Bibliometric Analysis of Artificial Intelligence in Library Services: Research Trends and Insights

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Abstract

This study examined the transformative role of artificial intelligence (AI) in library services through a bibliometric review of existing research trends. A systematic search in the Scopus database was conducted to identify AI-related papers on library services published in English from 1987 up to March 2024. The key bibliometric indicators which are publication output, citation analysis, and co-citation networks, were analyzed using the VOS viewer application. The study methodology and analysis concentrated on English-language journal articles and conference papers that examined the application of AI technologies in library services, and operations, highlighting AI's increasing significance in the field. By excluding book chapters and standalone books, researchers were able to focus on the most pertinent studies, ultimately resulting in a dataset of 973 relevant papers for bibliometric analysis. The findings of the study revealed a gradual increase in publication trends from 1987 to 2024 showing an increase in research on artificial intelligence (AI) in library services, with annual publications rising from 20 before 2007 to over 140 publications in 2023, particularly after a significant surge in 2017. The United States leads in both publications (296) and citations (4,905), followed by China (151) and India (76), revealing disparities in contributions and suggesting barriers for India in citation impact. Co-citation analysis positions the U.S. as a central hub for international collaborations, notably with countries like South Korea and Japan, while also highlighting expanding networks in African nations. Furthermore, cluster analysis underscores the interconnectedness of topics like "libraries," "metadata," and "knowledge-based systems," reflecting AI's transformative role in library operations. However, the study's reliance on the Scopus database limits its scope by excluding relevant research from other databases and non-English publications.

Keywords: *Artificial intelligence, Machine learning, Library services, Library operations, AI technologies, Chatbots, libraries.*

Introduction

Artificial Intelligence (AI) has become an increasingly prominent and transformative force across numerous industries and domains (Bawack, Wamba, Carillo & Akter, 2022; Guo, Hao, Zhao, Gong, & Yang, 2020). From healthcare to finance, AI is revolutionizing the way organizations operate and deliver services

to their clients. The library and information science field has not been left behind in this rapidly changing technological landscape (Massis, 2018; Omame & Alex-Nmecha, 2020); this includes intelligent chatbots, recommendation engines, automated cataloguing and discovery tools. This advanced technology is poised to reshape and enhance how libraries interact with and serve their patrons (Okunlaya, Syed Abdullah & Alias, 2022). Libraries, often viewed as traditional institutions, have demonstrated a keen ability to adapt and integrate cutting-edge innovations like AI to improve their offerings and stay relevant in the digital age (Omame & Alex-Nmecha, 2020). The integration of AI technologies has significantly enhanced various aspects of library operations, including user assistance, collection development and information retrieval (Ajakaye, 2022; Gundakanal & Kaddipujar, 2019; Oyelude, 2021). One of the most exciting AI applications in libraries is the implementation of intelligent chatbots and virtual assistants (Nawaz & Saldeen, 2020). These conversational AI agents can engage with library users in natural language, providing real-time reference and information services. Additionally, AI-powered algorithms can automatically generate metadata for library materials, streamlining the cataloguing and indexing process (Affum & Dwomoh, 2023; Gundakanal & Kaddipujar, 2019; Massis, 2018). This automated metadata generation not only improves the discoverability of library resources but also frees up librarians' time, allowing them to focus on higher-value tasks (Omame & Alex-Nmecha, 2020). Furthermore, AI-driven analytics and predictive models can support data-informed decision-making in collection management and strategic planning (Anumula, Anumula, Anumula & Damerla, 2024; Iwu-James, Haliso & Ifijeh, 2020; Oyelude, 2021; Pence, 2022). Overall, the adoption of AI technologies in libraries has empowered librarians to deliver more efficient, personalized and user-centric services, ultimately enhancing the overall library experience for patrons.

AI in the library involves the utilization of AI-based methods, systems, tools, or algorithms to support and enhance various library operations and services (Ajakaye, 2022; Bakiri, Mbembati & Tinabo, 2023; Barsha & Munshi, 2023; Mwandosya, 2022; Mwilongo & Mwageni, 2022). For several decades, researchers have investigated the implications and applications of AI technology within the context of library services and operations. However, the understanding of AI in libraries is not as extensive as the rapid growth of AI. The lack of rigorous analysis of AI in libraries poses a challenge for researchers to know the extent to which research related to AI in libraries has been conducted and what research gaps it addresses. Conducting research on AI in libraries is crucial as it will provide

valuable information, insights, and direction for the integration and application of AI technology in library operations and services. Such research efforts can offer an in-depth understanding of the capabilities, limitations, and challenges associated with using AI in various library activities. Therefore, this study aimed to analyze the existing research on the application of AI in libraries and provide direction for further research in this area.

