Chapter 12

Using IBM Watson for Discovery and Research Support:

A Library-Industry Partnership at Auburn University

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Introduction

Researchers at the Auburn University Libraries are collaborating with cross-campus units and private companies to explore the application of artificial intelligence and machine learning (AI/ML) tools to scholarly repositories, structured and unstructured datasets, and the open web. The goal is twofold: to develop hands-on AI/ML expertise in the libraries and to better position the libraries to support and participate in Auburn University's research activities.

This chapter describes an exploratory project the libraries are working on with the IBM Research Triangle Park Center for Advanced Studies (IBM RTP-CAS) on using the IBM Watson Studio of AI/ML services to build natural-language query interfaces for scholarly repositories and datasets in specific subject domains. Since 2017, the libraries have been providing high-level information technology support and subject-matter expertise to the Military REACH Project, which is based in the College of Human Sciences (CHS) at Auburn University and funded by the US Department of Agriculture and the

US Department of Defense. The mission of the Military REACH Project is to support US military families and family readiness by translating academic research and other resources into practical applications. A key component of the project is the design and development of a publicly accessible, easy-to-navigate library of research publications and other resources on military life and family health, delivered through a user-friendly website. With IBM's help, the Watson suite of tools and services is being used to build an AI/ML-powered query interface and recommendation system for the Military REACH Library and public datasets in the same field.

In this chapter, the authors discuss the larger library and professional context for this project, its background and rationale, the deliverables they are producing, and the technical, logistical, and administrative challenges that they have encountered in this effort. The goal is to provide other academic libraries with a model for embarking on similar projects and a clear understanding of the benefits and challenges involved.

Setting the Context: AI/ML and Academic Libraries

The past five years have seen an increasing number of articles, technical reports, white papers, and webinars on the implications of AI/ML for libraries in general and academic libraries in particular. Early pieces on AI/ML and libraries were mostly speculative or theoretical in nature. They focused on what AI/ML might mean for academic libraries and information work in general. More recently, the discussion has expanded to include working examples of how AI/ML is being used in library applications and the establishment of dedicated AI laboratories in academic libraries.

Writing in 2016, Peter Fernandez of the University of Tennessee Libraries identified seven library functions that will be affected or enabled by AI: discovery, cataloging and metadata creation, translational reference, interpretation collection analysis and development, and storage and inventory management.[1] UK-based researchers Andrew Cox, Stephen Penfield, and Sophie Rutter covered some of the same territory in a 2019 article on "the intelligent library."[2] They interviewed thirty-three stakeholders inside and outside the academic library community on the implications of AI for academic libraries, issues arising from the use of AI applications, and the role of academic libraries in supporting and using AI. Among the possible library roles identified by interviewees were: procuring or creating content for AI/ML services; procuring or designing AI tools; performing data curation, quality control, and analysis; designing data infrastructure; teaching critical data literacy; serving as navigators to the new information environment; and writing AI algorithms.[3]

Kenning Arlitsch and Bruce Newell, however, argued in a 2017 article that AI/ML will almost certainly have substantial disruptive effects on library operations and library employment. Citing a much-referenced paper on computerization and the future of employment by Frey and Osborne, Arlitsch and Newell observed that certain library tasks or operations were at risk of being replaced by robots.[4] They argued that librarians

need to start acquiring "quantitative and analytical skills to learn the value of big data" and "make the machines work for us."[5] They left open the question of whether this is a realistic goal for the current generation of librarians, whose training and career paths have largely been determined by traditional MLIS programs.

