

Research on the Application and Frontier Issues of Artificial Intelligence in Library and Information Science

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Abstract

This article explores the application of artificial intelligence (AI) in the field of library and information science, as well as the frontier issues it brings. With the rapid development of information technology, AI has become an important force in driving technological progress, especially in the field of library and information science. The application of AI technology has not only improved work efficiency but also enhanced the intelligence and personalization of information services. The article analyzes the hot topics of AI research in the field of library and information science in China and abroad through content analysis, including information retrieval and recommendation systems, smart library construction, information security and privacy protection, and open science and research data management. These research hotspots reflect the extensive application of AI technology in the field of library and information science and reflect the academic community's pursuit of improving the quality and efficiency of information services.

Keywords

Artificial Intelligence, Library and Information Science, Research Trends, Information Security, Interdisciplinary Applications

1. Introduction

With the rapid development of information technology, artificial intelligence (AI) is increasingly applied across various fields and has gradually become an important force driving technological progress. In the field of library and information science, the introduction of AI has not only revolutionized traditional ways of working but also brought new opportunities and challenges to information management

and services. As a vital branch of information science, library and information science is tasked with organizing, retrieving, utilizing, and disseminating information. The application of AI technology in this field has not only improved work efficiency but also enhanced the intelligence and personalization of information services.

Against the backdrop of rapidly evolving information technology, the new scientific and technological revolution has put forward new demands for the field of library and information science and has brought new opportunities. As the research interest in artificial intelligence within library and information science grows, it becomes increasingly important to analyze the relevance and differences in the content of domestic and international AI research themes in the field using content analysis methods, especially for the development of domestic artificial intelligence. This paper uses content analysis to explore the frontier issues of AI in the field of library and information science, providing a certain reference and inspiration for related research in library and information science. The significant contribution of this paper lies in its in-depth analysis of AI-related research in the field of library and information science, using a combination of qualitative and quantitative methods. By collecting literature resources from both domestic and international sources over the past decade, the study maps the content onto a knowledge graph and summarizes the frontier issues in the development of AI research in the library and information science field, providing valuable insights and references for scholars in related areas.

2. Literature Review

The application of artificial intelligence (AI) in libraries is gaining increasing attention. Although some libraries have implemented applications based on AI or claim to be “smart” libraries, the importance of AI is not emphasized in the strategic plans or agendas of most academic libraries. Relevant studies indicate that the applications of AI technology in libraries include intelligent chatbots, AI archive management, and enhanced information retrieval systems. For example, Cordell’s report, “Machine Learning + Libraries: A Report on the State of the Field”, outlines the current state of machine learning applications in the library sector, while Subaveerapandiyar’s research reviews the applications of AI in libraries and its impact on operations (Verma, 2019).

As AI technology becomes more widespread, ethical and fairness issues are gradually coming to the forefront. Researchers have explored the representation of libraries in artificial intelligence regulations and the implications for ethics and practice, such as in Bradley’s studies and O’Neil’s book, “Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy” (O’Neil, 2017). Furthermore, frontier issues regarding AI in libraries also include the development of technology, data openness, and librarians’ acceptance of AI. Ylipulli and Luusua discuss the role of public libraries as nodes of technological empowerment in the era of smart cities, AI, and big data.

There are significant differences in how libraries in different countries and regions prioritize AI in their strategic planning. For instance, a study comparing the strategic plans of academic libraries in the UK and mainland China found that AI is rarely mentioned in the strategic plans of UK universities, while most Chinese universities emphasize the application of AI in their vision statements (Huang, Cox, & Cox, 2023). The use of AI-generated content (AIGC) by librarians is influenced by various factors, with relevant studies employing Interpretive Phenomenological Analysis (IPA) and the Technology Acceptance Model (TAM) to explore these factors. In summary, despite some progress in AI research within the library and information science field, many research gaps still require attention. This study will analyze the hot topics related to AI in the LIS field both domestically and internationally, exploring future frontier research directions of AI technology in this field to provide a theoretical basis and practical guidance for advancing technological progress in library and information science.

3. Analysis of Frontier Issues

Based on the analysis of the hot topics in the field of artificial intelligence in library and information science both domestically and internationally, this paper summarizes the future frontier research issues of artificial intelligence in the field of library and information science, which mainly include information retrieval and recommendation systems, smart library construction, information security and privacy protection, and open science and research data management.

3.1. Information Retrieval and Recommendation Systems

Artificial intelligence research in the field of library information retrieval and recommendation systems is mainly focused on conversational search and intelligent question answering, personalized recommendation and intelligent services, and multimedia information retrieval.