The main objective of this study was to present a holistic perspective on library-related AI research as well as to identify potential future directions that could benefit librarians and library patrons. Through an extensive, globally scoped review of the literature on AI in libraries, this analysis sought to examine the AI-focused research targeting library services. This analysis serves as a vital resource for researchers, providing an overview of the AI field in the library context, which will help inform and guide the development of further library-oriented AI studies. Furthermore, this analysis serves as a crucial reference for those less familiar with this domain, but who are interested in exploring the applications of AI in library services.

Methodology

This study conducted a systematic search in the Scopus database to identify all research papers published in English on the topic of AI in library services, from 1987 to March 2024. The search strategy was designed based on bibliometric indicators to screen the titles for eligibility, with the abstracts and full texts being reviewed as needed. The key bibliometric indicators utilized in these studies were publication output, citation analysis and co-citation networks. The analysis of these indicators was performed using the VOS viewer software. Through this software, the researcher gathered and analyzed the relevant AI-related literature focused on library services.

The initial literature review identified relevant search keywords covering AI technologies, library services and libraries. These keywords were then combined using Boolean operators to construct a comprehensive search string that was used to obtain the results. The search string included the following components: TI=("artificial intelligence") OR TI=("data learning") OR TI=("machine learning") OR ("intelligent agents") OR TI ("AI applications") OR TI=("expert systems") OR TI=("fuzzy logic") OR TI=("computer vision") OR TI=("automatic programming") OR TI=("speech understanding") OR TI=("autonomous robots") OR TI=("Smart Systems") OR TI= ("automated

metadata generation") OR TI=("intelligent agents") OR TI=(chatbots) OR TI=("voice recognition") OR TI=("text mining") OR TI=("robotics) AND (TS=(library) OR TS=("library service") OR TS=("library collections ") OR TS=("library operations") OR TS=("library resource discovery") OR TS= ("library services")).

This comprehensive search approach helped to ensure that relevant literature on the application of AI technologies in the context of library services and operations was identified and included in the review. The search conducted on 17th August 2024, in the Scopus database retrieved 20,513 papers published from 1987 to 2024.

Screening and searching process

The screening process for this analysis focused on English-language journal articles and conference papers relating to the use of AI technologies in libraries, library services and operations. This deliberate choice reflects the growing importance of AI in the library field. The screening included peer-reviewed articles and conference papers but excluded book chapters and books, allowing a researcher to capture the most relevant and impactful research at the intersection of AI and library/information science.

The study began with a pilot screening process to refine the bibliometric methodology. The researcher established initial search criteria, which are relevant keywords, subject areas, publication types and date ranges. A preliminary search in the Scopus database gauged the volume and relevance of results. Based on this assessment, the researcher iteratively refined the search strategy by adjusting keywords, filters and parameters to ensure the comprehensiveness and accuracy of the findings. Additionally, a random sample of 50 papers from the pilot search results was manually screened against predetermined inclusion and exclusion criteria. This exercise identified gaps in the screening process and estimated the time and resources needed for full-scale screening. Ultimately, 31 out of the 50 papers were removed as they were deemed unrelated to AI in library services.

The final search was conducted on 17th July, 2024, yielding 20,513 results. From these, 19,540 publication papers were excluded due to lack of relevance to library services and AI, non-English language and irrelevant formats. This rigorous process resulted in a data set of 973 relevant papers for the subsequent bibliometric analysis.

Data analysis process

Bibliometrics review is the study of literature used to identify developmental trends in a given field (Shaikh *et al.*, 2023). This type of study helps to understand how a specific field is growing and changing by looking at a number of publications, topics being researched, source of research and journals which are publishing them. The study also looks at trends, like which topics are popular over time.

This study looked at the growth of research on AI and library services by analyzing the number of publications from 1987 to 2024. The study focused on newspapers published in each year. It also examined citation trends and identified the top 10 countries with high citation rates on AI in library services. Moreover, the study highlighted the main topics and keywords in these publications.

