Data: Early Activity and Development,” *Library Technology Reports* 52, no. 1 (January 2016): 24.
 8. Stacy Allison-Cassin and Dan Scott, “Wikidata: A Platform for Your Library's Linked Open Data,” *Code4Lib Journal* 40 (May 2018), <http://journal.code4lib.org/articles/13424>.

Index

A

access

- digital publishing and, 173–177
- digital repositories for, 153–154
- to digital repository materials, 159–160, 164
- with institutional repositories, 154
- as investment strategy, 176
- to preservation repository, 157, 159
- in web archiving, 45

access repositories, 155–156

accessibility

- of access repository materials, 156
- of personalized data, 102–103
- of web archives, 53

account credentials, 66–67

Adam Matthew Digital (AMD), 171–176

advertising

- IBeacons for library advertising, 22–23
- web browser plug-ins to block, 61–62

advocacy, 97–98

AGI (artificial general intelligence), 232

AI

- See artificial intelligence

ALA (American Library Association), 60

Albert, Kendra, 31–32

Allison-Cassin, Stacy, 13

“alt” tags, 102

always-on assistants, 23

Amazon

- Alexa-enabled Dot/Echo, 213

Echo, library use of, 18, 23

Echo, specialized script for, 215

platform lock-in, web archiving and, 50

Amazon Web Services (AWS), 146–147, 231

Amber project

- independent snapshots of web pages, 31
- WordPress plug-in, 33
- work of, 30

AMD (Adam Matthew Digital), 173–176

American Library Association (ALA), 60

Ammon, Keith, 68

Amnesic Incognito Live System (Tails), 66

analytics

- analytics-driven collection strategy, 251
- Google Analytics, 143
- LTI integrations for, 207
- Matomo, 143–144

And Chill chat bot, 220

Andrews, Carl R., 199

AngularJS, 140

Annals of Mathematical Statistics, 90

ANNs (artificial neural networks), 228–231

anticircumvention laws, 38

API

- See application programming interface

Apple

- e-book platform, 246–247
- facial-recognition software, 60
- HomePod, library use of, 23
- iPhone, Siri of, 213

- Apple (cont.)
 platform lock-in, web archiving and, 50
 Siri, library use of, 23
- Apple iPad
 apps, 247
 e-book platform, 246–247
 as fixture in modern life, 246
 introduction of, 242–243
- application programming interface (API)
 bot interaction with for content delivery, 215
 for ML in library, 235
See also IIIF Image API
- applications (apps)
 data collection with mobile technology, 249–250
 for iPad, 247
 for mobile devices, 246
 mobile technology, future of, 248–249
See Collections, 94
- archival digital repositories
 access repositories, 155–156
 future directions for, 161–163
 preservation repositories, 156–159
- archival management system, 157
- Archive-It, 46, 47
- Archivematica, 157
- archives
 digital publishing through third-party vendors, 168–170
 linked open data in archives/special collections, 10–12
 tools for linked open data, 12–13
See also web archiving
- Archives and Special Collections
 Department, UMN Libraries
 digital delivery modes, platforms, products, 169–170
 digital publishing case study, 173–176
 technology for digital conversion projects, 170–173
- ArchivesSpace, 160
- archivists, 50–52
- artificial general intelligence (AGI), 232
- artificial intelligence (AI)
 augmented intelligence, 233
 data in machine learning, 231–232
 fears of AI apocalypse, 232–233
 as feature of life for ordinary people, 236
 in future library, 251
 ML definition in context of, 224
 ML in library, 233–235
 on mobile devices, 250
 modeling brain with ANNs, 228–230
 teaching machines using symbols, 224–225
 uncertainty/experience in teaching machines, 225–228
- artificial neural networks (ANNs), 228–231
- Ashton, Kevin, 18
- assessment data, 89–90
- Association of College & Research Libraries, 244–245
- AT&T, 242
- audiovisual materials, 191–192
- augmented intelligence, 233
- Aumcore, 245–246
- Austin Public Library, 218
- authors, 160–161
- automated task
 bots, functionality of, 214–216
 bots for, 212
 bots in libraries, 216–218
- AWS (Amazon Web Services), 146–147, 231
- B**
- Babcock, Kelli, 181–193, 257
- backups
 of preservation repository materials, 158
 for web archiving, 34, 35
- Bagger, 157–158
- Baglt, 157
- Bahde, Anne, 94
- bar chart, 75
- Bauder, Julia, 75–86, 257
- Bell Labs, 242

Berkeley Electronic Press, 141
 Berkman Klein Center for Internet and Society, 30
 Berners-Lee, Tim, 6, 48
Best Apps for Academics: A Guide to the Best Apps for Education and Research (Hennig), 246
 Bibliographic Framework Initiative (BIBFRAME), 7–9
 bibliographic metadata, 7–10
 bibliographic records
 large-scale linked data in libraries, 7–8
 research in future with linked open data, 13
 BiblioGraph.net extension, 10
 Blississima, 192
 big data analytics, 251, 252
 Boise State University, 246
 Bond, Sarah E., 134
 books
 e-books, production process for, 43–44
 JSTOR's Topic**graph** for search of, 81–83
 See also e-books
 Bostrom, Nick, 232
 botnets, 25
 Botnik Studios, 220
 bots
 characteristics of, 214–216
 for civic causes, 220
 conclusion about, 220–221
 definition of, 212
 history of, 213–214
 for internal library communication, 220
 in libraries, 216–218
 for library instruction/outreach, 218
 for library services/events, 220
 library use of, 211–212
 tool kit for, 219
 “Bots and the Library: Exploring New Possibilities for Automation and Engagement” (Sewell), 211–221
 BotSpot website, 213

Botwiki
 definition of bot, 212
 features of, 219
 on types of bots, 213
 Bouquin, Daina, 98
 brain, 228–230
Breaking the Book (Mandell), 128
A Brief History of Data Visualization (Friendly), 90
 Briney, Kristin, 100
 British Educational Communications and Technology Agency, 246
 British Library, 191, 247
 Brooklyn Public Library
 Digital Privacy Project, 69
 IV for public services data, 92, 93
 browsing
 history, VPNs and, 63
 IV for visual search and browse, 94–96
 Burkell, Jacquelyn, 61
 business analytics, 92
 “buttonology,” 128

C

California, 108
 Canvalytics, 205
 Canvas LMS, 198, 205–206
 Capek, Karel, 212
 Carlson, Scott, 217
 Carolina Digital Humanities Initiative (CDHI), 130
 Carrot Document Clustering Workbench, 85
 Carrot Project, 85
 Carrot Search, 80
 Case Map, in Ravel platform, 83–85
 case study
 digital publishing, 173–176
 EBSCO Curriculum Builder at Louisiana State University, 201–203
 Ex Libris Leganto at University of New South Wales, 203–205
 LibGuides at Utah State University, 205–206