Conversational search and intelligent question answering is one of the key research directions at present. Conversational search is considered to be the new paradigm for information retrieval in human-computer interaction scenarios in the future (Sun, Jing, Liu, & Zhao, 2024). Research hotspots include the integration of algorithms for conversational search, user interaction, effectiveness evaluation, and intelligent question-answering systems based on large language models such as ChatGPT (Guo et al., 2024; Lu et al., 2023; Wu & Sun, 2023). Chatbots can provide more natural information retrieval and reference services, and leverage large language models like ChatGPT to enhance the capabilities of conversational systems (Ali, 2024; Harisanty et al., 2023). In addition, research on user behavior in conversational search and the credibility assessment of results are also receiving attention (Wang, Fan, Liu, & Wang, 2024; Wu & Sun, 2023).

Personalized recommendation systems and intelligent services play an important role in enhancing user experience and service efficiency. Research mainly focuses on personalized information delivery based on user profiling, and human-

computer interaction studies of intelligent recommendation systems (Wang, Wu, Liu, & Luo, 2023), such as hybrid recommendation systems based on deep learning that provides users with highly semantically similar paper recommendations through document similarity, hierarchical clustering, and keyword extraction (Gündoğan & Kaya, 2022). Additionally, the application of virtual digital humans in library services and accessible services for special groups are also attracting attention (Chu, Du, & Li, 2023; Guo, Pang, Zhou, & Ma, 2024).

Multimedia information retrieval is another important research direction, including image retrieval based on computer vision, the application of speech recognition and semantic understanding technologies in retrieval, and cross-media retrieval technologies (Pan, Li, Li, & Sun, 2024; Wang & Yan, 2020). The application of knowledge graphs in the development of AI assistants and chatbots has significantly improved information retrieval and user experience (Rajabi, George, & Kumar, 2024). For example, Tsinghua University Library's "Qingxiaotu" is an intelligent question-and-answer chatbot system that uses natural language processing technology to create a knowledge base covering multiple categories, such as book borrowing and returning, electronic resources, and seat reservations. This system can understand readers' spoken inquiries and improve accuracy through machine learning. Users can interact with "Qingxiaotu" via WeChat to obtain answers related to library services. The application of AI in digital audio archive management has demonstrated preliminary results of intelligent systems in audio preservation and document processing (Sanabria Medina & Rodríguez Reséndiz, 2022). The development of these technologies will significantly enhance the capabilities of library information retrieval and user experience.

3.2. Smart Library Construction

Artificial intelligence research in smart libraries is primarily focused on the intelligentization of business processes and service innovation, the construction of intelligent environments and knowledge organization, and intelligent management decision-making and the transformation of the librarian role.

Artificial intelligence technology is reshaping the core business processes and service models of libraries. In terms of business processes, technologies such as machine learning are applied to automatic literature classification and intelligent cataloging, enhancing work efficiency and quality (Guo, 2017). In terms of service innovation, personalized recommendation systems based on big data analysis and machine learning are widely researched to provide more precise knowledge services (Mao, 2018; Wang, Yuan, & Lei, 2019). Additionally, the application of intelligent robots in services such as reference consultation has become a hot topic (Li, 2017).

The construction of intelligent environments and knowledge organization is an important direction for research. Researchers are exploring how to use the Internet of Things, artificial intelligence, and other technologies to build intelligent library spaces (Liang & Liu, 2018; Mao, 2018). For example, the Chicago Public Library provides intelligent navigation services for readers using Internet of

Things technology. Readers can easily check the location and borrowing status of books through mobile apps or self-service devices, making it easier to obtain the resources they need. In terms of knowledge organization, natural language processing and knowledge graph technologies are used to achieve the intelligent organization of massive digital resources and in-depth knowledge discovery (Wang, Yuan, & Lei, 2019; Wang & Yan, 2020). The intelligent library uses natural language processing technology to analyze the user's behavior data in the library management system, such as reading records, search records, ratings, etc., to build a user preference model. This model can capture users' preferences for different types, topics, and authors, and recommend books that may be of interest to them based on this.

The application of artificial intelligence in library management decision-making has become a research hotspot. Scholars are exploring how to use big data analysis and artificial intelligence technology to assist in management decision-making and optimize resource allocation (Mao, 2018; Wang et al., 2019). At the same time, the transformation of the librarian role in the age of artificial intelligence has also attracted widespread attention, with researchers exploring the capabilities needed by librarians in the new era and new models of human-computer collaboration (Li, 2017; Liang, & Liu, 2018).

The development of smart libraries also faces many challenges, such as data quality and integration issues, library staff lacking expertise in artificial intelligence, the cost of implementing artificial intelligence systems, potential job replacement issues, and ethical issues such as data privacy and algorithmic bias (Huang, Cox, & Cox, 2023; Zhou, Ning, Chen, & Yin, 2023).