Perceptions of and attitudes toward AI/ML in the library community have shifted from complacency to urgency in the past several years. In a 2018 article on the results of a survey they conducted, Barbara Wood and David Evans at Kennesaw State University identified "an overwhelming sense of complacency among librarians" about the disruptive effects of AI. Although 56 percent of the more than 300 librarians who responded to the survey answered in the affirmative when asked, "Do you think supercomputers like [IBM] Watson will have a transformative effect on librarianship?", almost 44 percent believed that AI would have no or not much effect on the profession. At the same time, most librarians surveyed put the probability of AI/ML solutions like IBM Watson being used in libraries at 50 percent by 2027 and 90 percent by 2047.[6]

The combination of big data and AI/ML raises serious ethical and policy questions in almost every area of society. Librarianship and information management are deeply implicated in these questions. Library observers have identified a number of ethical issues and dangers associated with the irresponsible or maladroit use of AI/ML for library applications. The main ones have to do with promoting or contributing to misinformation, "fake news," algorithmic bias, violations of patron privacy and the possibility of high-tech surveillance, and "perpetuat[ing] existing forms of structural inequality."[7] In 2019, the Association of Research Libraries devoted a special report to libraries and the ethics of artificial intelligence.[8]

A growing number of libraries are moving beyond AI/ML theory to practice. Examples include the Stanford University Libraries AI Initiative and AI Studio; the University of Rhode Island AI Lab, which is based in the URI Library; Andromeda Yelton's AI/ML-driven HAMLET (How About Machine Learning Enhanced Theses?) interface at MIT ("the first machine learning system developed by a library and deployed to production in a library anywhere in the US," according to Jason Griffey)[9]; and other AI/ML-driven projects at academic, public, and municipal libraries in the United States, United Kingdom, and Europe.[10]

Furthermore, academic and public libraries in the United States and the UK have implemented Yewno Discover, a commercial AI-driven system dedicated to "transforming information into knowledge."[11]

The Auburn University Libraries as an AI/ML Testbed

The Auburn University Libraries represent a promising testbed for artificial intelligence and machine learning projects. Established in 1856, Auburn University is a land-grant university in east-central Alabama specializing in agriculture (including fisheries and forestry), architecture, business, engineering, and the applied sciences. In early 2020, the

Auburn University Libraries formed a new Research Support Department offering an array of services in twelve areas, including research data management, grant funding and proposal development, digital scholarship and digital humanities, maximizing research impact and visibility, and IT tools and consulting. As part of this effort, the Auburn University Libraries recently constructed an Innovation & Research Commons (I&RC) on the ground floor of the main library. Among other things, the I&RC has a data services hub—the DataSpace—offering on-site expertise in using big data sets and AI/ML.

The Auburn University Libraries also joined the FOLIO Product Council in 2017 and are contributing subject matter expertise and software developer time to the project. Launched in 2016 by EBSCO Information Services, Index Data, and the Open Library Environment (OLE) consortium of academic libraries, the FOLIO Project is an ambitious international initiative to build an open source library services platform (LSP) consisting of discrete, interchangeable applications for core library functions (acquisitions, cataloging, circulation and patron management, and reporting) that can also be linked to or integrated with other content management systems (e.g., archival management systems).[12] FOLIO has shown that libraries and industry partners can build paradigm-shifting open source software applications on an enterprise scale. Combining the FOLIO core platform with AI/ML tools offers some intriguing possibilities for extending FOLIO's capabilities.

The Auburn University Libraries have had a longstanding customer relationship with EBSCO Information Services. Due to the libraries' participation in the FOLIO Project and its involvement in two National Science Foundation (NSF) Convergence Accelerator proposals, this relationship has expanded to include a research and development component, with EBSCO and the libraries working together on R&D projects of mutual interest. The NSF proposals also led to a research partnership between the Auburn University Libraries and the IBM Watson Team at the IBM Research Triangle Park Center for Advanced Studies. The partnerships with EBSCO and IBM have made it possible for the authors to explore applying AI/ML tools to current library priorities, such as developing tools and services that directly support the university's research goals.

These factors were instrumental in the decision to embark on an exploratory project using a commercial AI/ML solution. The project in question applies the IBM Watson suite of AI/ML services to the Military REACH Library. The project began in early 2020 and is still in progress at the time of writing.