- Catal Hyük map, 90
- CDHI (Carolina Digital Humanities Initiative), 130
- cell phones, 241–243
See also smartphones
- cellular communication, 241–243
- chat bots
 description of, 212–213
 development of, 214
 for internal library communication, 220
 for libraries, benefits of, 216
- Cheap Bots Done Quick, 219
- checksum, 157, 158
- Chesapeake Project, 32
- “Chroncling America” newspaper archive, 126
- citations
 data citation initiative, 145
 Ravel Law visualizations of court cases, 83–85
 reference rot and, 31–32
 reference rot prevention strategies, 36
- “Cite It!” bookmarketlet, 203, 204
- civic causes, 220
- CKAN, 146
- cloud computing
 adoption of in libraries, xi
 analytics-driven collection strategy, 251
 in future library, 251
 hosted data environments, 146–147
 hybrid acquisition model in future library, 251–252
 impact of mobile technology, 243–244
 mobile infrastructure, future of, 249
 scalability for ML tasks with, 231
- clustering, 228
- CMS
See content management system
- CMS LTI tool, Springshare, 206
- Coalition for Networked Information and Data Science Training for Librarians, 100
- Codecademy, 219
- coding languages, 215
- Colaboratory, Google, 130
- Cold War International History Project, 94, 95
- collaboration
 for digital humanities, 127–128, 133–134
 at UMN Libraries, 170
 for web archiving, 52
- collaborative websites, 213, 214
- Collection Analyzer, 131, 132
- Collection Discovery, 131, 132
- collection metadata, 47
- collection policy, 46
- collections
 analytics-driven collection strategy, 251
 digital collections/digital humanities platform, 131–133
 digital publishing through third-party vendors, 167–170
 IV for visual search and browse, 94–96
See also special collections
- Collections U of T, 189
- College & Research Libraries News*, 124
- College of Charleston, 94
- comment threads
 dynamic content, as challenge for web archiving, 49–50
 web as venue for new media objects, 44
- communication
 bots for internal library communication, 220
 through vision, 91
See also scholarly communication
- community
 future community of IIF-enabled institutions, 192–193
 web archives, access to, 53
- compression, 157
- Compton, Kate, 219
- computers
 IP address as unique identifier, 19
 VR headset requirements, 115
- ComScore, 243

- Conner, Matt, 94, 96
- Connexion, 216
- Connolly, Matthew, 17–27, 257
- consciousness, 223–224
- content customization, 248
- content drift, 30
- content management system (CMS)
- IIIF and, 190
 - link preservation, 33
 - web archiving and, 37
- ContentDM, 141
- context, link rot and, 31
- Convocate project, 132
- cookies, 62
- cooperation, 50–51
- See also* collaboration
- copyright
- access repository materials and, 156
 - Leganto and, 204–205
 - vendors links to e-resources and, 38
- Cornell University
- Fedora, development of, 138–139
 - IIIF use by, 191
 - on mobile technology for teaching, 246
- Corporation for National Research initiative, 138–139
- costs
- of digital publishing, 175–176
 - LTI applications for lower course materials costs, 206–207
- course materials
- EBSCO Curriculum Builder at Louisiana State University, 201–203
 - Ex Libris Leganto at University of New South Wales, 203–205
 - LibGuides at Utah State University, 205–206
 - LTI use cases for libraries, 198–200
- court cases, 83–85
- Cramer, Tom, 190
- Creative Commons Rights Expression Language, 8
- credentials, 199
- Crontab, 215
- CurateND platform, 133
- curatorial expertise, 168
- customer relationship management (CRM), 250–251, 252
- D**
- Dalhousie University Libraries, 96–97
- dark archive, 157
- Darnell, Alan, 223–236, 257
- data
- aggregation, privacy threats with IoT, 26
 - as experience for machine learning, 225–228
 - Internet of Things, libraries and, 17–27
 - link rot, reference rot, link resolvers, 29–38
 - linked open data in libraries, 3–14
 - in machine learning, 231–232
 - privacy protection for account credentials/data, 66–67
 - publishing by digital repositories, 147
 - web archives, engaging libraries with, 43–54
 - See also* linked open data
- Data (data journal), 147
- data analytics
- IoT and, 27
 - recognition of, 90–91
- Data API, 146
- data collection
- digital humanities in libraries, 127–128
 - mobile technology and, 249–250
- “Data for Discovery” (Bauder), 75–86
- data journalists, 92
- data journals, 147
- data repositories, 144–146
- data science, 235
- Data Science and Visualization Institute of Librarians course, 100
- “Data Visualization Camp Instructional Materials (2017)” (University of Wisconsin–Milwaukee), 100

- data visualizations
 early, 75
 Gale Topic Finder, 77–80
 JSTOR's Topic**graph**, 81–83
 Ravel Law visualizations, 83–85
 tools for creation of, 85–86
 visualized discovery interfaces,
 76–77
See also information visualization
Data Visualizations and Infographics
 (Mauldin), 100
- data wrangling, 127
- databases, 3–6
- Dataverse, 145–147
- DBpedia, 7
- DEC (Digital Exhibits and Collections), 131,
 132
- Deep Blue Data at the University of
 Michigan, 145
- DeepMind's AlphaGo, 231
- Dehmlow, Mark, 123–134, 258
- Delmas-Glass, Emmanuelle, 192
- Dempsey, Lorcan, 168
- Designing Bots: Creating Conversational
 Experiences* (Shevat), 219
- DH
See digital humanities
- D.H. Hill Library makerspace, 24
- Di Cresce, Rachel, 181–193, 258
- digital archival content, 155–156
- digital collections repositories, 137–138
- Digital Commons, 141, 143
- digital conversion
See digitization
- digital exhibit platforms, 131–133
- Digital Exhibits and Collections (DEC), 131,
 132
- “Digital Exhibits to Digital Humanities:
 Expanding the Digital Libraries
 Portfolio” (Johnson & Dehmlow),
 123–134
- digital humanities (DH)
 description of, 124
- digital access repositories for scholars in,
 155–156
- digital exhibit platforms/tool kits,
 128–130
- future of, 133–134
- IV, use of, 92
- in libraries, 126–128
- platform, developing, 131–133
- tracing digital library to, 124–125
- digital images
 IIIF, early adopters of, 190–191
 IIIF, future trends for, 191–192
 IIIF, how it works, 184–188
 in IIIF definition, 182–183
 IIIF use cases, 188–190
- “‘Digital’ Is Not the Opposite of
 ‘Humanities’” (Bond, Long, &
 Underwood), 134
- digital libraries
 digital humanities in libraries, 126–128
 evolution of, 124–125
 future of digital humanities and,
 133–134
 large-scale, adoption of in libraries, xi
 overview of, 123–124
- Digital Privacy Project, 69
- Digital Public Library of America, 9
- digital publishing
 case study, 173–176
 conclusion about, 176–177
 of special collections, 167–168
 technology for, 170–173
 through third party vendors, 168–170
- digital repositories
 archival digital repositories, 155–159
 conclusion about, 148, 163–165
 current trends/future directions,
 142–148
 early adopters of, 141–142
 functions of, 153–154
 future directions for, 159–163
 IIIF, how it works, 184–188
 IIIF, impact on, 188–190

