FUTURE AND EMERGING TECHNOLOGIES IN AI&ML

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Future and Emerging Technologies in AI & ML

Review

Application of Artificial Intelligence and Machine Learning in Libraries: A Systematic Review

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ABSTRACT

Academics, researchers, and information professionals are all actively involved in AI and ML research because of the growing importance of these concepts and their applications. The purpose of this research was to compile findings from empirical studies that investigated the use of AI and ML in library settings. A systematic literature evaluation was carried out in accordance with the initial criteria supplied by Kitchenham et al. (2009) in order to accomplish the study's aims. The databases Scopus, LISA, and LISTA as well as the Web of Science were used to gather data. A total of thirty-two publications were ultimately chosen, examined, and analyzed after following the strict/established selection method. The most common domains and methods utilized in AI and ML were the subject of thirty-two publications that were examined and summarized. The results demonstrate that theoretical works constitute the majority of AI and ML research in the LIS sector at the present time. On the other hand, case studies and implementation projects were also the focus of other scholars. Several machine learning approaches, such as logistic regression, KNN, and AdaBoost, have found extensive usage in library collection management for tasks such as metadata production, resource identification, and book procurement. While recommender systems, support vector machines, and association rules have been used for circulation-related tasks such as book suggestion, user rating, and bibliographic data. In order to promote more tech-oriented methods and to anticipate future innovation routes, this study will provide academics, practitioners, and educators a bird's-eye perspective of AI and ML in libraries.

Keywords
Artificial intelligence (AI); Machine learning; Libraries; Systematic review.

INTRODUCTION

In the last few decades, AI and ML have played a pivotal role in revolutionizing our society and the way humans perceive, behave, and make choices (Vysakh & Babu, 2020). Various features of artificial intelligence and machine learning have recently In order to enhance their goods and services, several top firms have used intelligence, including Google, IBM, Amazon, Netflix, Expedia, and many more. Almost every important area, including healthcare, schools, the economy, agriculture, and governmental and non-governmental organizations from across the world is likewise interested in and making use of these technologies to streamline and equalize workload, boost productivity, decrease human contact, and—most importantly—lead the digital world with intelligence and sophistication. Information science and library science are much like any other industry: they are arming themselves with a plethora of exciting new technology. The ever-increasing data quantities, sometimes known as big data, the need to analyze and provide results from data in real-time, and the different demands of library users are constantly pushing the information and library sectors to their limits. In contrast, the ability to mine real-time data and provide information outputs in accordance is made possible by a number of significant possible combinations, such as the widespread use of networked environments for data processing and the enormous improvements in computer processing speed and capacity (Johnson, et. al., 2015). For example, by adapting to the needs of users and offering customizable and ubiquitous knowledge services, intelligent library systems can replace traditional library services. This is made possible through the application of AI and ML, which improves interaction among smart technologies and increases the effectiveness of various libraries. Hence, ML approaches that provide computational solutions for automatically learning new information are essential for building an intelligent library (Esposito et al., 1998) that works equally well in every environment (Zhiyong, 2019).

As a result, one might say that libraries' technical and user services have entered a new era thanks to the advent of AI and ML. Library

patrons may benefit from the increased efficiency and collaborative nature of all library services made possible by the self-learning and self-doing capabilities of AI and ML. But in order to Librarians must adapt to the new reality by taking on new responsibilities and advocating for the use of machine learning and artificial intelligence to revolutionize library operations and services. A plethora of study has been carried out to comprehend the phenomena and generate innovation in this domain, all in the name of developing the smart technologies indicated before. Knowing the current research emphasis and how a topic is expected to evolve in the future is crucial for tracing its intellectual structure and understanding its evolution. Hence, the purpose of this research is to identify the present level of expertise in AI and ML applications to libraries and to forecast the direction of future studies in this area.