The Military REACH Project and IBM Watson

As academic libraries seek new ways to align with current university research practices and to engage as vital partners in campus research activities, the Auburn University Libraries have built a successful partnership with the Auburn University College of Human Sciences (CHS) on an externally funded research initiative: the Military REACH Project.[13] The mission of the Military REACH Project is to support US military families and family readiness by translating academic research and other resources into practical applications.

This means making research both accessible to and usable by Department of Defense (DoD) family support specialists and military families themselves.

Originally based at the University of Minnesota, Military REACH moved to Auburn in late 2017 as the result of a successful proposal in response to a competitive funding solicitation from the Department of Agriculture (USDA) and the DoD. At the invitation of the project's principal investigator, Dr. Mallory Lucier-Greer of the CHS Department of Human Development and Family Studies, the libraries contributed their knowledge and expertise to the successful funding proposal that brought the Military REACH Project from Minnesota to Auburn. From the beginning of the project, the libraries' Military REACH support team has worked with their counterparts in CHS and the project's leadership to build the robust IT and bibliographic infrastructure on which the project rests. This has included setting up and configuring Military REACH servers in the Auburn University OIT Data Center; creating the Military REACH Library in DSpace; assisting in the development and hosting of the Military REACH website; providing expert guidance on metadata standards, accessibility, usage statistics, and social media; training IT support staff in CHS on the tools used in Military REACH; and helping the Military REACH team transition gradually to a new IT support structure.

Among the questions that Military REACH is designed to answer are:

- How does military deployment impact child development outcomes?
- What parenting support programs are available for military parents?
- What challenges do veterans face after leaving the military?
- What factors help service members cope with PTSD?

The source for answering these and other questions is the Military REACH Library, a DSpace repository and bibliographic database of research publications and other resources on military life and family health. It currently contains more than 3,000 documents dating from 1971 through 2020, including approximately 1,300 Military REACH Research Summaries/TRIP Reports (detailed two-page abstracts of research articles from peer-reviewed journals), as well as longer research reports on issues affecting US military families. The Military REACH Library uses a standard DSpace search interface, with filters for publication year, publication type, focus terms, military branch of service, and age group. This type of interface is not well suited for answering the kinds of natural-language questions referenced above. To make the Military REACH Library even more accessible to its intended audience, a different approach is needed.

Enter IBM Watson. Named after IBM's first CEO, Thomas J. Watson, Watson is a suite of AI/ML software tools and services built around natural language processing (NLP), natural language understanding (NLU), image and video analytics, speech recognition, and more.[14] Originally developed in the first decade of this century as part of IBM's DeepQA project, Watson gained wide public attention when it competed against human contestants on the TV quiz show *Jeopardy!*, winning the first prize of $1 million in 2011. Today, Watson is used in health care, construction, education, finance, weather forecasting, fashion design, and other areas. Watson can be used to surface concepts, categories, sentiment, and emotion, and to apply knowledge of unique entities in the subject domain to the target data. With Watson Knowledge Studio (WKS), researchers can define

domain-specific ontologies and use them to enhance NLU engines for better responses. Other Watson services (e.g., text-to-speech/speech-to-text) can be used to build voice-based interfaces for AI expert systems.

The decision to use Watson for this project was inspired by the experience of working with researchers from the IBM Research Triangle Park Center for Advanced Studies on one of the NSF proposals referenced above. Although that proposal was unsuccessful, conversations with the IBM team suggested possibilities for using Watson on local repositories and datasets. The Military REACH Library was identified as an excellent candidate for an exploratory AI/ML project. The authors pitched the idea to the IBM RTP-CAS team in late 2019 and began working on it in January 2020.

The goal in the first phase of this exploratory project is to develop a Watson-driven natural-language query interface for non-copyrighted documents in the Military REACH Library. To that end, two of the services in the IBM Watson Studio, Watson Discovery and NLU, have been applied to a sample set of 1,285 PDF documents from the Military REACH DSpace repository. This involved the following operations:

Creating a Watson sandbox. Working with the Watson team at the IBM RTP-CAS in Raleigh, North Carolina, the AUL IT staff set up a complimentary Watson Discovery account in the IBM Cloud space. The account is for research purposes; access to it is currently limited to the project team members at the Auburn University Libraries and IBM RTP-CAS.