- IIIF and, 182
 - IIIF for digital images, 182–183
 - IIIF use cases, 188
 - institutional repositories, 154
 - investments in, 181
 - repository systems, 138–141
 - types of, 137–138
 - “Digital Repositories: A Systems Perspective”
 - (Westgard, Dohe, Durden, & Koivisto), 137–148
 - “Digital Repositories” (Webster), 153–165
 - Digital Repository at the University of Maryland (DRUM), 145
 - digital repository vendors, 12–13
 - digital rights management (DRM), 33
 - digital scholarship
 - centers, 125
 - use of IV, 92
 - Digital Tools for Manuscript Study project, 189
 - digitization
 - digital publishing, 176–177
 - by libraries, 127
 - technology for, 170–173
 - direct manipulation interfaces, 76
 - disambiguation, 8, 14
 - disciplinary problems, 51–52
 - discovery
 - digital repositories, integration with, 159–160
 - digital repositories, trends in, 142–144
 - See also* visualized discovery interfaces
 - discussion boards, 44
 - distribution channel, 43–44
 - document level metadata, 47
 - Dohe, Kate, 137–148, 258
 - Domain Name System (DNS), 64–65
 - DoNotPay bot, 220
 - DPLA Bot, 217
 - Dragoman Renaissance Research Platform, 7
 - DRM (digital rights management), 33
 - DRUM (Digital Repository at the University of Maryland), 145
 - Dryad, 147–148
 - DSpace
 - code base, simplification of, 141
 - for dedicated data repositories, 145
 - features of, 139–140
 - with Google Analytics, 143
 - IIIF and, 190
 - linked data capabilities of, 12
 - Dublin Core
 - Metadata Terms, 8
 - search engine optimization and, 144
 - DuckDuckGo, 63
 - DuraSpace, 138
 - Durden, David, 137–148, 258–259
 - Dyn, 25
 - dynamic content, 49–50
 - dynamic queries, 76
- E**
- EAC-CPF (Encoded Archival Context-Corporate Bodies, Persons and Families), 12
 - early adopters
 - of digital repositories, 141–142
 - of IIIF, 190–191
 - of mobile technology, 245–247
 - of privacy-protection technology tools, 67–69
 - e-books
 - Apple’s e-book platform, 246–247
 - EBSCO Curriculum Builder and, 202
 - production process for, 43–44
 - EBSCO Curriculum Builder
 - Leganto vs., 204
 - at Louisiana State University, 201–203, 207
 - personalization with LTI, 199
 - EBSCO Discovery Service
 - EBSCO Curriculum Builder and, 201
 - personalization with LTI, 199
 - economic consequences, of ML advances, 233
 - EDM (Europeana Data Model), 9

- education
 - about VR, 110
 - IV as library service, 96
 - IV education for librarians, 101
 - mobile learning, 245
 - privacy education in libraries, 70
 - with VR, 111
 - See also* training
 - EDUCAUSE, 207
 - EFF
 - See* Electronic Frontier Foundation
 - Ege, Otto F., 192
 - electronic devices
 - Internet-connected, growth of, 19–21
 - IoT, use of in libraries, 21–24
 - Electronic Frontier Foundation (EFF)
 - browser-based privacy-protection tools of, 62
 - privacy-protection policies/tools, 60
 - VPN choice, information on, 64
 - electronic library, 125
 - Electronic Product Code (EPC), 19
 - ELIZA, 213
 - e-mail chains, 44
 - embeddedness
 - EBSCO Curriculum Builder at Louisiana State University, 201–203
 - Ex Libris Leganto at University of New South Wales, 203–205
 - LibGuides at Utah State University, 205–206
 - with LTI, 197
 - LTI, conclusion about, 206–207
 - LTI use cases for libraries, 198–200
 - “Embracing Embeddedness with Learning Tools Interoperability (LTI)” (Magnuson), 197–207
 - Encoded Archival Context-Corporate Bodies, Persons and Families (EAC-CPF), 12
 - encryption
 - privacy protection for account credentials/data, 66–67
 - by VPN, 63
 - “Engaging Libraries with Web Archives” (Suomela), 43–54
 - Engseth, Ellen, 167–177, 259
 - environment, library, 23–24
 - Environmental Data & Governance Initiative, 32–33
 - environmental sensors, 24
 - EPC (Electronic Product Code), 19
 - EPrints, 140
 - Epstein, Helen-Ann Brown, 98
 - equipment
 - for digital conversion project, 172
 - VR, knowledge about, 114–115
 - equivalence connections, 5
 - e-resources, 38
 - ethics, 54
 - European Union, 60
 - Europeana Collections, 9
 - Europeana Data Model (EDM), 9
 - “Everything Is Online: Libraries and the Internet of Things” (Connolly), 17–27
 - exit node, 68
 - experience, 225–228
 - exploratory interface, 11
 - “exposure therapy,” 112
 - Extensible Markup Language (XML), 6
- F**
- Facebook
 - bots for internal library communication, 220
 - chat bots, 214
 - Oculus VR, purchase of, 109
 - platform lock-in, web archiving and, 50
 - virtual reality, future of, 116
 - factual statements, 4
 - faculty
 - collaboration with librarians for digital humanities, 127–128
 - collaboration with librarians with LTI, 198
 - Leganto at University of New South Wales, 203–205

LibGuides at Utah State University, 205–206

Fagerheim, Britt, 205

Federal Communications Commission (FCC), 242

Fedora

- code base, simplification of, 141
- development of, 138–139
- IIIF use cases, 188, 189
- linked data capabilities, 12–13
- RDF for linked open data, 142

Fedora Object XML (FOXML), 138

Fenner, Martin, 147

Few, Stephen, 102

Fifth generation (5G) mobile networks, 243

“Fighting Linkrot” (Nielson), 29

file fixity, 158

file formats

- for access repository material, 155
- format diversity as challenge for web archiving, 49
- metadata for archival repositories and, 162
- for preservation repository materials, 157, 158

file size

- of access repository materials, 156
- of preservation repository materials, 157

FilmFinder, 76

filter bubbles, 232

firmware update, 25–26

fixity checks, 158

Florida Library Association Marketing Committee, 97–98

Fondren Bot, 217

Fondren Library at Rice University, 217

format migration, 49

formats

- See file formats

Fortier, Alexandre, 61

FOXML (Fedora Object XML), 138

Frank, Emily

- on access to library materials, 198

EBSCO Curriculum Builder at Louisiana State University, 201–202, 207

FreeflyVR, 113

French Renaissance Paleography project, 188, 189

Friendly, Michael J., 90, 91

Front Porch Center for Innovation and Wellbeing, 218

Fulcrum, 133

funding, 169

future

- of digital humanities, 133–134
- IoT-connected library of future, 26–27
- of IV/libraries, 100–103
- of ML in library, 233–235
- of mobile technology, 247–250

“The Future of Data Analysis” (Tukey), 90

G

Gale, 76, 126

Gale Topic Finder, 77–80

General Data Protection Regulation (GDPR), 60

generations, of mobile technology networks, 243

Glitch, 219

Goel, Vindu, 116

Good Old-Fashioned Artificial Intelligence (GOFAD), 224

Goodreads, 220

Google

- Colaboratory platform, 130
- hosted data environments, 146–147
- OK Google, 23
- platform lock-in, web archiving and, 50
- search engine optimization and, 144