Results

Distribution of publications on artificial intelligence (AI) and library services

The first objective of this study was to assess publication trends on AI and libraries. This was important because it provides a comprehensive understanding of how AI applications in libraries have evolved**.** The results revealed gradual annual publication trends related to artificial intelligence and library services as indexed by Scopus from 1987 to 2024. The findings in Figure 1 illustrate the trends of changes:

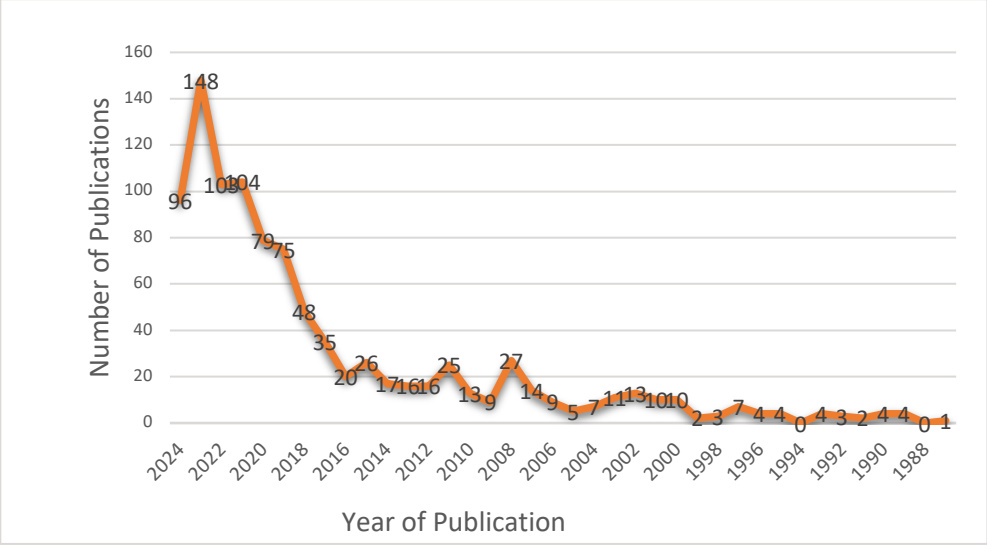

Figure 1: Distribution of Publications per Year

The findings in Figure 1 reveal significant trends in the publications related to artificial intelligence (AI) and library services, as indexed by Scopus from 1987 to 2024. Initially, the publication numbers were low, remaining below 20 annually from 1987 to 2007, indicating minimal research activity in this area. This low numbers of publication may reflect a lack of integration between AI technologies and library practices, as well as limited awareness of AI's potential benefits (Iwu-James *et al.*, 2020).

From 2008 to 2016, there was a gradual increase in publications. This may be suggesting a growing recognition of the AI in enhancing library services. This slightly increase of these publications could be influenced by advancements in AI technologies and an increasing number of studies exploring their application in information management (Noh, 2015).

A substantial shift occurred around 2017, when the volume of publications began to rise more sharply, culminating in a notable spike in 2023, with over 140 publications. This surge reflects a growing academic interest and investment in the field, and this could possibly be driven by the increasing importance of digital transformation in libraries and the need for innovative solutions to enhance user experiences (Affum & Dwomoh, 2023; Ajakaye, 2022; Anumula *et al.*, 2024; Pence, 2022). The rise in publications during this period aligns with broader trends in the adoption of AI technologies across various sectors, emphasizing the critical role of libraries in adapting to these changes (Liu *et al.,* 2021).

Overall, the data suggests a significant evolution in the use of AI in the library landscape and it becomes an integral part of research and practice. The expectation of continued high levels of publication in the coming years indicates that libraries are increasingly prioritizing the integration of AI technologies to improve services and address contemporary challenges in information management (Oyelude, 2021).

Publication trends by country

The study also assesses publication trends by country, which is crucial for understanding the global landscape of AI technology in libraries. By analyzing trends across different countries, the study identified leading nations in AI research and application, as well as regions that may be lagging. This geographical analysis helps highlight disparities in technological adoption and innovation,

providing insights into the factors driving or hindering progress in various parts of the world. Such information is valuable for fostering international collaboration, sharing best practices, and ensuring that advancements in AI benefit libraries globally.