Background

Artificial Intelligence

The capacity of a digital computer, computer-controlled equipment, or software to mimic the cognitive abilities of an intelligent creature (human) in its operation is known as artificial intelligence (AI). The field of artificial intelligence (AI) is defined by leading academics and textbooks as the study and creation of "a fully conscious, intelligent, computer- based entity" (Raynor and Shoup, 1999) with inherent advantages over humans in seeing the world and completing complicated tasks (Russell & Norvig, 2003). As stated by McCarthy et al. (2007), "the science and engineering of making intelligent machines" is how AI is defined by the man who first used the word in 1955. (Nilsson 1998; Poole, Mackworth & Goebel 1998; Russell & Norvig 2003; Luger & Stubblefield 2004; Copeland, 2015) Artificial intelligence aims to reason, discover, generalize, manipulate things, and comprehend natural language. Artificial intelligence (AI) has recently garnered a lot of attention from several fields, including computer science, psychology, mathematics, information science, and more.

disciplines, including those of language and science. The advent of the expert system has been determined to be the most extensive AI presence in the context of LIS. Expert systems aid library workers in making better decisions and increasing productivity, in addition to assisting with routine library tasks (Guliciuc et al., 2017).

Because AI can mimic human thought and behavior in the absence of human intervention, it may facilitate the development of an intelligent library endowed with dormant intelligent functions that can carry them out autonomously (Massis, 2018). According to Huang and Rust (2018), libraries may greatly benefit from AI's self-learning capabilities in areas such as user management, networking, and communication. By integrating preexisting library resources with third-party information, AI has the potential to empower mobile and social networking settings with new virtual reference services that are updated in real-time. In addition, the use of robots in library operations, indexing systems, and natural language processing are also potential applications of artificial intelligence in libraries.

Artificial Intelligence

Arthur Samuel first used the phrase "Machine Learning" in 1959 in reference to a presentation given by Alan Turing to the London Mathematical Society on February 20, 1947, in which Turing said, "We want such a machine with the ability to learn from experiences" (Samuel, 1959). Machine learning, or Ml, was thus described by Samuel as a "field of study that gives computers the ability to learn without being explicitly programmed" (Samuel, 1959, pp. 210-241). 229 dollars. Machine learning is described in the Ex Libris Whitepaper (2020) as "...when machines create their own classifications by learning from examples, dramatically accelerating statistical pattern recognition." By making predictions based on data and discovering patterns, ML researches and builds algorithms. intricate patterns that facilitate intelligent decision-making (Foster and Kohavi, 1998). Machine learning, in layman's words, is the process of using computers to find patterns in massive datasets (Ayyadevara, 2018; de Mello & Ponti, 2018). Machine learning, as the name indicates, is based on the premise that computers can learn to conduct better analyses with time and more data (Bellam, 2018; de Mello & Ponti, 2018). On the other hand, learning algorithms enable supervised or unsupervised learning models (Ayyadevara, 2018; Fernandes de Mello & Antonelli Ponti, 2018), which are the two primary methods to machine learning. A simple way to express it is that algorithms are just sets of instructions for computers to follow in order to solve a certain kind of learning issue (Bellam, 2018).

The ability of machine learning to solve complex real-world issues in a scalable manner that is applicable to many different types of computer activities has led many to believe that it will revolutionize the industry. There is a blurring of lines between data mining and machine learning, with the former concentrating on making predictions based on known qualities learnt from training data and the latter on finding new, undiscovered features in the data. We need to know how libraries can benefit from machine learning technologies. Possibilities and opportunities, in a nutshell, are endless. For instance, the discovery of new resources may benefit from ML approaches. Users of library resources may be reimagined via the use of web crawlers and other data collecting techniques for automation and enhanced categorization of information resources (Mitchell, 2006). To better understand library use patterns, data mining methods may be employed to extract information from heterogeneous and homogeneous systems (Walker & Jiang, 2019).

Research Question

Two research questions were defined and applied to the selected studies. The research questions are as follows-

- RQ 1: What are the main areas of library where AI and ML have been applied?
- RQ 2: Which AI and ML techniques are applied in libraries?

