The Role of Machine Learning in Managing and Organizing Healthcare Records

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ABSTRACT

With the exponential growth of medical data, Machine Learning (ML) algorithms are becoming increasingly important to the management and organization of healthcare information. This study aims to explore the role that ML can play in optimizing the management and organization of healthcare records, by identifying the challenges, advantages, and limitations associated with this technology. Consequently, the current study will contribute to the understanding of how ML might be applied to the healthcare industry in a variety of circumstances. Using the findings of this study, healthcare professionals, researchers, and policymakers will be able to make informed decisions regarding the adoption and implementation of ML techniques for regulating healthcare records. The findings of this paper revealed that ML can play an important role in efficiently directing and classifying healthcare records using different perspectives.

Keywords-machine learning; healthcare records; literature review methodology

I. INTRODUCTION

Today, healthcare management systems store a plethora of patient data regarding medical records and reports, body scans, treatments, medications, hospital records, etc. These data are increasingly complicated to handle. Inefficient data management can lead to bad decision-making [1-3]. Such huge data sets require some smart technology to be processed and extracted in a useful manner. It is necessary to have an accurate diagnosis system, especially when it comes to diseases like cancer, so that better treatment can be provided. A combination of human knowledge and computer derived assistance could be used to accomplish this. Various fields have already proven that ML is a fast and precise means of obtaining valid results; therefore, physicians can benefit from employing this intelligent technology to make better decisions [4, 5]. Doctors and hospitals can regulate this immense amount of data by applying ML techniques, keeping electronic health records of patients accessible from anywhere at any time, and thus being able to provide better treatment. The use of ML has become integral to our daily lives. Several domains, such as transport and manufacturing have already proven their value, but now they are gaining popularity thanks to their excellent results in healthcare fields, like lung disease classification [6, 7], body organ recognition by medical images [8], lung nodule detection [9], reconstruction of medical images [10], and segmentation of brain tumors [11, 12]. To examine patients, the use of intelligent systems that are based on ML is increasing [13]. Combining mobile and cloud technology with ML provides more predictive outputs that can create human-like intelligent systems. At the same time, using ML in administering human resources has faced several challenges in privacy, security, and

data quality. Accordingly, this study explores how ML can organize and manage healthcare records. Therefore, the findings of this study will clarify how ML may affect the healthcare industry. A key benefit of this study is that it enlightens healthcare professionals, researchers, and policymakers, allowing them to make informed decisions about the implementation of ML techniques in arranging patients' healthcare records. This research is eventually anticipated to promote the evolution of healthcare practices by taking advantage of the ML capacity to assist in more effectively disposing patient data, which will accordingly lead to improved patient outcomes and medical services.

II. METHODOLOGY

To review the studies conducted on healthcare, ML areas, and the role ML plays in revolutionizing the healthcare world, this study adopted the literature review method [14-17]. A literature review plays a crucial role in research designs, granting a full assessment and a combination of the offered literature. It accomplishes several goals, involving recognizing gaps, discovering and integrating data, directing research, and significantly assessing existing work [14]. Figure 1 illustrates the adopted methodology, which involved the following stages:

- Identification: This stage entailed identifying the search terms, i.e. language, publication year, and keywords utilized in the search process. By employing six search engines, namely Google Scholar, IEEE Xplore, Science Direct, Scopus, Springer, and Web of Science (WoS), papers written in English and published from 2015 to 2024 about healthcare records and ML were collected. Then, papers related to healthcare records and ML were selected based on their subjects. Our search procedure used the following keywords: "healthcare records" and "machine learning". Out of the total 4,885 papers extracted from the search engines, 1760 articles derived from Google Scholar, 750 from Scopus, 233 from IEEE Xplore, 33 from Science Direct, 109 from WoS, and 2000 from Springer (see Figure 2).
- Screening: In this stage, the gathered papers were screened based on the title, abstract, and conclusion. All the 4,885 papers were screened, among which 1901 papers were excluded as duplicate entries.
- Exclusion: In this stage, some of the papers were excluded based on several criteria. For example, 1300 papers were ruled out for reasons, such as duplicate publications, poor quality, incomplete information, and insufficient data. Also, 529 were ejected due to irrelevancy, and 1127 owing to lacking results. Figure 3 displays the exclusion stage.
- Inclusion: In this stage, 28 papers were included as they were focused on either healthcare or ML, or on both, as depicted in Table I.

Based on the summary exhibited in Table I, ML applications can play a central role in the organization and management of healthcare records along with covering a variety of features, including data classification, organization, analysis, and summarization, identifying, and matching patients, managing medications, providing clinical decision support, predicting and diagnosing diseases, engaging patients, and providing telemedicine, ML applications contribute to more valid healthcare outcomes by improving effectiveness, data accuracy, and the value of healthcare.

