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22 How Ex Libris Uses Artificial Intelligence and Smart Services to Transform Libraries

Abstract: Ex Libris is a member of the Clarivate group and with three decades of involvement in the business of academic institutions, libraries and technology companies, works closely with its stakeholder community, user groups and partners to provide services which manage access to and delivery of scholarly content and enhance goal achievement of the organisations and individuals concerned. Ex Libris is working to embrace generative AI and new technologies in the implementation of value-added products which ensure the effective, accurate and responsible implementation of new services by its client groups. This chapter explores some of the initiatives being examined and offered by Ex Libris.

Keywords: Library management systems; Artificial intelligence in libraries; Transformation; Information retrieval systems

Introduction

Ex Libris™, a part of Clarivate™, is a leading global provider of intelligent and forward thinking library solutions, empowering libraries, academic institutions and research organisations. With a rich history and an extensive portfolio, Ex Libris is at the forefront of technological advancements, including artificial intelligence (AI) serving a diverse customer base worldwide, comprising academic libraries, national libraries, library consortia, research institutions and museums. Ex Libris solutions are trusted by thousands of institutions in over 90 countries, enabling optimisation of operations, improvement of user experiences and smart, data-driven decisions by utilising best-fit modern technologies, such as AI.

> With three decades of continuous innovation and together with our global community of industry leaders from academic institutions, libraries, and technology powerhouses, we are embracing generative AI, linked open data and conversational discovery. Leveraging the latest innovation to optimize library management, research, teaching and learning across the entire higher education ecosystem (Ex Libris n.d.a).

With a strong commitment to innovation, Ex Libris' primary focus is ensuring that modern technologies such as AI are used to solve real challenges, resulting in exciting new developments in recent months. For example, over the past year stu-

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dents have increasingly incorporated the use of generative AI in their research and homework, often with unreliable results. In response, Ex Libris has developed the Primo Research Assistant which provides immediate answers to natural language queries and offers visibility into dependable resources and references, emphasising transparency, proper accreditation, and intellectual property rights. Ex Libris is also prioritising the automation of simple but time-consuming tasks for library staff with products such as Specto that harnesses AI technology to enhance metadata records for resources like digital collections, to expedite cataloguing and discovery of valuable insights and information.

By empowering libraries with cutting-edge technologies, Ex Libris plays a pivotal role in facilitating the discovery, access and preservation of knowledge in today's digital age. As part of its growth strategy, Ex Libris is continuously looking to develop exciting new opportunities and directions for libraries, made possible through the responsible implementation of new information technologies such as AI and machine learning (ML).

Clarivate is home to Ex Libris, Innovative™ and ProQuest™, as well as industry-leading solutions such as the Web of Science™, engaging students, research and faculty in all learning environments. A Clarivate data science team has been created to support Clarivate's mission to advance the success of people and organisations through transformative intelligence and trusted partnerships.

> Clarivate is a global leader in trusted and transformative intelligence. We bring together enriched data, insights, analytics and workflow solutions, grounded in deep domain expertise across the spectrum of knowledge, research and innovation. Whether it's providing insights to transform the water industry or accelerating the delivery of a critical vaccine, our aim is to fuel the world's greatest breakthroughs by harnessing the power of human ingenuity (Clarivate 2024a).

The organisation uses AI and other technologies to facilitate customer insights, enhance user experience and boost efficiency.

As part of the Clarivate family, Ex Libris benefits from the synergy with other best-in-class solutions, services and trusted content offered by Clarivate, a global leader in connecting people and organisations to intelligence. Clarivate curates trusted, diversified content and services; is committed to data privacy; supports unified and personalised discovery; and connects library technology, powered by AI and linked data.

AI has the potential to revolutionise the world, but its effectiveness relies heavily on the quality of the data manipulated and massaged. With billions of trusted and curated articles, books, documents and propriety best-in-class data points, the Clarivate family is well-placed to lead the market in making the most of the opportunities presented. The AI landscape is changing rapidly. Clarivate and Ex

Libris keep all developments under close observation to think innovatively and to plan ahead no matter what new technologies might emerge, with clients and customers confident in their reliance on the organisations for partnerships which will take libraries forward in meeting emerging needs.