Document extraction. AUL IT staff extracted 1,285 non-copyrighted research summaries in PDF form from the Military REACH Library in DSpace and uploaded them as a research collection to the AUL Watson Discovery account in IBM Cloud (figure 12.1).

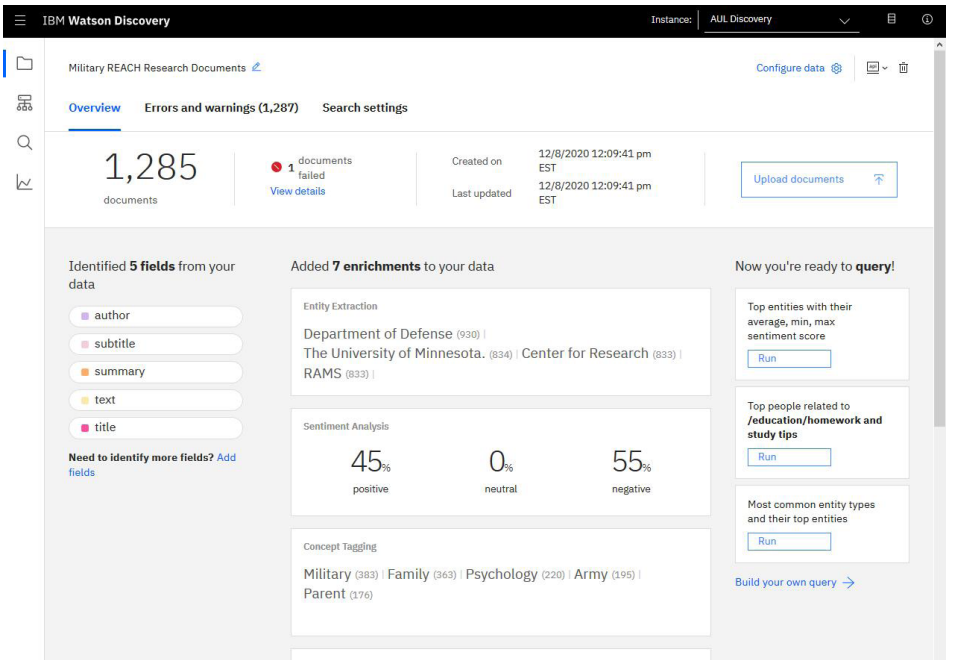

Figure 12.1
The Military Reach Research documents collection in IBM Watson Discovery.

The research summaries in the training dataset are structurally and semantically similar, with each of the automatically selected forty-four sample documents falling into one of two templates. Document sections are clearly delineated with headers and white space, which resulted in object identifications by Watson that were relatively unambiguous. This implies that such tools can more reliably identify fields and objects in otherwise unstructured data if the documents are formatted for human readability. While Watson can detect patterns corresponding to cohesive blocks of information within the document, it is up to the trainers to define which parts of the documents are of interest and how they should be represented. In this test case, the relative homogeneity of the data has allowed the authors to select field identifiers common to both document styles, which was important as the tool limits the number of custom fields they can create. Training Watson necessitates making judgments about which information should be highlighted or de-emphasized, as the tool is neutral toward which of the fields it identifies are worthy of focus. Depending on how it is trained, Watson could respond in multiple ways to the same underlying dataset, which means it is important to define the intended application before training begins.

Document markup and field identification. Using Watson Discovery's Configure Data tools, the authors applied color-coded field identifiers (for header, footer, image, text, title, author, summary, findings, implications, methods, and questions) to the forty-four Watson-selected sample documents in the Military REACH collection (figure 12.2).