Google Analytics, 143

Google Cardboard, 114–115

Google Cloud Platform, 231, 235

Google Daydream, 114–115

Google Fusion Tables, 99

Google Home, 23, 213

Google Knowledge Graph, 3

Google Open Gallery, 131–132

Google Scholar, 125, 144
 Google Sheets, 99, 219
 government information, 32–33

H

hackers, 25
 hardware, for VR, 114–115
 Harper, Stephen, 51
Harry Potter and the Deathly Hallows
 (Rowling), 4–5
Harvard Law Review, 32
 Harvard University's Institute for
 Quantitative Social Science, 145–146
 harvesting, 45
 headset
 for VR, 108
 VR, knowledge for purchase of, 114
 VR, logistics of incorporating, 113
 health apps, 250
 health considerations, 113–114
 Health Sciences Library at the University of
 North Carolina at Chapel Hill, 96
 Hennig, N., 246
 Hensley, Merinda Kaye, 128
 Herbert, L., 243
 Heritrix web crawler, 46, 48
 Hesburgh Libraries, Notre Dame, 126,
 131–133
 Higgins, Devin
 on digital humanities tools, 128–129
 on text mining, 133–134
 home automation
 description of, 18
 IoT devices, 19–20
 library use of IoT components for, 23–24
 Honeycomb platform, 131–133
 hosted data environments, 146–147
 hosted solutions, 141
 “How to Make a Twitter Bot with Google
 Spreadsheets” (Whalen), 215
 Hsuanwei, Michelle Chen, 101
 HTC Vive, 115
 HTTPS Everywhere browser plug-in, 62

hybrid acquisition model, 251–252
 hyperlinks, 30

I

IA
 See Internet Archive
 iBeacons
 for library navigation, 26–27
 for library navigation/advertising,
 22–23
 use of by stores, 18
 IBM
 Simon (smartphone), 242
 Watson, 231
 IDC, 244
 If This Then That (IFTTT) online service
 bots for library instruction, 218
 for input from IoT devices, 18
 for IoT integration, 20–21
 IIIF Image API
 function of, 184
 functionalities of, 191
 image returned by, 185, 186
 publication of, 190
 IIIF viewer
 future community of IIIF-enabled
 institutions, 193
 library websites with, 189
 search and discovery through, 190
 IIPC (International Internet Preservation
 Consortium), 44–45, 46
 Image API
 See IIIF Image API
 image recognition
 with ANNs, 230–231
 with Google Cloud Platform, 235
 ML in library, 234
 images
 See digital images
 imitation game, 225
 IMLS
 See Institute of Museum and Library
 Services

- Immigration History Research Center Archives (IHRC)
 - digital publishing case study, 173–176
 - purpose/work of, 170
 - technology for project, 171, 172
- “Impact of International Image Interoperability Framework (IIIF) on Digital Repositories” (Babcock & Di Cresce), 181–193
- IMS Global Learning Consortium, 197
- Incognito mode, 63
- indexing, 144, 154
- infographics
 - information visualization and, 90
 - for library advocacy, 97–98
- information technology, 108
- information visualization (IV)
 - applications for, 91–92
 - conclusion about, 103–104
 - function of, 89–90
 - future for IV/libraries, 100–103
 - history of, 90–91
 - for library advocacy, 97–98
 - as library service, 96–97
 - for library usage/public service data, 92–94
 - for metadata/collections, 94
 - tools for, 98–99
 - tutorials on, 100
 - vision, communication through, 91
 - for visual search and browse, 94–96
 - See also* data visualizations
- infrastructure, 48
- innovation, 108–110
- inside-out model
 - costs reduction with, 176
 - description of, 168
 - sharing of digital materials in, 170
- Institute of Museum and Library Services (IMLS)
 - funding for privacy-protection projects, 69, 70
 - privacy-protection policies/tools, 60
- institutional challenges, for web archiving, 50–52
- institutional repositories (IR)
 - benefits of, 154
 - current trends/future directions, 142–144
 - DSpace, 139–140
 - early adopters of, 141–142
 - EPrints, 140
 - function of, 137
 - future directions for, 160–161
 - research data, trends in, 144–146
 - web archiving and, 37
- intelligence
 - artificial general intelligence, 232
 - augmented intelligence, 233
 - as part of consciousness, 223
 - Turing test for AI, 225
- interface
 - of access repository, 156
 - of DSpace, 139–140
 - on mobile devices, future of, 248
- International Children’s Digital Library Foundation, 247
- International Image Interoperability Framework (IIIF)
 - definition of, 182–183
 - early adopters of, 190–191
 - future community of IIIF-enabled institutions, 192–193
 - future trends for, 191–192
 - how it works, 184–188
 - impact on digital special collection repositories, 188–190
 - need for, 181–182
 - use cases, 188
- International Internet Preservation Consortium (IIPC), 44–45, 46
- International Standard Name Identifier International Agency, 8
- International Standardization Organization (ISO) standards, 162
- Internet
 - bots developed for, 213–214

Internet (cont.)

- mobile technology, impact on libraries, 244–245
- mobile technology, practices for early adopters, 245–247
- user privacy protection, 59

Internet Archive (IA)

- large-scale web archiving efforts of, 48
- reference rot prevention, 36
- as tool for link rot, 33, 34
- Wayback Machine, 47
- web archiving work of, 35

Internet of Things (IoT)

- IOT-connected library of future, 26–27
- overview of, 17–18
- security concerns/privacy implications, 24–26
- technology of, 18–21
- uses of in libraries, 21–24

interoperability

- bots, 211–221
- IIIF, impact on digital repositories, 181–193
- with Learning Tools Interoperability, 197–207
- machine learning for libraries, 223–236
- mobile technology, 241–253

inventory control, 21–22

IoT

See Internet of Things

IP address, 63, 64–65

IR

See institutional repositories

Islandora

- Fedora and, 12–13
- IIIF and, 188, 189, 190
- for user interface on top of Fedora repository, 139

IT industry, 243–244

IV

See information visualization

J

James Ford Bell Library (Bell Library)

- digital publishing case study, 173–176
- purpose/work of, 170
- technology for project, 172

JavaScript, 215

JavaScript Object Notation for Linked Data (JSON-LD), 6

- JavaScript Object Notation (JSON) file
 - for bots, 215
 - manifest in form of, 186
 - view of, 187

Jefferson, Charissa, 96

Jewish Heritage Project Navigator, 11

Jin Xiu Guo, 241–253, 259

Jobs, Steve, 243

Johnson, Daniel, 123–134, 259

Jones, Gwyneth, 23

journals

- institutional repositories, upload to, 160–161
 - web as distribution channel for, 43–44

JSTOR, 76, 81–83

K

Kahle, Brewster, 30–31

Kain, Erik, 109

Kamada, Hitoshi, 124

Kelly, Elizabeth Joan, 89–104, 259–260

Kilton Library of Lebanon, New Hampshire, 67–68

Kingsborough Community College Library, 94

Koivisto, Joseph, 137–148, 260

Kyoto University Rare Materials Digital Archive, 191

L

Lampert, Cory, 10–11

Landis, Cliff, 3–14, 260

large-scale linked data, 7–10

latent Dirichlet allocation (LDA), 82–83

Lavin, Matthew J., 127

- learning
- LTI for learning analytics, 199–200
 - meaning of, 223
 - with mobile technology, future of, 247–250
 - uncertainty/experience in teaching machines, 225–228
 - See also* machine learning
- learning analytics, 199–200
- learning management systems (LMS)
- EBSCO Curriculum Builder at Louisiana State University, 201–203
 - Ex Libris Leganto at University of New South Wales, 203–205
 - LibGuides at Utah State University, 205–206
 - link preservation and, 36–37
 - LTI, conclusion about, 206–207
 - LTI for external tools for, 197
 - LTI use cases for libraries, 198–200
- Learning Tools Interoperability (LTI)
- benefits of, 206–207
 - EBSCO Curriculum Builder at Louisiana State University, 201–203
 - function of, 197
 - Leganto at University of New South Wales, 203–205
 - LibGuides at Utah State University, 205–206
 - technical architecture of, 200–201
 - use cases, 198–200
- legal issues
- legal citations, 34
 - legal decisions, reference rot and, 31–32
 - Ravel Law visualizations of cases, 83–85
 - references, Chesapeake Project for preservation of, 32
- Leganto, Ex Libris, 203–205
- Legrady, George, 94
- Lessig, Lawrence, 31–32
- Lewis, David, 233–234
- LexisNexis
- Ravel Law, purchase of, 83
 - Ravel Law visualizations, 76–77
- LFI (Library Freedom Institute), 69, 70
- LFP
- See* Library Freedom Project
- LibGuides, 205–206
- librarians
- digital humanities in libraries, 126–128
 - information visualization, functions of, 89–90
 - IV and, future of, 100–103
 - IV as library service, 96–97
 - machine learning in library and, 233–234
 - ML systems, interaction with, 234–235
 - privacy education for, 70
 - privacy-protection technology tools, early adopters of, 69
 - privacy-protection tools, role in, 59–60
 - as users of privacy-protection technology tools, 71
 - VR, educating people about, 110
 - VR, logistics of incorporating, 113–115
 - web, views of, 43–44
 - web archiving and, 37–38
 - web archiving, institutional challenges of, 50–52
 - web archiving, technical challenges for, 48–50
- libraries
- bots in, 211–221
 - bots in, conclusion about, 220–221
 - digital humanities and, 124–125
 - digital humanities, future of, 133–134
 - digital humanities in, 126–128
 - digital libraries field, changes in, 124
 - digital publishing case study, 173–176
 - digital publishing through third-party vendors, 167–170
 - Internet of Things, use of, 18
 - IoT, security/privacy concerns, 24–26
 - IoT, use of in, 21–24
 - IoT integration tools, 20–21
 - IoT-connected library of future, 26–27
 - IV and, future of, 100–103