Library Services

Ex Libris library services span nearly all areas that academic and non-academic libraries require in order to provide innovative tools and deliver better experiences to librarians, researchers and users. The following lists the Ex Libris services and relevant terminology to be used subsequently in this chapter. The services outlined include, but are not limited to discovery and delivery, metadata management, support of teaching and learning, and support of research:

- Discovery and delivery
  - Discovery refers to all patron-facing or end-user interfaces providing search and discovery services within the library catalogue to access physical, digital, and electronic resources and information content, both locally held and/or globally managed, and
  - Delivery refers to all librarian-facing or internal library interfaces providing services to manage the library's collection of physical, digital, and electronic resources, both locally held and globally accessed, from acquisition to fulfilment, including all supporting services within libraries and between libraries as part of consortium agreements or other collaborations which might exist.
- Metadata management
  Ex Libris products and services support the management of content solely on the metadata level, while the content itself may be stored or hosted on various other platforms, such as catalogues or databases provided by the library or external content providers. The services of Ex Libris support large-scale metadata management within its KnowledgeBase which contains multiple databases from many providers, and stores article, book, and journal-level metadata for collection management, access permissions and fulfilment purposes, amongst others
- Support of teaching and learning
  Teachers and learners within academic institutions require professional support and rely on library resources and services to conduct and participate in lessons and courses. For example, educators and librarians create reading lists for courses taught within educational institutions to make information content and learning materials easily discoverable, accessible and available

to students and learners from within the library and information resources held or accessed remotely at no personal charge to users because access to or ownership of the information resources has already been purchased by the library, and

– Support of research
  Research is the backbone of many academic institutions. Researchers require support not only for searching, discovering, and accessing relevant content but also in the preparation of research outputs, communication, and collaborative activity with other researchers both within their own institutions and externally, and funding for research projects. Various services can assist in these activities both for librarians and the researchers themselves.

Technological Developments

With AI technological and conceptual advancements over recent years, Ex Libris, like other library software solutions providers, has been continuously developing tools and features powered by AI to provide better support for the customer community and to address new challenges and needs.

AI tools are just one of the ways in which Ex Libris can augment its products, tools and services. AI has great potential to change the entire world. Whether its impact is for better or worse depends on legislative frameworks, organisational strategies and how service providers and users engage with and deploy new tools and technologies. Everyone wants to ensure that the use of AI technology solves real problems and community needs and Ex Libris wishes to ensure that its customers are confident in purchasing new products and optimising functionality of existing services so that any critical decisions made will result in successful outcomes mitigating any risks involved. Importantly, most AI tools are only as good as the data input to them. For many years Ex Libris has been actively researching and implementing AI across its portfolio to enhance its services and solutions. Ex Libris is mindful of the massive potential of such applications, while being fiercely protective of data from all sources to ensure the privacy and security of customers and partners, as well as users of services.

The following sections outline several examples of AI technologies which have been implemented in various Ex Libris products, ranging from rules-based responses to ML advancements, and research into deep learning technologies. Four products are examined: Data Analysis Recommendations Assistant (DARA); Esploro; Use of Knowledge Graph in the Ex Libris Central Discovery Index (CDI); and Rialto Selection Plans.

Data Analysis Recommendation Assistant (DARA)

Data Analysis Recommendation Assistant (DARA) is used in Alma. Alma is one of the few unified library services platforms in the world which manages print, electronic, and digital materials through a single interface. It is a library management system (LMS) or integrated library system (ILS) that provides secure, scalable end-to-end library software for managing the acquisition, sharing, cataloguing, discovery, access and use of all kinds of information resources.

Released back in 2019, DARA is an early example of a rules-based AI engine bot that provides users of Alma with smart recommendations to improve workflows and optimise usage of Alma. DARA also explains how and why a specific recommendation is generated, and provides a service to implement the recommended action, all in one. If action is required by the user, DARA will guide the user through the process to ensure it is completed successfully. The success and usefulness of DARA within the Alma product is due to its recommendations being powered by a large data input of community best practices and optimal workflows.

Ex Libris is looking to develop DARA further and to upgrade its engine from a rules-based approach to incorporate ML technology. This advancement will enable the system to offer a greater variety of smart recommendations from workflow optimisation to collection management insights based on anonymised data collected within Alma (Ex Libris n.d.b).