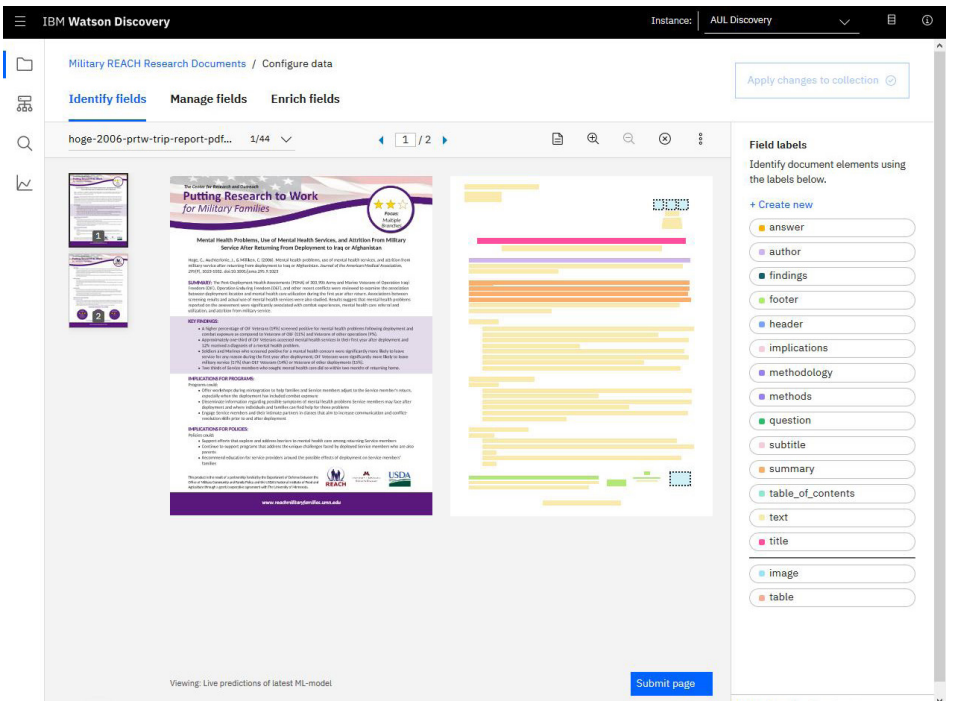

Figure 12.2
Document markup and field identification in IBM Watson Discovery.

Once the trainers have settled on a system for describing the underlying information in a useful way, the process of marking up the training documents themselves is straightforward. Field labels are selected and applied to box-shaped areas of the document that correspond to the underlying data. As the process continues with new examples, the tool begins to predict and assign labels to some objects within the training documents on its own, leaving the human trainer to correct any mistakes or apply labels to areas that were missed. For instance, if the first line of the document is marked as *title* frequently enough, the next document presented to the trainer might already have the box occurring in that area labeled as *title*, but it might not yet detect multi-line titles. In that case, the trainer would designate the box or two immediately below the first one as *title* until Watson "understands" that the end of the title is not the same as the end of the first line, but the beginning of the white space between sections. This type of work does not require extensive technical knowledge on the part of the trainer. It is important, however, for the trainer to understand what should be included and excluded from each field they are asked to assign.

Collection enrichment. Watson Discovery automatically enriches (adds cognitive metadata in JSON to) the text field in ingested documents with semantic information collected by four Watson NLU enrichment functions: entity extraction, sentiment analysis, category classification, and concept tagging. Using Watson Discovery's Configure Data tools, the authors added four more enrichment functions to the test collection: keyword extraction, relation extraction, emotion analysis, and semantic role extraction (figure 12.3).