libraries (cont.)

- IV as library service, 96–97
- IV for advocacy, 97–98
- IV for metadata/collections, 94
- IV for usage/public service data, 92–94
- IV for visual search and browse, 94–96
- large-scale linked data in, 7–10
- link rot/web archiving and, 32–33
- LTI use cases for, 198–200
- machine learning in, 233–235
- media transformation with web and, 43–44
- mobile technology, future library and, 250–253
- mobile technology, future of, 247–250
- mobile technology, impact of, 244–245
- privacy-protection technology tools and, 60–61, 69–71
- reference rot prevention and, 36–37
- Tor in, program for, 67–68
- virtual reality, demand for, 107–108
- virtual reality in, 108–110
- virtual reality in future and, 116–117
- visualized interfaces, tools for creation of, 85–86
- VR, logistics of incorporating, 113–115
- VR in, possibilities for, 110–113
- web archiving and, 37–38
- web archiving, ethical issues, 54
- web archiving, institutional challenges of, 50–52
- “Libraries and Information Visualization: Application and Value” (Kelly), 89–104
- library and information science (LIS) programs, 101
- Library Coalition, 133
- Library Freedom Institute (LFI), 69, 70
- Library Freedom Project (LFP)
 - privacy-protection policies/tools, 60, 69
 - resources of, 71
 - Tor in libraries program, 67–68
- library instruction, bots for, 218
- Library of Congress
 - archive of tweets, 48
 - BIBFRAME from, 7–9
 - “Chronicling America” newspaper archive, 126
 - Labs website, LC for Robots page, 217–218
 - MODS, 138
 - Twitter archive at, 53
- library service, IV as, 96–97
- library usage data, 92–94
- library users
 - See users
- licensing, 173–174
- Liebert, June, 31, 34
- Liebler, Raizel, 31, 34
- lifelogging, 101, 103
- lighting, 23–24
- linear model, 226–227
- link resolvers, 30
- link rot
 - conclusion about, 37–38
 - definition of, 30
 - in early days of web, 29–30
 - libraries and, 32–33
 - link resolvers for, 30
 - prevention, future of, 36–37
 - scope of problem, 30–32
 - solutions for, 33–35
- “Link Rot, Reference Rot, and Link Resolvers,” 29–38
- Linked Jazz Network Visualization Tool, 11
- Linked Jazz project, 11
- linked open data
 - in digital repositories, 142
 - extra-special collections, 10–12
 - large-scale linked data in libraries, 7–10
 - overview of, 3–7
 - research in future, 13–14
 - tools for, 12–13
- “Linked Open Data in Libraries” (Landis), 3–14

LIS (library and information science)
 programs, 101

LMS
See learning management systems

local history, VR for, 113

location-aware devices, 26–27

Lonog, Hoyt, 134

Los Angeles Times, 217

lossless compression, 157

Louisiana State University (LSU), 201–203,
 207

LTI
See Learning Tools Interoperability

LTI launch, 200

LTI tool consumer (TC), 200

LTI tool provider (TP), 200

LUNA Imaging Inc., 172

Lynch, Clifford
 on OA journals, 33
 speech by, 31
 on web archiving, 51–52

M

Maceli, Monica, 59–71, 260

Machine Learning for Language Toolkit
 (MALLET), 85

“Machine Learning for Libraries” (Darnell),
 223–236

machine learning (ML)
 ANN, pattern recognition,
 230–231
 augmented intelligence, 233
 concerns about AI, 232–233
 conclusion about, 236
 data in, 231–232
 description of, 223–224
 librarian interaction with ML systems,
 234–235
 in libraries, future of, 250
 in library, as third technology wave,
 233–234
 neural networks, modeling brain with,
 228–230

teaching machines using symbols,
 224–225
 uncertainty/experience in, 225–228

machine translation
 with Google Cloud Platform, 235
 in library, 234

Macrina, Alison, 68

macros, 216

magazines, 44

Magnuson, Lauren
 on IIIIF, 193
 information about, 260
 on LTI, 197–207

maintenance, of linked open data, 6

makerspace
 bots for library instruction in, 218
 IoT-specific workshops at library, 24
 library as novel technology space, 70
 VR in library and, 111–112

malicious content, 217

MALLET (Machine Learning for Language
 Toolkit), 85

malware, 60

Manakin framework, 140

Mandell, Laura, 128

manifest, 187–188, 189

MAP (Metadata Application Profile), 9

MARC records, 175

MarcEdit, 216

Margulies, 34

Mary Washington University, 130

master files, 172, 173

Matomo, 143–144

Mauldin, Sarah K. C., 100

“Maximizing Assets and Access through
 Digital Publishing: Opportunities and
 Implications for Special Collections”
 (Engseth & Ragnow), 167–177

McAndrew, Chuck, 68

McCartney, Paul, 112

Mellon Foundation, 133

Memento links
 function of, 34–35

- Memento links (cont.)
 reference rot prevention, 36
 of web resources, 37
- Mentor Public Library of Ohio, 216
- Merge VR, 114–115
- metadata
 for access repository material, 155
 for archival repositories, 161–162
 for digital repositories, 159, 164
 digital repositories, trends in, 142–144
 information visualization for, 94
 for large-scale linked data in libraries,
 7–10
 for linked open data, 5–6
 for preservation repository materials, 157
 research in future with linked open data,
 13–14
 web archiving considerations, 47
- Metadata Application Profile (MAP), 9
- Metadata Object Description Schema
 (MODS), 138
- Microsoft
 in PDA market, 242
 platform lock-in, web archiving and, 50
 virtual assistant for Cortana, 213
- Mindmeister, 99
- Mirador viewer
 IIIF use cases, 188, 189
 images in, 183
- Mirai botnet, 25
- misinformation, 217
- Mitchell, Tom M., 224
- ML
 See machine learning
- mobile infrastructure, 249
- mobile learning, 245
- mobile technology
 definition of, 241
 early adopters of, 245–247
 future library with, 250–253
 future trend of, 247–250
 history of development of, 241–243
 impact on IT industry, 243–244
 impact on libraries, 244–245
 networks, generations of, 243
- “Mobile Technology” (Xu & Jin), 241–253
- mobile users, 252–253
- mobile-dependent people, 245
- MODS (Metadata Object Description
 Schema), 138
- Moodle, 198, 201, 204
- Morgan, Eric Lease, 134
- Morrone, Melissa, 69
- Motorola, 242
- Murray Hill Middle School Library,
 Maryland, 23
- N**
- Nadella, Satya, 214
- named entity recognition, 85–86
- Named Entity Recognizer (NER), 85–86
- National Archives and Records
 Administration (NARA), 162,
 171
- National Digital Stewardship Alliance
 (NDSA), 146
- National Library of France, 191
- National Library of Israel, 191
- National Library of Norway, 191
- National Science Foundation (NSF),
 144–145
- Natural Language Processing (NLP), 85
- natural-language processing, 234
- navigation, 26–27
- NDSA (National Digital Stewardship
 Alliance), 146
- Neal, James, 235
- needs assessment
 for privacy-protection technology
 tools, 61
 for web archiving program, 45–46
- Neil, Alison, 203–204
- NER (Named Entity Recognizer), 85–86
- networks, security tools for, 63–66
- neural networks, 228–230
- New York Public Library, 214, 247