Esploro

Esploro is a research information management solution which drives research impact and improves efficiency and effectiveness. “Esploro Research Portal and Profiles automatically captures publications and datasets, connecting all information into one portrait of your institution” (Clarivate 2024b). It breaks down data silos, linking comprehensive scholarly information across all academic disciplines. Institutional or research repositories assemble, organise and disseminate the research outputs of organisations to publicise their research. Esploro facilitates the automatic capture of research output and data, improving an institution’s ability to showcase its research, enrich its reporting, and relieve the administrative burden. Smart harvesting AI is at the heart of how Esploro facilitates keeping research repositories and researcher profiles comprehensive, accurate and always up to date. It uses AI to manage accurate and complete research information.

The strength of Esploro lies in the connections it facilitates between authors, researchers, and the associated content of their publications and communications. Those connections are driven by smart harvesting from the Central Discovery Index

(CDI) for author identification and matching based on multiple data points, such as name and ORCID ID to import an author's list of known publications from the CDI:

> The Ex Libris Central Discovery Index (CDI) is a central, unified index, for scholarly and academic material worldwide. It contains over 5 billion records and many different resource types from thousands of publishers, aggregators, and repositories. CDI is content neutral and indexes any type of subscribed, purchased or open access content that is of use for research, teaching, and learning. While CDI primarily focusses on metadata, it also indexes full text for part of the content. In addition to what is indexed, CDI encompasses a suite of services available via an API and our discovery systems, Primo and Summon (Ex Libris n.d.c).

When there are missing data or no ORCID ID, Esploro will continue cross-referencing and searching to find the correct author, based on name, subject area and research affiliation, and will then indicate the probability of the match when associating publications to the researcher's profile (Ex Libris n.d.d, 2022).

Use of Knowledge Graph in the Ex Libris Central Discovery Index (CDI)

As already mentioned, the Central Discovery Index (CDI) is a central, unified index for scholarly and academic materials produced worldwide which is created and maintained by Ex Libris. With over 5.26 billion records, the CDI manages a vast variety of resource types from thousands of publishers, aggregators and repositories. Its goal is to provide smart services for excellent information discovery, access and use experiences. CDI powers the Ex Libris Primo and Summon discovery search engines, as well as other products that rely on this extensive database. The CDI has been developed and designed with the foresight for it to support contextual relations based on a knowledge graph or semantic network approach (IBM n.d.) for effective search and discovery, both intentional and serendipitous. Based on contextual connections, whether derived from formal or informal relations, CDI and the search engines it powers can generate smart services, relevant search recommendations, glanceable associations on the screen and insightful discovery paths.

It must be noted that any and all data-generated insights rely solely on the existing metadata and content available within the CDI itself. The CDI content scope is maintained and carefully curated by Ex Libris in collaboration with the customer community to ensure that any ingested content serves organisational and client joint goals of making relevant, appropriate, and high-quality content available to library patrons.

CDI and the knowledge graph enable discovery beyond searching by using contextual relations. Contextual relationships can be expressed in a variety of ways,

including formal, informal and curated. Formal connections are the most familiar classic connections, such as a book and the chapters within it. Informal connections are more tangential, like co-usage within the bX article recommender, which "captures anonymous usage information from millions of scholars around the world, then leverages this data to enrich and expand the user discovery experience with relevant recommendations for articles and ebooks" (Ex Libris n.d.e). Exploratory content that other users have looked at is recommended. Curated relationships are empirical connections such as the citation trail which draws on articles citing each other, or reading lists and collections created by the library or others, thereby fashioning associations between content.

Rialto Selection Plans

ProQuest's product Rialto™ is a one-stop vendor-neutral marketplace for academic content from a variety of publishers, aggregators and platforms. "Built on the Ex Libris Higher-Ed cloud platform, Rialto creates a seamless, unified and end-to-end library workflow from requests and searches to selection, acquisition, and discovery" (Ex Libris n.d.f). Applying next generation technology and innovative thinking to address the challenges of legacy approval collection management and selection plans in managing profiles, the Rialto selection plans have been created, predicting spending and coordinating disparate profiles. The Selection Plans are library-configured queries, and contain rules and spending caps that allow libraries to prioritise the purchase of the highest-value titles available at any time. At each purchase interval, Rialto identifies relevant content, sorts and ranks results on outcomes as determined by the library, chooses actions to take on those titles and presents details for review by librarians before final action is taken. Further information is available about the Selection Plans in a white paper on Rialto (ProQuest n.d.).

What Next?