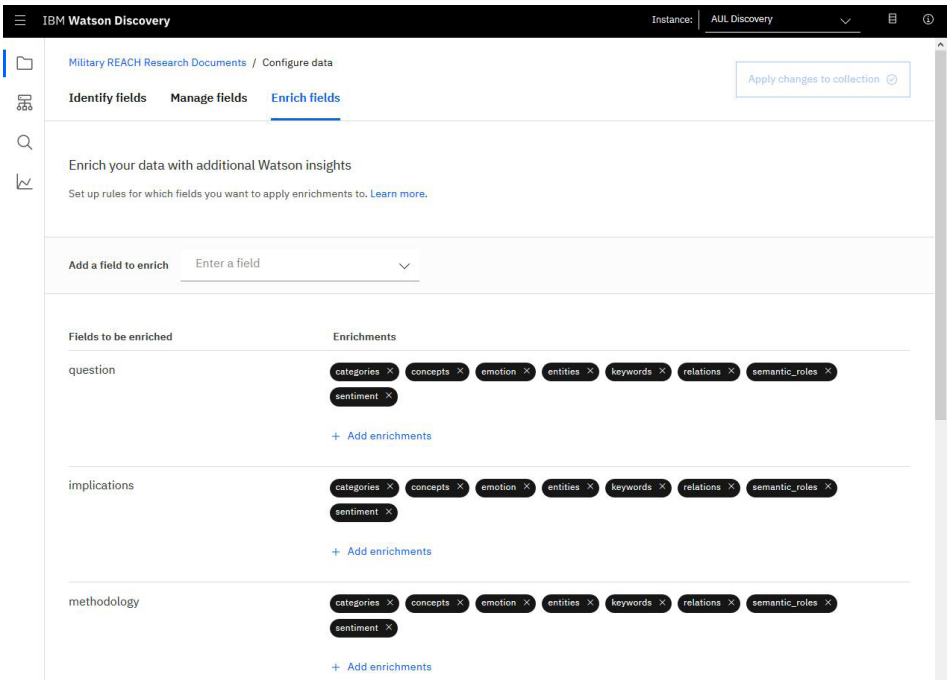

Figure 12.3
The Field Enrichment Tool in IBM Watson Discovery.

Building natural language queries. This is where the project stands at the time of writing. The authors are working with the principal investigator and subject matter experts on the Military REACH Project to identify natural language questions in this area and run them against the test collection to see whether the results are plausible or whether they fall into the category of what Andromeda Yelton has called "attractive nonsense."[15] Preliminary results using sample queries suggest that the documents that Watson is surfacing are clearly responsive to the test queries (figure 12.4).