The findings in Figure 2 illustrate the number of publications by country, revealing significant disparities in research contributions. Thus, in this context, the United States leads with 296 publications, indicating its dominant position in the field. Also, China with 151 publications, reflecting its growing in research. India, with 76 publications, demonstrates an increasing engagement, while European countries like the United Kingdom (68) and Germany (65) also show strong contributions. Italy (42), Canada (47), France (31) and Spain (36) have lower outputs, with Singapore at the bottom with just 26 publications. Overall, these findings highlight the competitive landscape of research, particularly among the top contributors, which may shape future collaborations and research priorities.

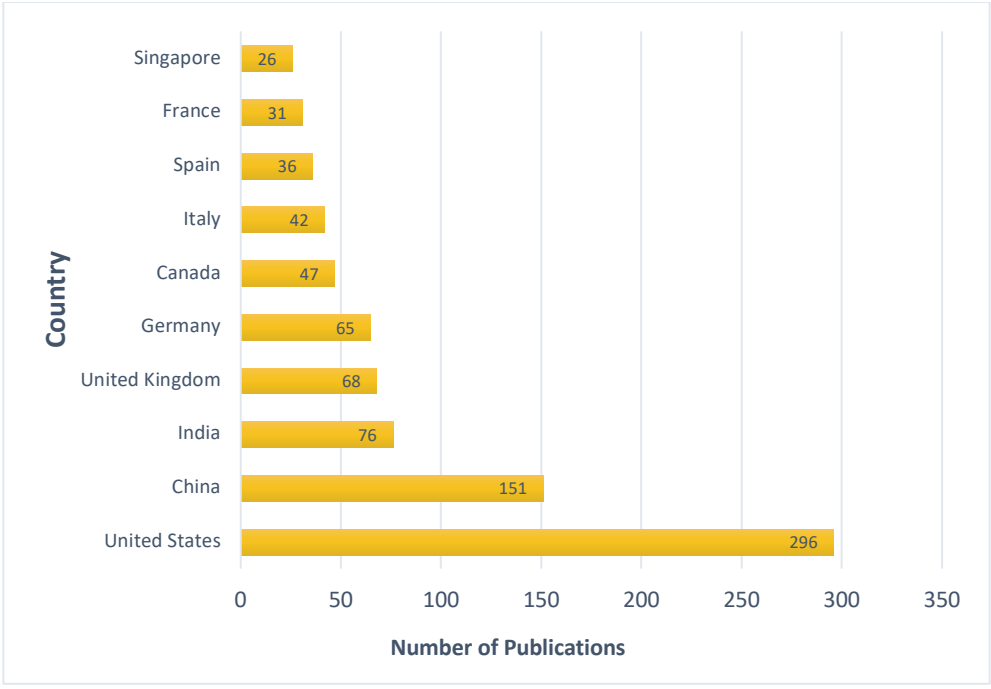

Figure 2: Publication Trends by Country

The findings on publications by country reveal significant alignment with findings in previous studies in the field. The United States is leading with 296 publications which is consistent with earlier research indicating its dominant role in global scientific output. This could be attributed to substantial funding, advanced research infrastructures and a strong emphasis on innovation (National Science Foundation, 2021). As Figure 2 depicts, other countries like China, Italy, Canada, France and Spain have a notable contribution to the publications on AI technologies and library services.

However, the findings indicate a low number of publications in middle- and low-income countries, raising concerns given that these nations typically face limited library resources and services, along with the barriers that AI technologies aim to address. This limited research output may hinder the development and implementation of AI solutions tailored to their specific needs, perpetuating inequalities in access to information and technology. Furthermore, the limited research in middle and low-income countries can result in a disconnect between global advancements in AI and the unique challenges facing these countries, such as inadequate infrastructures, limited funding and insufficient training for library staff (Diseiye, Ukubeyinje, Oladokun & Kakwagh, 2024). Addressing these gaps is crucial for ensuring that AI technologies effectively enhance library services and support equitable access to information in all regions.

Number of citations

This study also analyzed the number of citations. Analyzing the number of citations is a key aspect of assessing publication trends. Citations indicate the impact and influence of research in the academic community. Through examining citation counts, the study identifies the most influential works and authors in the field of AI and libraries. This helps track citation trends over time and reveals shifts in research focus and emerging areas of interest. Understanding citation patterns also aids in recognizing leading researchers and institutions, fostering collaboration and guiding future research efforts.