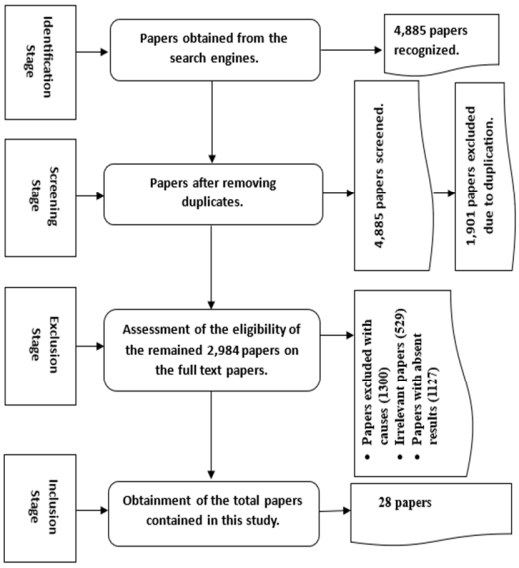

Fig. 1. The adopted methodology.

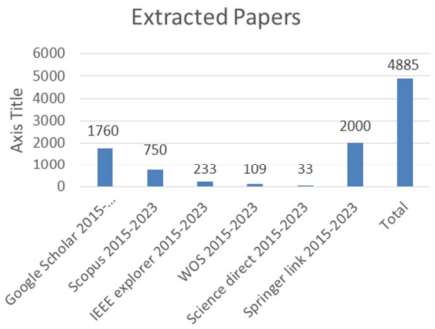

Fig. 2. Extracted papers from known search engines.

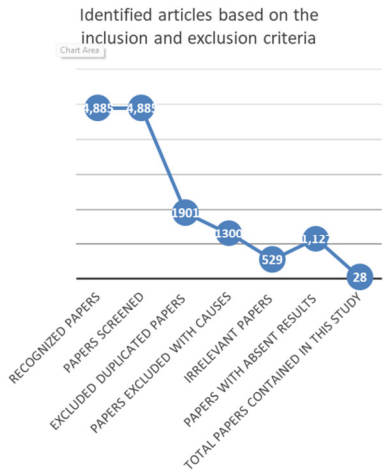

Fig. 3. Identification process based on the inclusion and exclusion criteria.

TABLE I. SELECTED PAPERS IN THIS STUDY

Ref.	Year	Focal points	ML application factors						
			Data classification	Data summarization	Patient identification	Medication management	Clinical decision support	Disease prediction	Patient engagement
[18]	2022	A framework for predicting the length of stay in lung cancer patients using ML models.	√	×	√	√	×	√	×
[19]	2015	Interactive collaborative care solutions for chronic diseases, which would empower patient-doctor relationships.	×	×	√	×	×	√	×
[20]	2016	A disease classification method using Disease Closeness, Disease Matrix, and Middle Measure to identify accurate and relevant diseases.	√	×	×	×	×	√	×
[21]	2019	A thorough review of the relationship between ML and blockchain technologies in smart healthcare. Several challenges arising when implementing ML in blockchain-based healthcare systems are discussed.	×	√	×	×	×	×	×
[22]	2020	A secure blockchain-based architecture specifically to address the requirements of e-healthcare systems.	×	×	√	√	×	×	×
[23]	2020	Combined healthcare pathway discovery and recovery time prediction models are discussed.	×	×	×	×	×	√	Q
[24]	2020	Generalizable ML approach by using data collected from a 40-year period from over 860,000 patients corresponding to over 6,700 prescription medications.	×	×	√	×	√	×	×
[25]	2020	Illustrating how ML models can be designed to have a "conversational" approach, through combining modeling decisions with domain expertise.	×	×	×	×	√	×	×
[26]	2020	A review of the importance of ML in healthcare.	×	×	×	×	×	×	×
[27]	2020	Comparison of the classification accuracy of ML methods using simulated EHR logs.	√	×	×	×	×	×	×
[28]	2021	Predicting patient survivability and determining which variables are most likely to affect it.							
[29]	2021	Presenting a decentralized workflow for trust-based federated learning without compromising privacy.	×	×	×	√	×	×	×
[30]	2021	Discussing methods already proposed for protecting privacy in cloud computing, including service-oriented architecture, and secure multiparty computation.	×	×	×	×	×	×	×
[31]	2021	Employing a variety of ML techniques to analyze healthcare records using different algorithms.	√	√	×	×	×	×	×
[32]	2022	A study on the impact of ML on the development of healthcare systems.	×	×	×	×	√	×	×
[33]	2022	Literature review regarding blockchain technology and improved health record management techniques that utilize artificial intelligence technologies.	×	×	×	×	√	×	×
[34]	2022	The possibility of generating EHRs by text-to-text translation using language models, which allows for highly flexible event imputation, is discussed.	√	×	×	×	×	×	×
[35]	2022	An optimized stacking ensemble learning model for breast cancer detection and classification using ML.	×	×	×	√	√	√	×
[36]	2022	Investigation of pneumonia patient profiles after initial RTI consultations in a large general population sample by using both conventional and ML approaches.	×	×	√	×	×	×	×
[37]	2022	Development and comparison of several ML algorithms to determine the hypertension risk among residents of Shanghai, China.	×	×	×	√	×	×	×