New York Times
 on Facebook and VR, 116
 Google Cardboard and, 114
 NYT Politics Bot, 217
 New York University (NYU), 69
 news, preservation systems for, 31
 news organizations, 36
 newspapers, 44, 126
 Nielson, Jakob, 29
 NLP (Natural Language Processing), 85
NMC Horizon Report: 2013 Higher Education Edition (Johnson et al.), 246
NMC Horizon Report: 2014 Library Edition (Johnson, Becker, Estrada, & Freeman), 246
 North Carolina State University Libraries
 data visualization workshops, 100
 IoT-specific workshop at, 24
 Notre Dame Center for Civil and Human Rights, 132
 Notre Dame's Hesburgh Libraries, 126, 131–133
 NSF (National Science Foundation), 144–145
 “NYC Digital Safety: Privacy & Security” initiative, 69
 NYPL Postcard Bot, 217

O

OAIS (Open Archival Information System), 162
 OAuth, 200
 Oculus Rift, 115
 Oculus VR, 109
 OERs
 See open educational resources
 Olney, Austin, 107–117, 260–261
 Omeka
 Honeycomb platform and, 131
 IIIF use cases, 189
 Omeka S, 12
 omnidirectional content, 112, 116

Online Computer Library Center (OCLC)
 BiblioGraph.net extension, 10
 ContentDM, 141
 open access, 154
 open access (OA) journals, 33
 Open Archival Information System (OAIS), 162
 Open Archives Initiative Protocol for Metadata Harvesting (OAI-PMH), 160
 open data
 See linked open data
 open educational resources (OERs)
 adoption of, LTI and, 202–203
 from institutional repositories, 154
 LTI applications for lower costs, 206–207
 Open Graph, 9–10
 open licensing, 6
 open source
 digital repositories, early adopters of, 141
 repository systems, 138–140
 OpenAI movement, 235
 OpenML movement, 235
 outreach, 176, 218
 outsourcing, 45–46
 OWL (Web Ontology Language) vocabulary, 5
 ownership
 access repository materials and, 156
 of data, 232
 Oxford University, 191

P

Palm Computing, 242
 Pandorabots, 219
 partnerships
 archival repositories and, 163
 digital publishing case study, 173–174
 See also collaboration
 password managers, 66
 patch crawl, 47
 pattern recognition, 230–231

- Pattueli, Cristina, 11
- paywall, 173–174
- PC Part Picker, 115
- PDA, 242
- Perma.cc
 - reference rot prevention, 36
 - as tool for link rot, 33, 34
 - web archiving work of, 35
- personal assistants
 - bots for library instruction, 218
 - development of, 213
- personalization
 - accessibility issues, 102–103
 - with LTI, 199, 207
 - privacy issues, 103
- Pew Research Center, 217, 245
- Philips, 20
- pie chart, 75
- Piktochart, 99
- planetary scanning systems, 172
- platform lock-in, 50
- platforms
 - AMD partnerships with, 172–173
 - bots, interaction with, 215
 - for data repositories, 145–146
 - digital humanities/digital exhibit platforms, tools for, 128–130
 - for digital publishing, 169, 170
 - Honeycomb platform, 131–133
 - IIIF interoperability and, 189–190
 - platform lock-in, web archiving and, 50
 - See also* digital repositories
- Playfair, William, 75
- PlayStation VR, 115
- plug-ins, 61–63
- Posner, Miriam, 130
- POWRR (Preserving Digital Objects with Restricted Resources), 53
- predictive analytics, 102
- Presentation API
 - audiovisual materials and, 191–192
 - function of, 184
 - manifest, 186
 - publication of, 190
- preservation
 - data repositories for, 145
 - digital repositories for, 153–154
 - link rot, solutions for, 33–35
 - link rot/web archiving and, 32–33
 - reference rot/link rot and, 31
 - in web archiving, 45
- preservation copies
 - of digital file, 153–154
 - uncompressed/lossless compression, 157
- preservation repositories
 - function of, 153–154
 - future directions for, 161
 - key features of, 156–159
- Preserving Digital Objects with Restricted Resources (POWRR), 53
- printers, 24
- privacy
 - always-on assistants and, 23
 - information visualization and, 103
 - IoT's implications for, 24–26
- Privacy Badger, 62
- privacy-protection technology tools
 - for account credentials/data, 66–67
 - IMLS support for early adopters, 69
 - librarian's role in explaining, 59–60
 - libraries of future of, 69–71
 - libraries' role in, 60–61
 - security while traversing networks, 63–66
 - Tor in libraries, 67–68
 - for web browsing/browser safety, 61–63
- “Privacy-Protection Technology Tools: Libraries and Librarians as Users, Contributors, and Advocates” (Maceli), 59–71
- probability, 225–228
- processing power, 115
- professional development, 101
- programming languages, 200
- Project Counter, 143

- Proteus VR Labs, 113
- public service data, 92–94
- publishers
- on Apple's e-book platform, 246–247
 - web archiving, collaboration for, 52
 - See also* vendors
- publishing
- digital content through third-party vendors, 168–170
 - by digital repositories, 147
 - See also* digital publishing
- Python, 130, 215
- Q**
- quality control, 47
- R**
- radio telephony, 241–242
- Ragnow, Marguerite, 167–177, 261
- RAMP (Repository Analytics and Metrics Portal), 143
- rapid capture, 171–172
- Ravel Law
- visual interface of, 76–77
 - visualizations of court cases, 83–85
- RDA (Resource Description and Access), 8
- RDF (Resource Description Framework), 6, 142
- RealAudio, 49
- Reclaim Hosting, 130
- recommender systems, 232
- redundant backups, 158
- reference rot
- conclusion about, 37–38
 - with content drift/link rot, 30
 - legal implications for, 31–32
 - prevention, future of, 36–37
 - in scholarly communication, 31
 - solutions for, 33–35
- RelFinder, 7
- Renaissance Computing Institute, 96
- repositories/access
- digital libraries portfolio, 123–134
 - digital publishing, 167–177
 - digital repositories, 153–165
 - digital repositories, systems perspective, 137–148
- Repository Analytics and Metrics Portal (RAMP), 143
- repository systems
- DSpace, 139–140
 - EPrints, 140
 - Fedora 4, 138–139
 - hosted solutions, 141
- research
- data, trends in, 144–146
 - IIIF's impact on, 192–193
 - scholarly output, digital library and, 125
 - virtual research ecosystems, 147–148
- research data repositories, 138, 144–146
- “Research Help” tool, 205, 206
- research journal, 43–44
- Research Libraries Group (RLG), 162
- researchers
- digital access repositories and, 155–156
 - web archives access for, 53
 - web archiving, collaboration for, 52
- “Resilience and Engagement in an Era of Uncertainty” (Lynch), 31
- Resistbot, 220
- resource description, 7–10
- Resource Description and Access (RDA), 8
- Resource Description Framework (RDF), 6, 142
- resource discovery, 13–14
- responsibility, for web archiving, 50–51
- responsive web design, 245
- RFID tags
- in future library collections, 27
 - for Internet of Things, 18–21
 - IoT, library use of, 21–24
 - for libraries, benefits of, 21–22
- Rhodes, John S., 29–30, 38
- Rhodes, Sarah, 32
- RightsStatements.org, 9
- risks, 113