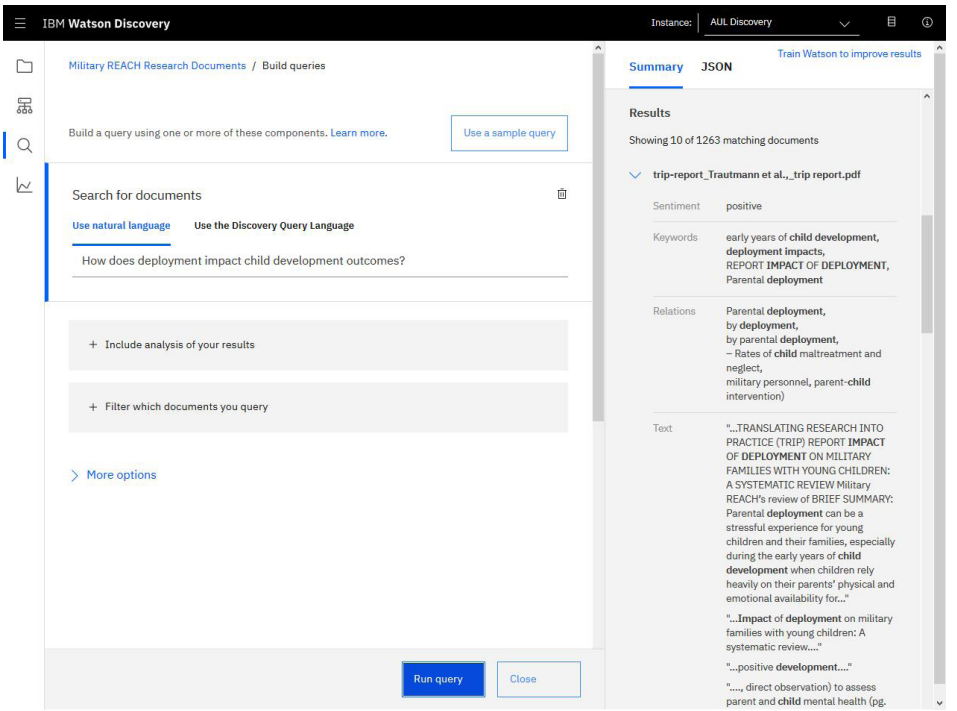

Figure 12.4
Preliminary results of a natural language search query in IBM Watson Discovery.

Next steps in this project include the following:

Adding more materials to the test collection. At 1,285 documents, the Military REACH test collection is too small to allow a proper assessment of Watson's capabilities. The authors have been using it primarily to become familiar with Watson's features and to identify stumbling blocks. An insufficiently large body of material is one of Yelton's "traps for the unwary."[16] This can be remedied by including documents from the Auburn University institutional repository (AUrora) and database of electronic theses and dissertations (AUETD). Taken together, these sources should add approximately ten thousand items to the test collection. Eventually, the authors intend to add materials harvested from the Public Library of Science (PLoS) and relevant public datasets from Data.gov.

Building a public-facing natural language query interface and recommendation engine. The user interface and content display are far from being ready for unveiling as an alpha version, much less a production version. The IT team is working with the

IBM Watson team on this, using APIs that have been developed for other collections. In addition, the Computer Science and Software Department in the Samuel Ginn College of Engineering at Auburn University is building a Senior Design Project around using IBM Watson Assistant to make the Military REACH Library more accessible to users. The same department is also working with the Military REACH team on using AI tools and techniques to search the scholarly literature for relevant publications and presentations for inclusion in the Military REACH Library. The authors hope to unveil an alpha version of the natural-language query interface in the second half of 2021. The long-term goal is to use IBM's speech-to-text/text-to-speech services to develop an AI-driven chatbot that service providers and military family members can access on their mobile devices or personal digital assistants.

Enlisting Military REACH and other subject matter experts in this field in training the system using IBM Knowledge Studio. This will be an iterative process as the authors add more material to the Military REACH test collection. Watson Discovery has a built-in training module that we intend to use for this purpose (figure 12.5).

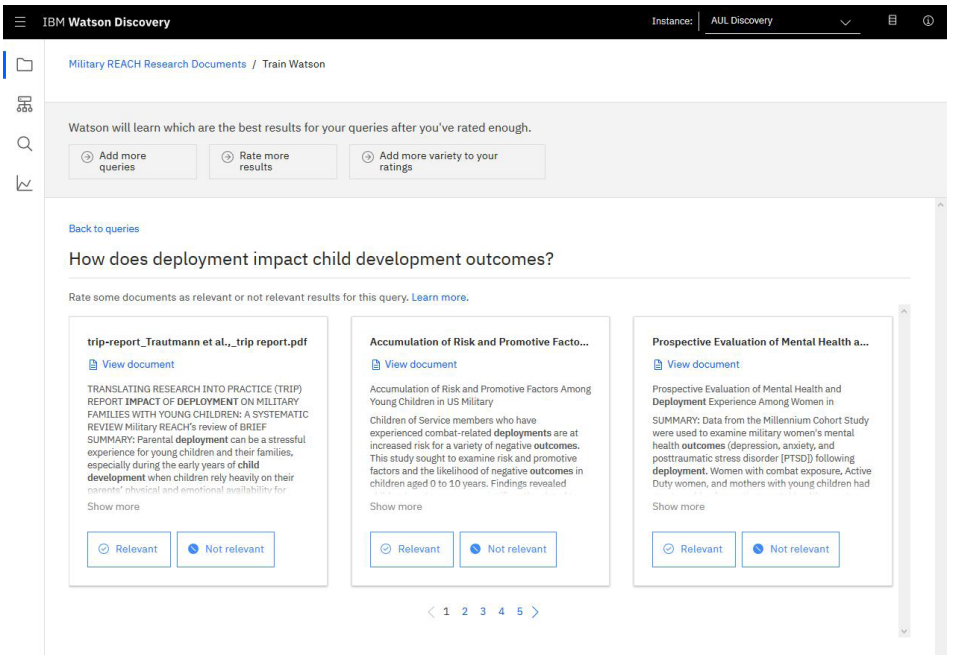

Figure 12.5
The IBM Watson Discovery training interface.