Future research directions may include the development of artificial intelligence standards and best practices for libraries, in-depth study of user acceptance and the impact of artificial intelligence, attention to human-computer collaboration in library environments, artificial intelligence applications in specialized library fields, and cross-institutional artificial intelligence cooperation programs (Bi et al., 2022; Vasishta, Dhingra, & Vasishta, 2024). These directions will promote further development and innovation in the field of smart libraries.

3.3. Information Security and Privacy Protection

The research directions of artificial intelligence in the field of library and information science regarding information security and privacy protection focus on user privacy protection, library data security management, privacy and copyright issues related to AI technologies, and ethical and governance concerns surrounding AI applications in libraries.

First, user privacy protection in smart library environments has become a key research area. With the widespread application of AI in library services, the collection and use of user data have raised significant privacy concerns (Wang, Jiang, & Lu, 2024; Wu, 2021). Researchers explore how to protect users' privacy rights while providing personalized services. Wang, Jiang, and Lu (2024), from the perspective of privacy concession, analyzed the privacy dilemmas in information

services in the digital age and proposed corresponding strategies. Hlatshwako & Tsabedze (2024) suggested improving librarians' skills through training and professional development opportunities and formulating clear guidelines and policies to address concerns about user privacy and data security, while promoting collaboration and knowledge sharing among librarians.

Second, library data security management has become a research hotspot. In the era of big data and AI, libraries face the challenge of managing vast amounts of data securely (Deng, Qian, Xia, & Wang, 2023; Wang, Yuan, & Lei, 2019). Research mainly focuses on preventing security risks during data collection, storage, processing, and transmission, as well as on classified and hierarchical data management. Firstly, information in the database may be attacked due to potential vulnerabilities such as unauthorized access, data tampering, or system crashes. Attackers may use weak passwords, abuse of internal employee privileges, SQL injection, and other means to obtain database access privileges, and then steal or tamper with sensitive information. In addition, vulnerabilities in the database software itself, risks in backup files, and logical design issues may also lead to data leakage or damage. Wang et al. (2019) discussed how AI reshapes library application architecture and service models, with data security management being a significant aspect. Bradley (2022) highlighted the reflection of library data security management in national AI plans and explored how libraries can participate in other aspects of AI regulation, including the development of ethical frameworks. These studies not only focus on technical security measures but also address the optimization of management systems and processes. To address these challenges, libraries need to take a series of measures to strengthen data security management. On the one hand, by strengthening access control, data protection and encryption, data consistency and integrity, libraries can effectively prevent unauthorized access and data tampering. For example, implementing strict access control policies, assigning minimum privileges to each user, and enforcing complex password policies; At the same time, strict filtering and parameterized queries are performed on the input to prevent SQL injection attacks; The database is backed up and encrypted to ensure data security and recoverability.

Third, privacy and copyright issues related to AI technologies have garnered widespread attention. Libraries use AI to develop intelligent recommendation systems, which improve service accuracy but also raise the risk of privacy leaks (Hao, 2024). Hao (2024) studied the factors affecting the disclosure of privacy information in AI human-computer interaction and personalized recommendation, providing a theoretical basis for building safer intelligent recommendation systems. In addition, digital resources face new challenges in copyright protection and access control (Cai & Yang, 2023). Research mainly focuses on how AI technologies can strengthen digital resource copyright management while ensuring the proper use of intellectual property rights. Cai and Yang (2023), in their study of ChatGPTs application risks, also addressed the issue of copyright rules being challenged, providing important insights for library digital resource management.

Finally, the ethical and governance issues of AI applications in libraries are receiving increasing attention. Researchers are concerned with how to apply AI technologies in libraries while ensuring they align with ethical standards and social values (Fei & Liu, 2021). Fei and Liu (2021), from the perspective of responsible innovation, studied AI industry policies, which offer valuable insights for the ethical governance of AI applications in libraries. Related research covers various aspects such as fairness, transparency, and interpretability of AI decision-making.

AI research in the LIS field concerning information security and privacy protection is characterized by diversity and systematization. These studies not only focus on technical security measures but also involve multiple dimensions such as ethics, law, and management. Future research trends may place greater emphasis on practical applications, exploring how to balance AI applications with information security protection in specific library environments. Additionally, interdisciplinary research may be strengthened, integrating knowledge from information science, computer science, law, ethics, and other disciplines to comprehensively address the security challenges libraries face in the AI era. Moreover, with the application of emerging technologies such as blockchain and federated learning in libraries, related security research may become a new hotspot.

3.4. Open Science and Research Data Management

Research on artificial intelligence in the field of library and information science (LIS) concerning open science and research data management focuses on data management, knowledge services, scientific innovation, and the opportunities and challenges that arise from these areas.