RLG (Research Libraries Group), 162
 Robert Morris College, 216
 robot, 212
 robot.txt files, 52
 Rosenfeld, Jennifer, 94, 96
 routing, 65
 Rowling, J. K., 4–5
 Russell, John E., 128

S

safety recommendations, 113–114
 SAGE Publishing, 171
 “sameAs” predicate, 5
 Samsung Gear VR, 114–115
 Samvera, 12–13, 139
 Sanchez, Anthony, 130
 Santa Rosa Junior College, 202
 scans, 171–172
 Schema.org, 9–10
 scholarly communication
 in evolution of digital library, 125
 institutional repositories for, 142, 154
 institutional repositories, future directions for, 160–161
 libraries as publishers of, 133
 reference rot in, 31
 School of Electronics and Computer Science at the University of Southampton, 140
 scope, 46
 Scott, Dan, 13
 search
 Gale Topic Finder, 77–80
 IV for visual search and browse, 94–96
 JSTOR’s Topic**graph**, 81–83
 with linked open data, 13–14
 Ravel Law visualizations of court cases, 83–85
 visual search tools, future of, 101–102
 in web archiving process, 46
 search engine optimization (SEO), 144
 Seattle Central Library, 92, 93, 94

security
 IoT and, 24–26
 of mobile devices, 249
 of preservation repository, 157
 Sedol, Lee, 231
 SeeCollections (web application), 94
 seed, 46, 47
 selection, 45
 self-checkout systems, 21–22
 SELIDA project, 20
 semantic search, 4
 SEO (search engine optimization), 144
 services
 data for discovery, 75–86
 information visualization, libraries and, 89–104
 privacy-protection technology tools, 59–71
 virtual reality, 107–117
 Sewell, Jeanette Claire, 211–221, 261
 shelf organization, 22
 Shevat, Amir, 219
 Shneiderman, Ben, 76
 Simon (smartphone), 242
 Siri, 23, 213
 Sirico, 34
 Sisk, Matthew, 134
 Slack, 214, 220
 “smart” light bulbs, 20
 smartphones
 history of, 242–243
 impact on IT industry, 243–244
 IoT, library use of, 22, 23
 personal assistants/apps for, 213
 practices for early adopters, 245–246
 SMO (social media optimization), 144
 SNAC (Social Networks and Archival Context) Cooperative, 11–12
 social media
 bots, misinformation spread by, 217
 bots for, 213–214
 dynamic content, as challenge for web archiving, 49

preservation of materials, 36
 VR and, 109
 web as venue for new media
 objects, 44
 social media optimization (SMO), 144
 social networking
 data, ownership of, 232
 impact of mobile technology on, 244
 institutional repositories and, 161
 VR in future and, 116
 Social Networks and Archival Context
 (SNAC) Cooperative, 11–12
 software
 for archival repositories, 161
 bots and, 215
 for data repositories, 145–146
 for digital publishing, 170
 for digital repositories, 159, 163
 IoT integration and, 20–21
 IoT security concerns and, 25–26
 for link rot, 33–35
 privacy-protection tools, 59
 that supports digital libraries, 123
 for web archiving, 45–46, 52
 Southwick, Silvia, 10–11
 SPARQL (PARQL Protocol and RDF Query
 Language), 6
 special collections
 digital publishing case study, 173–176
 digital publishing, conclusion about,
 176–177
 digital publishing through third-party
 vendors, 168–170
 IIIF and, 182, 188–190
 inside-out model and, 168
 investments in, 181
 library collaboration with faculty for,
 127–128
 linked open data in, 10–12
 opportunities for sharing, 167
 tools for linked open data, 12–13
 speech-to-text tools, 234
 Spotlight, 131, 132

Springshare LibGuides, 205–206
 staffing issues, 174–175
 Stager, Gary, 111
 standards
 IIIF, 181–193
 as technical challenge for web archiving,
 48–49
 Stanford University
 IIIF initiated by, 190–191
 Named Entity Recognizer, 85–86
 statistics
 as experience for machine learning,
 225–228
 institutional repository, usage statistics
 for, 142–144
 IV for library usage/public service data,
 92–94
 STEM, 192
 stereoscope, 108–109
 storage
 for archival repositories, 161
 for digital assets, 173
 for digital publishing, 170
 for digital repositories, 164
 preservation repositories for, 156–159
 Storymap JS, 99
 Student Messenger, 246
 students
 LTI applications for lower course
 materials costs, 206–207
 mobile technology use by, 244–245
 subject-area repositories, 137
 Suomela, Todd, 43–54, 261
Superintelligence: Paths, Dangers, Strategies
 (Bostrom), 232
 supervised learning, 227
 symbols, 224–225

T
 Tableau, 99
 tablets
 Apple iPad, 242–243
 direct manipulation, 76

tablets (cont.)

- IoT devices and, 20, 24
- mainstream use of, 246

Tails, 66

TDR (Trusted Digital Repository), 162–163, 164

teacher noise, 232

teachers

See faculty

technical architecture, of LTI, 200–201

technical infrastructure, 45–46

technologists, 52

technology

- for digital publishing, 169–173, 177
- of Internet of Things, 18–21
- libraries and innovation, 108–110
- LTI technical architecture, 200–201
- predictions/outcomes, xi–xii
- waves of technology in libraries, 233–234

temporal context information, 34–35

Tensorflow, 235

Texas A&M University, 246

text clustering, 85

text encoding, 127–128

text mining, xi

textbooks, 206–207

therapy, 112

third platform

- future of, 249
- switch to, 244

third-party vendors

- digital publishing case study, 173–176
- digital publishing through, conclusion about, 176–177
- publishing digital content through, 167–170

3-D printing

- IIIF and, 192
- IV as library service, 96–97
- of VR headset, 115

three-part statements, 4

TimeMapper, 99

tools

- bot tool kit, 219
- for digital humanities, 128–130
- for fixity checks, 158
- Honeycomb platform, 131–133
- for information visualization, 98–99
- for IoT integration, 20–21
- for IoT use in libraries, 21–24
- link rot, solutions for, 33–35
- for linked open data, 12–13
- privacy-protection technology tools, 59–71
- for visualized interfaces, 85–86

Top Technologies Every Librarian Needs to Know (Varnum), xi–xii

Topic Finder, Gale, 77–80

Topic**graph**, JSTOR, 81–83

Tor

- anonymity network, 65
- in libraries, program for, 67–68
- for network security, 65–66
- relays, library privacy protection contributions, 71
- relays, routing traffic through, 65

T-PEN, 188

TRAC (Trustworthy Repositories Audit & Certification: Criteria and Checklist), 162