The findings reveal that the United States leads significantly with 296 publications and 4,905 citations, underscoring its dominant role in research. It is followed by China with 151 publications and 1,788 citations, indicating its growing influence in the field. Other countries like Germany contributes 65 publications and 1,071 citations, while the United Kingdom has 68 publications and 1,318 citations,

showcasing their strong research outputs. Canada reports 47 publications and 596 citations and Australia has 25 publications and 634 citations. In addition, Spain contributes 36 publications and 814 citations, while India contributes 76 publications and 424 citations. Overall, this data highlights the varying levels of research activity and impact, with the United States markedly ahead in both publications and citations.

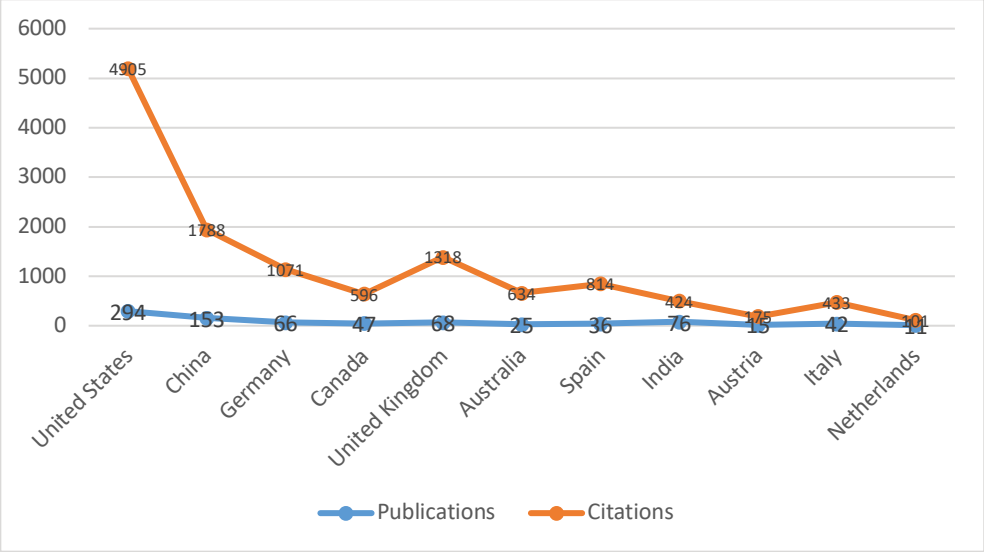

Figure 3: Number of Citations

The findings in Figure 3 highlight the United States' significant lead in research output, with 296 publications and 4,905 citations, reaffirming findings from previous studies which show that the U.S consistently ranks high in global research. This dominance is attributed to substantial investment in research and development as well as a robust academic infrastructure (National Science Foundation, 2021). The U.S leads not only in quantity but also in citation impact, indicating it is widely recognized in research. Other developed countries like China, Italy, Canada, France and Spain also have large numbers of citations, due to their possession of a good number of publications.

However, despite its relatively low citation count, India (76 publications, 424 citations) demonstrates a growing trend in research output, particularly among emerging economies. These findings align with the observations of Singh *et al* (2021) who noted that while India has significantly increased its publication

numbers, it continues to face challenges in achieving comparable citation impact. This discrepancy could be attributed to factors such as limited access to international journals and insufficient collaboration networks (Nielsen & Andersen, 2021).

Overall, these findings support existing literature on global research dynamics, emphasizing the competitive nature of academic output and the importance of international collaborations. As countries strive to enhance their research capabilities, the data suggests a potential shift in research priorities and partnerships, particularly as nations like China and India continue to expand their presence in the global research landscape.

Co-citations

The study conducted a co-citation analysis to explore authors' collaborative networks in AI and library services. Network visualization highlights the collaborative landscape of research. The findings of the study highlighted the United States connecting with 14 countries and reflecting its leadership in the field. Among these connections, South Korea stands out, indicating a robust collaborative relationship. Significant partnerships are also evident with Japan and the Russian Federation. Additionally, several European countries, including Hungary, Portugal, Finland and Poland demonstrate intra-European collaboration.