[38]	2022	A stochastic gradient descent method based on ML to manage medical records and optimize healthcare transactions.	√	×	×	×	×	×	×
[39]	2022	A review of the e-healthcare domain to help researchers better understand the benefits and drawbacks of using ML, blockchain technology, and other components to guarantee privacy and security in the healthcare system.	×	×	√	×	×	×	×
[40]	2022	Discussion about how ML is rooted in healthcare and some of its valuable applications in this industry.	×	×	×	×	√	×	×
[41]	2022	Discussing a variety of ML algorithms in addition to some of the ML properties of in healthcare along with their potential applications.	√	×	×	×	×	×	×
[42]	2023	Analysis of the increase in opioid prescribing in the U.S. during and after the peak of opioid prescribing.	×	×	×	×	√	×	×
[43]	2023	Applying automated intelligent practices to the early detection of heart diseases.	√	×	×	×	×	×	×
[44]	2023	Discussing various applications of quantum ML in healthcare, including quantum computing frameworks, algorithms, and concepts.	√	×	×	√	×	×	×
[45]	2024	Investigates the current state of the art in the application of ML to detect, categorize, and predict disorders stemming from cardiovascular and respiratory diseases.	√	×	×	×	×	√	×
[46]	2024	An effort to identify and overcome the limitations of traffic-centric approaches in cooperative cloud-edge networks by examining how these approaches can be utilized effectively.	√	×	×	×	√	×	×

The existing ML applications have exhibited a few limitations and challenges in their application to the management of health records, as displayed in Table II. On the other hand, several advantages have been offered by the ML application to healthcare record management as noticed in Table III.

III. FINDINGS AND DISCUSSION

Data were collected from six widely used search engines and were analyzed. At first, more than 4,000 journal articles, reports, books, book chapters, and dissertations were collected. After filtering with the above mentioned criteria, only 28 articles were finally selected to be analyzed. The results of the study reveal that ML can have a positive effect on handling and classifying healthcare records. In addition, the study found that the benefits of the ML utilization in the management and organization of healthcare records can be grouped in three categories, which are analyzed below.

A. Benefits for Healthcare Professionals

This study demonstrated the potential of ML techniques in upgrading the efficiency of healthcare systems. As healthcare professionals are expected to provide high-quality patient care while saving as much time as possible, they can benefit from the automated processing of administrative tasks, including data entry and retrieval. To improve their overall operational efficiency, minimize human error, and reduce manual processes, hospitals can utilize ML algorithms. Moreover, ML techniques have also proven to be extremely useful in ameliorating the accuracy and precision of healthcare records. If large datasets are analyzed employing ML-based algorithms, then patterns, trends, and anomalies that humans may not observe can be detected. By automating the process of data extraction and analysis, healthcare professionals can make more informed decisions due to the use of accurate and up-to-date medical data. Keeping records in this manner not only ensures consistency and reliability, but it also minimizes the possibility of errors. Furthermore, ML techniques have been added to the healthcare record management process to improve the access, efficiency, and accuracy of healthcare records. With traditional paper-based systems, it can be difficult to access important information in a timely manner and find the information needed. Using a digital healthcare record, healthcare professionals can now access patient data, medical history, and test results from anywhere and at any time. It is easier for health professionals to collaborate, to share knowledge, to make informed decisions, and to provide timely care because of a higher degree of accessibility.

B. Benefits for Researchers

These techniques will be useful to researchers because they allow them to analyze large datasets more efficiently. The analysis of patterns, trends, and associations among different types of data can lead to the identification of risk factors and the prediction of outcomes. ML techniques can also be deployed to analyze the management of healthcare records. Manual analysis of historical data may not be able to provide researchers with the necessary insight to detect trends or patterns. ML techniques can greatly benefit healthcare research, particularly in the regulation of medical records. Incorporating these techniques into one's research can provide a valuable understanding of large datasets. By doing so, prevention, treatment, and management of diseases can be conducted more efficiently.