In looking to the future and the immense possibilities surrounding the use of AI and other new technological advances, the basic tenet remains that AI tools are just one of the many ways used by Ex Libris to augment its products, tools and services. There are many real-world challenges that can benefit from AI-powered solutions. Ex Libris is excited to be at the forefront, investigating the enormous potential for AI and examining how AI can benefit the user community.

The following is an illustrative list of initiatives that are being actively pursued based on current expectations of future developments and on information currently available. But the area is rapidly evolving and final results may differ materially from current expectations. Three areas are addressed: Discovery, Collection Development, and Metadata Management.

Discovery

Within discovery, developments are expected to cover conversational search and discovery, additional resource recommendations, recommendations for related articles and citation extraction from syllabi files.

Conversational Search and Discovery

The need for and knowledge of Boolean queries and exact searches is occurring less frequently and becoming less commonplace. A simplified approach to search and discovery such as that provided by Google's search engine is recognised to be highly intuitive and one of the most common ways users interact with everyday search enquiries. Conversational searches, such as questions and prompts, are easier for users to generate and Ex Libris is looking at generative AI technologies and partnerships to match users' approaches and enable them to search intuitively and easily.

How search results are displayed is also evolving. Based on trends in the consumer industry, users expect bundled responses with informative summaries that are both useful and efficiently obtained. AI technologies can be used to generate quick, extensive, and accurate summaries based on vast amounts of data. Yet not all data are equal; AI outputs can only be as good as the input data. It is important that trusted, reliable scholarly content, including references and citations, is the foundation for generating AI-powered results. Ex Libris is seeking to enable intuitive academic conversational search and discovery which is specifically designed to foster excellence and drive success for students and researchers, while adhering to core academic principles and values, working both independently as a company and through strong partnerships with industry leaders in the field of AI.

Additional Resource Recommendations

Once a search is performed and results are returned, Ex Libris is hoping to expand the user experience by supplying recommendations for additional relevant content

and resources, based both on the original search query and the needs of individual users. Serendipitous navigation and movement within a database can yield deeper and more relevant results and findings. Anonymised big data and smart analysis of similar and identical past searches from users across the Ex Libris products, can generate tailored recommendations for additional content the user may find beneficial. Expanding on the existing bX article recommendation service with advanced AI technology will power future recommendations and smart analysis based not only on the search query itself but also specific needs of individual users and their areas of interests while remaining mindful of data privacy and anonymisation to protect users' interest.

Recommendations for Related Articles

For researchers and academics who would like to pursue specific areas of interest further and expand their knowledge and information resource base, establishing an Esploro portal that will generate content recommendations based on researchers' areas of expertise, interest and investment is being explored. Many academic libraries are known for championing certain research areas and an enhanced portal has the potential to support the enrichment of researchers' work and analyses.

Citation Extraction from Syllabi Files

Many instructors and teachers create course reading lists based on course syllabi which they have carefully constructed and curated. Leganto is the Ex Libris course resource list solution, and it is developing an AI-based tool that will extract citations from an uploaded syllabus file and generate course reading list suggestions based on the course's content. Instructors will be able to review the resulting suggestions as well as adjust for variables such as learning objectives, diversity, equity and inclusion considerations, scholarly vs popular publications, and more.

Collection Development

Collection development is a major component in library activity. Ensuring an appropriate lifecycle for collection content is vital and determines the current and future availability of and access to content for patrons. Libraries must be able to assess the appropriateness and effectiveness of existing content and collections spanning all formats including physical and digital content held locally or accessed remotely,

in addition to the platforms available for accessing content and various service offerings, such as centrally-managed content and/or various content sharing agreements.

AI technology can assist libraries in reviewing the effectiveness of collection development by clustering existing collections into categories and comparing them across the collective collection and other benchmarks determined by the library, to offer insights and recommendations. DARA has already been referred to in this chapter. It provides an existing rules-based recommendation assistant in the Ex Libris Alma product, supplying primarily workflow efficiency recommendations. Upgrading the DARA engine to run on ML technology would enable it to offer a greater variety of smart recommendations, including collection management insights based on anonymised data collected within Alma. DARA exists on an infrastructure level within several Ex Libris products, and the potential for determining how recommendations already available might be extended to benefit users of other products in the Ex Libris portfolio is being investigated with a view to driving efficiency in additional areas for user communities.