The synergy between AI and data management has become an important support for new productive forces, facilitating the value release of data resources. This collaboration is reflected not only in the technical aspects but also in the shared pursuit of innovation-driven progress and quality improvement (Miao, 2024; Chen, 2024). The application of AI technologies in managing user data in libraries, such as building user profiles, providing personalized services, and analyzing user interaction data, has garnered significant attention. These applications offer new directions for the development of smart libraries (Wang, 2023). Research on the impact of generative AI, such as ChatGPT, on scientific activities and strategies to respond to this influence has become a new hot topic, reflecting academic attention and reflection on the potential academic transformations AI might bring (Duan, Zhang, & Wang, 2023).

Additionally, the integration of big data and AI in areas like automation services and personalized recommendations continues to drive innovation, presenting both new opportunities and challenges for information resource management (Deng, Qian, Xia, & Wang, 2023). The influence of AI, machine learning, and other emerging technologies on the information sector has been thoroughly explored, including discussions on information skills, service models, and talent development (Lu, Sun, Zhang, & Li, 2022). In the context of smart library development, AI

applications in intelligent recommendations and knowledge services have become key research focuses, showcasing libraries' active exploration of new technologies during their digital transformation (Ren, 2020). At the same time, the combination of open government data and AI has promoted data openness and utilization, offering new possibilities for data-driven decision-making and public services (Zhai, Li, Sun, & Li, 2020).

Future research may need to further explore the specific implementation paths of AI in promoting open science and research data management, as well as how to balance technological innovation with ethical considerations to better serve scientific activities and societal development (Zhou, Xu, & Song, 2021; Xia, 2021).

4. Conclusion

Based on an in-depth analysis of the hot topics in artificial intelligence within the field of library and information science, this paper explores the future frontier research issues, covering areas such as information retrieval and recommendation systems, smart library construction, information security and privacy protection, and open science and research data management. These research hotspots not only reflect the extensive application of AI technology but also demonstrate the academic community's ongoing pursuit of improving the quality and efficiency of information services.

First, future research should further explore the development of intelligent information retrieval systems, especially conversational search, multimedia information retrieval, and personalized recommendation systems. By continuously advancing natural language processing, machine learning, and large-scale language models, studies should focus on enhancing user interaction and providing more accurate and context-aware information services, which are key to improving user satisfaction. Researchers also need to address how these technologies can be adapted to diverse user groups, including those with special needs, ensuring that AI-driven library services are more inclusive and accessible.

Second, ethical considerations and data governance will play an increasingly important role in AI applications in libraries. Future research should focus on how to balance the innovations AI brings to services with requirements for protecting user privacy, preventing bias, and ensuring transparency in AI-driven decision-making. Libraries should act as ethical stewards of AI, developing responsible usage guidelines, particularly concerning user data management, algorithmic fairness, and intellectual property rights. It is also essential to explore how AI can promote open science and manage research data while ensuring secure and ethical handling, which is vital for fostering innovation and trust in digital knowledge ecosystems.

Third, AI-driven smart library development offers opportunities to reshape the role of librarians and improve institutional decision-making. Future research should investigate how AI can enhance management efficiency, optimize resource allocation, and help libraries evolve into dynamic knowledge hubs in the digital

age. Studies on human-AI collaboration in libraries will offer insights into how librarians can use AI tools to enhance their capabilities rather than being replaced by them. In the smart library environment, skills such as information retrieval, data processing and analysis, digital technology application, and communication and service awareness have become particularly important. By mastering these skills, staff can manage and utilize the digital resources of the library more efficiently, quickly and accurately obtain the information needed by readers, optimize service processes, and enhance reader satisfaction. The improvement of these skills not only helps the smart library to maintain its competitiveness in the digital age, but also provides readers with a more personalized and high-quality service experience. Libraries can take various measures to improve the information literacy of their staff. Promote knowledge exchange and experience sharing by organizing regular training courses, establishing knowledge sharing mechanisms, and introducing professional talents. Moreover, interdisciplinary collaboration—especially between information science, computer science, ethics, and law—will be crucial in developing AI applications that meet both technological and humanistic needs.

Finally, AI's role in advancing open science and managing research data will be critical in promoting knowledge sharing, innovation, and interdisciplinary collaboration. The combination of AI and open data practices can drive new models of scientific discovery, offering unique opportunities for data-driven insights and decision-making. Research should delve into how AI can facilitate the seamless integration of research data with open-access systems while addressing challenges related to intellectual property, security, and the digital divide.

In summary, the future of AI in library and information science holds great promise, with the potential to transform how libraries operate, how users access information, and how knowledge is managed and disseminated. Continued research efforts are essential to fully harness AI's potential, providing practical guidelines and addressing the ethical, social, and technological complexities that come with its use. By focusing on innovation and responsible application, AI will serve as a key driver for the future development of library and information science, positioning libraries as central players in the knowledge economy of the 21st century.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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