TABLE II. OBSERVED CHALLENGES AND LIMITATIONS IN THE APPLICATION OF ML TO HEALTHCARE RECORD MANAGEMENT

Challenge	Description
Privacy and security	It is essential that patients' privacy and security are protected when using ML algorithms. Compliance with privacy laws and robust security measures are essential to safeguarding sensitive information.
Data quality	Healthcare data must be of high quality for ML models to be accurate. For medical data to be reliable and valid, they must be cleansed, normalized, and pre-processed.
Model explainability	Transparent and understandable models should be used to make healthcare-related decisions. Healthcare professionals need to know how ML algorithms make decisions so that they can trust the information they receive.
Healthcare domain knowledge	Clinical guidelines, medical terminology, and domain knowledge are essential to the development of ML algorithms for healthcare. Developing and validating models should be the responsibility of experts in the domain.
Dataset size and diversity	Managing healthcare records involves analyzing large and diverse datasets, which makes ML implementation difficult.
Bias and fairness	ML algorithms could be trained, and data could be selected in a way that biases the results. Biased models can result in inaccurate diagnosis and treatment recommendations.
Data integration and interoperability	Healthcare data are fragmented across different systems and resources, making it difficult to integrate and extract meaningful insights from them. ML techniques require large and diverse datasets to produce accurate results. Ensuring data integration and interoperability is crucial for leveraging ML effectively in healthcare record management.
Regulatory and ethical considerations	The use of ML in healthcare raises numerous regulatory and ethical considerations. Healthcare organizations must comply with regulatory requirements related to data privacy, data security, and informed consent. Additionally, they need to consider the ethical implications of using ML technologies, such as the potential for discrimination and bias.

C. Benefits for Policymakers

The findings of this study suggest healthcare policymakers should consider several important factors when designing and implementing healthcare policies in the future: increased efficiency, enhanced data security, personalized care, resource optimization, and integration with other healthcare technologies. Making informed decisions for better health outcomes can be achieved by applying ML techniques to optimize healthcare resources, identify healthcare disparities, and enhance healthcare outcomes. Moreover, ML algorithms can identify improvements that need to be made besides monitoring compliance. Among the significant impacts of this study is that policymakers can optimize the distribution of healthcare resources. Utilizing ML algorithms, policymakers can analyze huge amounts of healthcare data to identify patterns and trends, enabling them to determine the optimum use of resources, such as hospital beds, medical equipment, and healthcare professionals. When policymakers are given the ability to employ these tools in a more effective manner, resources can be allocated to maximize patient outcomes while minimizing cost. Policymakers can also use ML techniques to identify quality disparities among patients.

TABLE III. ADVANTAGES OF ML APPLICATION TO HEALTHCARE RECORD MANAGEMENT

Advantages	Description
Accuracy	ML algorithms are trained on vast amounts of data, making them capable of analyzing complex patterns and relationships. This enables them to accurately classify and extract meaningful information from healthcare records, reducing the chances of errors and inconsistencies.
Speed	ML algorithms can process large datasets quickly, giving healthcare providers the opportunity to access and retrieve information in real time. This increases productivity and allows appropriate decision-making in significant positions.
Data integration	To manage and organize healthcare records, it is often necessary to integrate data from a variety of medical systems, laboratories, and imaging devices. These data can be analyzed and integrated with ML algorithms to ensure their accessibility and normalization.
Clinical decision support	Clinical decision-making can benefit from the analysis of healthcare records by ML algorithms. The algorithms can help healthcare professionals identify patients at risk, recommend treatments, and allocate resources more effectively.
Quality assurance	Healthcare records can be analyzed using artificial intelligence algorithms to detect errors, inconsistencies, and frauds. Therefore, the integrity of the health system is improved, and personal information is safeguarded.
Enhanced efficiency	Healthcare professionals can focus more on patient care and decision-making if ML algorithms automate repetitive and time-consuming tasks.
Improved data accuracy	When using ML techniques, it is possible to validate and clean data, reducing errors and inconsistencies.
Streamlined access	Health professionals will be able to access relevant information no matter where their records are stored by ML-powered systems that integrate multiple data sources.
Enhanced security and privacy	Algorithms based on ML can be used to encrypt and protect healthcare records.
Research and innovation	ML techniques can be deployed to identify patterns, trends, and associations in healthcare records so that medical research and the development of new treatments can be facilitated.

IV. CONCLUSION

The need to manage and organize healthcare information is becoming increasingly important as medical data grow exponentially. Through identifying the challenges, advantages, and limitations associated with ML, this study focused on how ML technology can be implemented to optimize healthcare record management. Therefore, the study contributes to the understanding of how ML can be applied in healthcare settings. The findings of this study furnish meaningful input that can help healthcare professionals, researchers, and policymakers make sound decisions regarding the employment of ML techniques for retaining and handling healthcare records. As a result of discussing the ML usage to better regulate patient data, this research may ultimately produce enhanced patient results and healthcare provision. Since ML engages different perspectives and an efficient approach, it was found advantageous in dealing with healthcare records. Future work could be concentrated on developing a comprehensive system for arranging and systematizing healthcare records utilizing ML.

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