Methodology

Following the guidelines laid forth by Kitchenham et al. (2009), this research has conducted a systematic review. A systematic review is an organized and well-defined procedure for evaluating and synthesising the highest quality research on a particular subject. It uses transparent, responsible, and thorough research methodologies to provide evidence-based responses to the particular topics (Gough, Oliver & Thomas, 2012; Dickson, Cherry & Boland, 2014; Petticrew & Roberts, 2006). An objective and repeatable synthesis of the most

recent findings from the relevant literature is the primary goal of a systematic review. It aids in identifying research gaps and providing evidence for practice and policymaking (Siddaway et al., 2019).

Several things have inspired this research. A variety of library applications have made use of AI and ML principles. Research in this area has been expanding thanks to the growing interest in artificial intelligence and machine learning within the library industry. A literature analysis of the ML and AI methodologies utilized for libraries' many application areas is necessary in light of this development. Given the new trend's meteoric rise, we think it's time for a thorough analysis of its history and the ways in which AI and ML are being used in many areas of library science.

Information Gathering and Methodology

In 2020, a thorough search of the literature was conducted using the following databases: Web of Science, Scopus, LISA, and LISTA. These databases were chosen because they are well-known and extensively used by scientists for their academic writings. Also, LISTA and LISA have been reliable LIS research resources for a long time. Further steps were taken to eliminate search biases by doing individual database searches across many databases. We searched for every article published up to this point, sorting them by date of publication. Journal articles, conference papers, and proceedings that have been peer-reviewed were the only ones considered.

Choosing Who to Include and Who to Leave Out To be considered for inclusion, papers needed to meet three conditions: (1) be published in English, (2) include machine learning or artificial intelligence applications, and (3) be from the subfield of library and information science. (4) The publications' titles, abstracts, and keywords should focus on libraries that use AI or machine learning. First, publications didn't have to be digital; second, they couldn't be fully reviewed; third, the papers couldn't have been written in English; and fourth, libraries haven't used ML or AI in any way.

Research Prioritization

As part of the predetermined plan, we first checked the titles and abstract were performed by researchers. Afterward, the remaining articles were assessed by applying the aforementioned inclusion and exclusion criteria. Initially, 379 articles were retrieved (9 from Web of Science, 26 from Scopus, 21 from LISTA,

285 from LISA databases and 38 from individual database searching) with the established Boolean Expression. After removing 61 duplicates (16.09%), the search was reduced to 286 articles. After careful screening of the remaining 286 papers considering the inclusion and exclusion

criteria, 32 articles were included in this systematic review. The selection procedure is summarized in Figure 1.

Search Process for the Selection of Studies

Findings

AI and ML Techniques Applied in Libraries

As mentioned previously, after careful consideration, a total number of 32 articles have been finally selected and included for this study. The papers went through a rigorous data extraction method done by the two researchers. The relevant theme related to the use of AI and machine learning in different aspects of library operations were identified and summarized in the table-2.

Table 2's results suggest that recommender systems (RSs) are methods and tools for making useful product suggestions to consumers based on their preferences. By sorting the output by user-defined criteria like rating, preference, or potential interest, recommender systems provide a more tailored experience for each individual user (Burke, 2002). The use of RSs is developing into