Lessons Learned

This project has been extremely instructive in highlighting the possibilities and challenges of AI/ML in academic libraries. Perhaps counterintuitively, the authors discovered that implementing AI/ML solutions is an extremely labor-intensive task. AI/ML tools still require extensive human intervention—for example, in the areas of document markup and

system training—in order to be effective. The human factor is still essential, which should be encouraging news for librarians who are worried about being replaced by AI-driven bots. Alternatively, it means that some, perhaps many, library jobs may become redundant or irrelevant, and currently employed librarians will have to learn a challenging set of new skills.

AI/ML solutions and tool suites are extremely complex and are often not turnkey solutions. Major DIY assembly is required in the form of IT support, system administration, collection markup and enrichment, training, and interface design. Libraries interested in working with AI/ML tools will need access to an IT department with a deep and varied skill set, either locally or at the institution level. Getting buy-in will be difficult or impossible if AI/ML projects do not connect directly to library or institutional priorities. Even if there is support for AI/ML projects, creating the necessary IT bandwidth will almost certainly be a challenge. Campus IT is also likely to be involved.

Another challenge for academic libraries is cost. Commercial AI/ML solutions are expensive. The tiered price schedule for a production-grade instance of IBM Watson Discovery, just one service in the Watson suite of services, starts at $500 per month.[17] The Auburn University Libraries were fortunate in having a well-established working relationship with IBM that allowed them to negotiate complimentary R&D platforms for the project. The authors were also fortunate in having a project that aligned with the company's product development plans. The authors expect that the terms of the conversation will change once they move into the production phase. Establishing mutually beneficial R&D relationships with vendors at the outset may enable libraries to negotiate more favorable deals for jointly developed platforms.

As with any technology, there is a concern about the potential for misuse and misinterpretation of results. The process of training AI/ML algorithms necessarily involves allowing them to process pieces of information to find emergent patterns that reflect the machine's understanding rather than a human's understanding. Librarians who help to develop and support such applications should be mindful to supply additional context when needed to assist users in understanding the proper scope of the tools and avoiding unwarranted leaps of logic.

Despite the challenges noted above, there are upsides to working on AI/ML projects. There is nothing like learning by doing and applying industry-strength AI/ML tools on real collections for real purposes. This was far more instructive and useful than learning about them in the abstract or in a classroom situation. The authors have a clearer understanding of how AI/ML tools work, what they can realistically be used for, what to watch out for (Yelton's "traps for the unwary"), and areas where they, and the use of them, can be improved.

This experience has equipped the authors to understand "how and what an outside vendor could be doing in the training stages" and to help ensure that commercial AI/ML products meet the needs of libraries.[18] In other words, it has reduced the *black box* factor, the opacity of AI/ML systems, that Griffey, Yelton, and other observers have identified. Trust is good, but informed, hands-on experience is better. Suggestions have already been made to the IBM Watson team for developing a more librarian- and user-friendly interface for Watson Discovery.

Conclusion

Despite missteps and missed targets, in the project's original timeframe, progress was made toward functional prototypes of a Watson-driven interface for the Military REACH Library. This project has already helped point the way for future development, enhancements, research collaborations, and (possibly) research funding proposals.

The experience with Watson has positioned the authors to help other researchers at Auburn explore the use of AI/ML tools in their own work, including the conceptualization and drafting of external funding proposals. This is directly in line with the university's and the libraries' research priorities and strategic goals.

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