Automated decision making in relation to processes undertaken in library collection acquisition and development is also under investigation to improve efficiency for library operations. New ways to collaborate with textbook publishers and regional copyright agencies to automate and expedite manual processes using robotic process automation (RPA) are being investigated. Such collaboration could introduce a new automated command-driven efficiency tool that would be able to execute basic repetitive time-consuming activities like copy-and-paste and moving files, improving operational efficiency and effectiveness for libraries and librarians so that they can deliver quality experiences to patrons, students and faculty.

Metadata Management

Future developments in relation to improvements based on AI in metadata management relate to title matching, subject enrichment, and automated data record creation.

Title Matching

Titles are not always unique and a single item's title may be described and catalogued differently by various publishers, aggregators, individual libraries, or the authors themselves, as well as differently across resource formats either physical or digital. There are many solutions and workarounds that address the challenge,

primarily through unique identifiers such as ISSNs and ISBNs. Yet the use of these identifiers cannot always resolve the full end-to-end issue of connecting a single resource across multiple platforms, products, and companies, considering the variety in content levels, such as a journal vs a journal article. AI tools can enable smart analysis of titles and intelligent connections and provide the means for advanced cross-product and cross-platform resource sharing, shared cataloguing, collective collection analysis, and more.

Subject Enrichment

Subject headings are the mainstay of library approaches to bibliographic description and cataloguing involving MARC standards and BIBFRAME, creating the basis for major and minor connections and correlations between pieces of content, based on shared understandings of content classification. Currently, most subject headings are created and added manually by skilled cataloguers working with the Library of Congress and other national bibliographic authorities individually, albeit on a collective basis, to grow the interconnecting subject relationships. Yet it is a complex, time-consuming and highly skilled task, and cataloguers face large volumes of new incoming content requiring analysis and processing, occasionally involving delays or perhaps incomplete or inaccurate results. An AI-based ML tool using the available data within the full-text record to determine relevant subject headings would free up the time of cataloguers and allow them to focus on areas requiring their specific expertise and the provision of value-added services based on unique experience. Ex Libris is working on the development of such tools and there is already research in the industry supporting the processing and cataloguing of legal deposit material, which might be expanded to academic content as well.

Automated Metadata Record Creation

Title matching and subject heading enrichment are examples of how AI technology can generate high quality metadata for specific fields. There are prospects for expanding this approach to the AI-driven automated creation of a basic metadata record. When AI technology can generate a basic metadata record based on its full-text, the role of the cataloguers will no longer involve focusing on the creation of basic metadata, but rather on record enhancement to improve the quality of analysis and the provision of additional value based on expert treatment of complex materials. Basic metadata records generated by AI would be built to support linked data structures, thereby ensuring that flexibility of data generation and input

and preparation for incorporation in a knowledge graph database. AI-generated records would be able to take the structures into account at the point of creation, creating semantic records that are supported by the next generation of database management systems, as well as remaining compatible with the existing tools and databases used by libraries.

Conclusion

Ex Libris, a part of Clarivate, is committed to working closely with its community, user groups, and partners, to ensure the effective, accurate and responsible development and implementation of all technologies, including the exciting opportunities around AI. Ex Libris aims to empower users with the tools they need to gain insights from the ever-growing volume of scholarly content, while upholding academic integrity and observing ethical standards. By responsibly utilising new AI-powered services being offered, progressive institutions will be at the forefront of improved teaching and learning experiences and enhanced research activity.

Ex Libris has implemented AI across its product portfolio to enhance the tools and solutions which have been provided for decades and is adopting forward-thinking and progressive approaches to ensure the use of emerging new technologies, both independently and through strong partnerships with leading AI innovators. By bringing clarity to the complex, Ex Libris can give library customers the confidence to make critical decisions sensibly and smartly, to navigate roadblocks encountered with the best tools and to achieve their goals.

Details have been provided of some existing Ex Libris products, tools and features available across the extensive Clarivate portfolio that are currently driven by AI technology. They range from librarian workflow efficiency tools to patron discovery recommendations. The products and tools described already exist, and it is only the beginning. Building towards the future involves the continuation of investment in new AI technologies and partnerships to deliver better and more enriched experiences to librarians and patrons across their daily interactions with the library. Due to the rapidly changing nature of the AI landscape, continuous review is the operational focus along with evolving internal processes and guidelines to ensure a full awareness of the potential benefits and possible risks when researching and implementing new technologies. To advance, progress,and best serve the librarian community, Ex Libris continues to evaluate and research how AI technologies can best transform the world. AI can be used to transform librarians and library systems from data management to knowledge management and beyond.

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