well-known resources for analyzing and sorting through massive datasets as well. Xiao and Gao (2020) note that libraries have extensively employed various recommendation algorithms to enhance library services and provide consumers personalized services. To illustrate the point, Tsuji et al. (2014) generated book recommendations based on 2,293,642 loan data submitted by 44,571 University Library patrons. It was with the purpose of making book recommendations to faculty and students at all levels of education using two machine learning methods: (i) support vector machines and (ii) association rules. The following factors informed the employment of support vector machines: (a) association rule confidence, (2) title likeness, (3) category match/mismatch, and (4) book database outline similarity. In order to provide broad suggestions based on the popularity score, Xiao and Gao (2020) use Bayes estimator. Reading widely read novels increases the likelihood that additional readers will choose them. To test the feasibility of machine learning for demand-driven acquisition (DDA) and e-book purchase prediction models, Walker & Jiang (2019) used logistic regression and AdaBoost. Ada-Boost was powered by the adabag R package, and the logistic regression analysis was done using the general linear model (glm) R function. In their study, Yao et al. (2011) used self-directed learning methodologies to address the issue of Xiaotu, a recently built smart talking robot, implementing a virtual reference service in real-time. To improve cataloging and subject analysis, Short (2019) tried out text mining, classification, clustering, and topic modeling with an emphasis on 5-year-subject analysis of a book. Through respondent-robot natural language communication, this research also used natural language processing (NLP), a subfield of artificial intelligence, to comprehend the speaking function of Chinese. Pattern recognition is another advanced AI method that Yang et al. (2017) studied. A library's book inventory management system that relies on scene text reading for retrieval was the primary subject of this investigation. Using extensive supervision, they suggested a methodology for design text recognition. In order to recover the lost books, Lei et al. (2018) suggested a method based on convolutional neural networks for book label identification. The focus of the writers was on image processing.

methods use convolutional neural networks (CNNs) to train a classifier to recognize characters and extract the label characters from book shelf photos, respectively. A recent research by Du, Lim & Tan (2019) highlighted the need of library security measures such as passive RFID tags that use pattern recognition. These measures include collecting and analyzing data on distribution, reading activity,

and the reader's trajectory, which may help identify books that have been picked up or lost.

Discussion and Conclusion

A growing number of scholars and professionals in the field are interested in the potential benefits of using AI and ML in library operations. The goal of this comprehensive study was to find examples of library AI and ML applications and to evaluate how these technologies could improve library services and operations. We found 32 publications on the most common domains and methodologies for using AI and ML, and we examined and summarized them. This review doesn't pretend to cover everything, but it does give some good points and draw attention to some major implications:
Much of the present AI and ML work in the library and information science field is theoretical in nature. On the other hand, case studies and implementation projects were also the focus of other scholars. As previously stated in the literature, AI had the opportunity to influence library operations and services by directing attention to core functions, administration, research, scholarship, service innovation, usability, retrieval, and so on. Several machine learning approaches, such as logistic regression, KNN, and AdaBoost, have found extensive usage in library collection management for tasks such as metadata production, resource identification, and book procurement. While recommender systems, support vector machines, and association rules have been used for circulation-related tasks such as book suggestion, user rating, and bibliographic data. Machine learning and artificial intelligence have helped libraries with a variety of internal tasks, such as cataloging, indexing, document analysis, text recognition, and categorization.

Security, user authentication, book title recognition, RFID management, and other administrative tasks are all enhanced with the use of powerful artificial intelligence and machine learning algorithms, such as pattern recognition and MAS. Convolutional neural networks, deep learning, and neural network algorithms have all shown to be useful in the fields of research, discovery, and analysis.

Plus, a chatbot, which is an AI conversational assistant, may fill in for a real-life reference librarian. It improves the quality of face-to-face communication for virtual storytellers, readers' advisory librarians, automated virtual reference assistants, and tour guides on library websites. Regardless, there are limitations to this study that are typical of systematic reviews. Papers retrieved using keywords like "machine learning," "artificial intelligence," and "librar*" are the first to be reviewed in the research. The retrieval procedure may have missed articles that discussed the use of AI and ML techniques in libraries but did not include these keywords. Second, since no additional sources were considered, the results may not be representative of the full scope of the topic as they were derived only from scholarly publications and conference papers. Articles, thirdly only results from two databases (one LIS and one interdisciplinary) were considered. Despite the fact that this constraint might make the review incomplete, the authors maintain that it covers all the bases by offering reasonable insights into LIS research. In spite of the caveats, the results of this research may inspire new models or technologies to bolster libraries' current service ecologies. In order to promote more tech-oriented methods and to anticipate future innovation routes, this study will provide academics, practitioners, and educators a bird's-eye perspective of AI and ML in libraries.

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