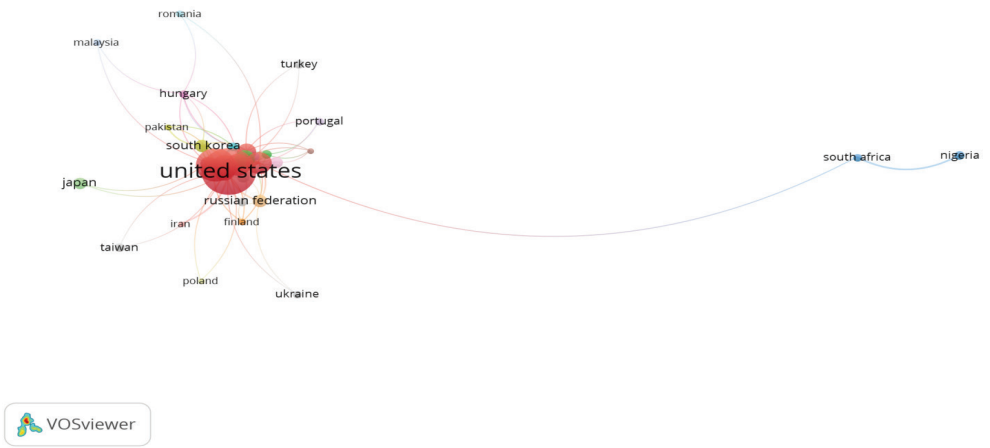

Figure 4: Co-citation Analysis

The findings of the study illustrate intra-European collaboration trends in this field; this includes the collaboration among Hungary, Portugal, Finland and Poland. Prior research has shown that European nations often collaborate to enhance their research capabilities, driven by the European Union's framework for fostering scientific cooperation (European Commission, 2020).

Notably, the findings reveal that authors from Africa, particularly Nigeria and South Africa, appear on the periphery of the collaborative network, suggesting an expanding web of global connections. This positioning indicates their increasing involvement in international research collaborations, which may enhance their visibility and influence in the global academic community. As these countries strengthen their research capabilities, they are likely to cultivate partnerships that facilitate the sharing of knowledge and resources, ultimately addressing local challenges with global insights. Furthermore, this trend highlights a growing recognition of the importance of African perspectives in the discourse surrounding AI and library services, paving the way for innovative solutions that are both culturally relevant and contextually appropriate. This aligns with findings that highlight the increasing role of African researchers in global scientific discourse, as they seek to establish partnerships that enhance their research visibility and impact (Adeleke, 2021).

Cluster analysis of artificial intelligence and library services publications

The study also conducted cluster visualization. This was done aiming at identifying the study hotspot and potential opportunities for collaboration. The findings of the study highlight the interconnectedness of key topics related to libraries, artificial intelligence (AI) or machine learning, with "libraries" at the centre. Surrounding this central theme are significant concepts such as "artificial intelligence," which is linked to terms like "metadata," "knowledge-based systems," and "information services," illustrating the transformative impact of AI on library operations. Additionally, "machine learning" emerges prominently, featuring keywords like "learning algorithms," "decision trees," and "performance computing," indicating active research into the application of these techniques in library contexts. Other relevant themes, including "electronic publishing," "information use," and "education," showcase the broad applications of technology in enhancing library services and user engagement. Overall, this visualization underscores the growing convergence of libraries with AI and

machine learning, highlighting the potential for innovation and improved services in the field. See the summary of the findings in Figure 5:

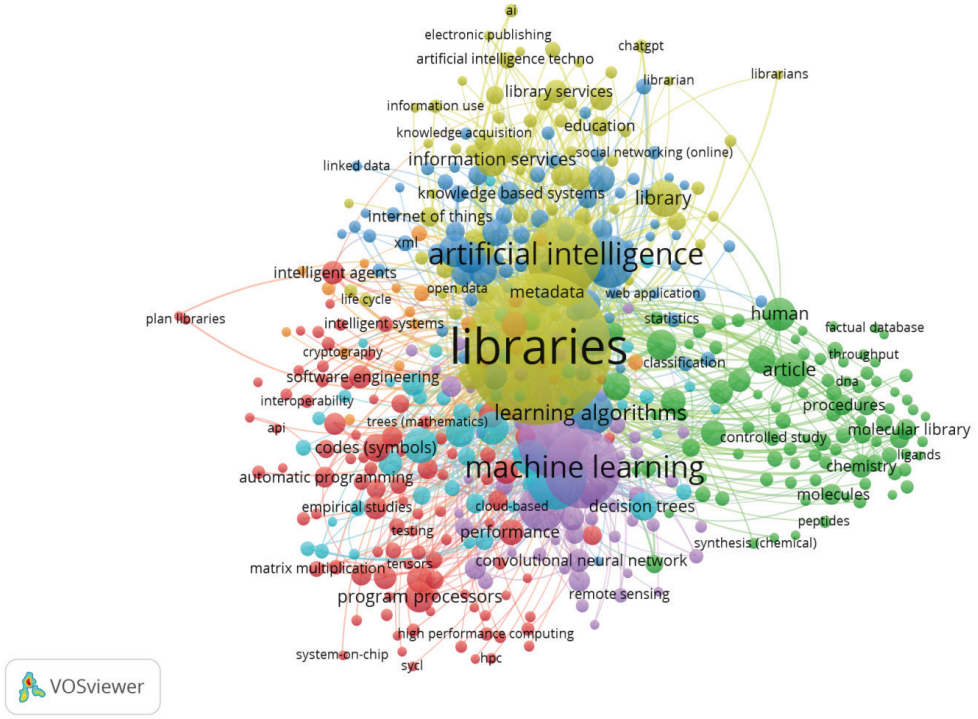

Figure 5: Cluster Analysis of Artificial Intelligence and Library Services Key Topics

The cluster visualization reveals a rich interconnectedness of key topics surrounding libraries, artificial intelligence (AI) and machine learning, with "libraries" positioned at the centre. This central theme emphasizes the evolving role of libraries as they integrate advanced technologies into their operations. The presence of "artificial intelligence" as a significant concept illustrates its transformative impact, linked to terms such as "metadata," "knowledge-based systems," and "information services." This suggests that AI is not only enhancing cataloguing and retrieval processes but also improving user experiences and operational efficiencies in libraries (Ajani, Tella, Salawu & Abdullahi, 2022).

Machine learning emerges prominently within the visualization, highlighting keywords like "learning algorithms," "decision trees," and "performance

computing." These terms indicate active research focused on applying machine learning techniques to optimize library services, such as personalized recommendations and automated data analysis (Liu *et al*., 2021). The integration of these technologies reflects a broader trend in the library field toward leveraging data analytics for enhanced decision-making and user engagement.

Other relevant themes, namely "electronic publishing," "information use" and "education" further showcase the diverse applications of technology in libraries. This aligns with existing literature that emphasizes the importance of digital literacy and the role of libraries in facilitating access to electronic resources and educational materials (Wang *et al*., 2022).

Overall, this visualization highlights the growing convergence of libraries with AI and machine learning, highlighting the potential for innovation and improved services. As libraries continue to adapt to technological advancements, they are positioned to play a crucial role in shaping the future of information access and management.

Limitations of the study

The limitations of this study include the reliance on the Scopus database, which provides only a subset of available publications. Further research should consider exploring additional databases such as Web of Science, Dimensions and others to uncover a broader range of relevant papers. Additionally, this study did not encompass books and publications in other languages. Thus, studies in other languages ignoring English, should also be studied or incorporated.

Conclusion

In conclusion, this study highlights the significant trends and collaborative dynamics in research related to libraries, artificial intelligence and machine learning. The analysis of publication trends from 1987 to 2024 reveals a gradual increase in research on artificial intelligence in library services. Initially, from 1987 to 2007, annual publications remained low; a slight rise occurred between 2008 and 2016, reflecting growing recognition of AI in the library field. However, a significant surge began in 2017, culminating in over 140 publications in 2023, indicating heightened interest and investment in the field. The United States leads with 296 publications, followed by China (151) and India (76), highlighting notable disparities in contributions. The U.S not only leads in publications but

also with 4,905 citations underscoring the influential nature of its research. Conversely, India, despite an increase in publications, demonstrates a lower citation impact, suggesting barriers to access to international journals.

Co-citation analysis shows the U.S as a central hub in international research collaborations, connecting with 14 countries, including strong ties with South Korea and Japan. Intra-European collaborations are also evident, while African nations like Nigeria and South Africa are expanding their research networks. The cluster analysis highlights the interconnectedness of key topics, with "libraries" at the centre, linked to AI concepts such as "metadata" and "knowledge-based systems," indicating AI's transformative impact on library operations.

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