Tracery library, 219

tracking, 70

training

- digital-privacy training in libraries, 69
- for IV tools, 98, 100
- of library staff in VR, 114
- for LTI tools, 206
- See also* education

triples

- description of, 4–5
- standards for expressing, 6

Trump administration, 32–33

Trusted Digital Repository (TDR), 162–163, 164

Trustworthy Repositories Audit & Certification: Criteria and Checklist (TRAC), 162
 Tufte, Edward, 91
 Tukey, John, 90
 Turing, Alan, 225
 Turing test, 225
 tutorials, 100
 Twitter
 API rate limit, 215
 archive at Library of Congress, 48, 53
 bot tools for, 219
 bots on, 214, 217

U

UBlock Origin, 62
 uncertainty, 225–228
 Underwood, Ted, 134
 Uniform Resource Identifier (URI)
 IIIF functions and, 184
 link rot, prevention of, 14
 Linked Jazz Network Visualization Tool, 11
 linked open data in triple databases, 5
 reference rot in scholarly communication, 31
 Uniform Resource Locator (URL)
 link rot/reference rot and, 30–32
 LTI for access to library materials, 198
 permanent, for link rot prevention, 34
 reference rot prevention, 36
 in web archiving process, 46
 United States, data protection laws in, 60
 University of Arizona Libraries, 130
 University of Brighton, 246
 University of California, Davis, 94, 96
 University of California, Los Angeles, 130
 University of Central Florida Library, 246
 University of Houston, 96
 University of Illinois at Urbana–Champaign Library, 8
 University of Maryland, 247
 University of Massachusetts, 85

University of Michigan Library and Press, 133
 University of Minnesota (UMN) Libraries
 digital delivery modes, platforms, products, 169–170
 digital publishing case study, 173–176
 technology for digital conversion projects, 170–173
 University of Nebraska–Lincoln, 216
 University of Nevada, Las Vegas (UNLV), 10–11
 University of New South Wales, 203–205
 University of North Carolina, 130
 University of North Carolina at Chapel Hill, 94, 96
 University of Patras Library, Greece, 20
 University of Toronto Libraries (UTL)
 IIIF, how it works, 184–188
 IIIF early adopters, 190–191
 IIIF projects, 182
 IIIF use cases, 188
 impact of IIIF on digital special collection repositories, 188–190
 University of Toronto Scarborough, 7
 University of Virginia, 138
 University of Wisconsin–Milwaukee, 100
 unsupervised learning, 228
 upload
 of digital repository materials, 159
 of publications into institutional repository, 160–161
 URI
 See Uniform Resource Identifier
 URL
 See Uniform Resource Locator
 US Supreme Court, 34
 usage statistics, 142–144
 use cases
 IIIF, 188–190
 LTI, 197, 198–200
 user interface
 See interface

users

- customer relationship management in
 - future libraries, 250–251
- data, ownership of, 232
- future library end users, 252–253
- LTI technical architecture and, 200
- personalization with LTI, 199
- privacy, information visualization and, 103
- privacy protection for, libraries and, 70–71
- privacy protection, lack of, 59
- VR, risks/health considerations, 113–114
- VR in library and, 110–113
- Utah State University, 205–206

V

- Vandegrift, Micah, 124
- Varian, Hal, 91–92
- vendors
 - collaboration for digital repositories, 163
 - digital publishing case study, 173–176
 - digital publishing through, conclusion about, 176–177
 - publishing digital content through
 - third-party vendors, 167–170
- VeraCrypt, 66
- Viral Texts Project, 126
- virtual conferencing rooms, 116
- Virtual International Authority File (VIAF), 8
- virtual library
 - in evolution of digital library, 125
 - users, 252
- virtual private network (VPN), 63–65, 71
- “Virtual Reality: Out of This World” (Olney), 107–117
- virtual reality (VR)
 - demand for, 107–108
 - description of, 108
 - development of, 108–109
 - future of in libraries, 116–117
 - in libraries, logistics of incorporating, 113–115

- in libraries, possibilities for, 110–113
 - libraries and innovation, 108–110
 - virtual research ecosystems, 147–148
 - virtual spaces, 111
 - Viscoll, 189
 - vision
 - accessibility of IV, 102–103
 - communication through, 91
 - The Visual Display of Quantitative Information* (Tufte), 91
 - visual perception, 91
 - visual search tools, 101–102
 - visualization
 - history of, 90–91
 - Linked Jazz Network Visualization Tool, 11
 - tools for creating, 7
 - See also* data visualizations; information visualization
 - visualized discovery interfaces
 - development of, 76–77
 - Gale Topic Finder, 77–80
 - JSTOR’s Topic**graph**, 81–83
 - precursors to, 75–76
 - Ravel Law visualizations, 83–85
 - tools for creation of, 85–86
 - vocabularies
 - of BiblioGraph.net, 10
 - external relationship vocabularies, 11
 - for resource description, 8
 - of URIs, 5
 - voice-activated personal assistants, 213, 218
 - voice-recognition technology, 26
 - Voyant Tools, 85, 99
 - VPN (virtual private network), 63–65, 71
 - VR
 - See* virtual reality
 - VR viewers, 114–115
- W**
- waiver, 113–114
 - WARC (Web ARChive) file format, 46–47
 - Watters, Audrey, 33

- Waugh, Mike
 on access to library materials, 198
 EBSCO Curriculum Builder at Louisiana
 State University, 201–202, 207
 web address, 5
 web advertising, 50
 Web ARChive (WARC) file format, 46–47
 web archives
 accessibility of, 53
 conclusion about, 53–54
 definition of, 44–45
 institutional challenges for, 50–52
 starting/operating, 45–47
 technical challenges for librarians, 48–50
 web, librarian views of, 43–44
 web archiving
 automated, 36
 conclusion about, 37–38
 decentralized, link rot and, 30
 definition of, 44–45
 link rot, libraries and, 32–33
 link rot, solutions for, 33–35
 reference rot prevention, 36–37
 web browser, 61–63
 web crawler
 limited number of, 48
 standards and, 49
 web archiving process, 46–47
 Web Ontology Language (OWL) vocabulary, 5
 web seeds, 48, 53
 websites
 full-service, Reclaim Hosting for, 130
 mobile technology and, 245
 responsive websites for mobile
 technology, 248
 “Websites That Heal” (Rhodes), 29–30, 38
 Webster, Jessica Wagner, 153–165, 261–262
 Westgard, Joshua A., 137–148, 262
 Whalen, Zach, 215, 219
 “What Is Digital Humanities and What’s It
 Doing in the Library?” (Vandegrift),
 124
 Wheatstone, Charles, 108–109
 White, Justin M., 29–38, 262
 Whitehouse.gov, 32
 Wikidata, 3–4
 Wikipedia
 bots, use of, 212
 link rot and, 32
 LTI application, 197
 Wikidata, linked open data, 3–4
 Wilson Center, 94, 95
 Wingfield, Nick, 116
 Woodson Research Center Special
 Collections and Archives, 217
 WordPress, 33
 workflow automation tools, 20–21
 workshops, on information visualization,
 100
 World War II, 241–242
 World Wide Web
 views of from librarian perspective,
 43–44
 in web archiving definition, 44–45
 See also Internet
 WorldCat, 10
- X**
- XML (Extensible Markup Language), 6
 Xu, Gordon F., 241–253, 262
- Y**
- Yale Centre for British Art, 192
 Yale University, 127
 Yewno, 77
- Z**
- Zapier, 20–21
 Zittrain, Jonathan, 31–32
 Zuckerberg, Mark, 109