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POTENTIAL OF IMPLEMENTING ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN ENHANCING HEALTHCARE OPERATIONS AND ADMINISTRATIVE PROCESSES

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Abstract

Professionals in the field of life sciences who specialize in Artificial Intelligence (AI) and Machine Learning (ML) are facing growing demands to expedite the development of algorithms. The potential to uncover novel insights and accelerate advancements resides in the use of extensive datasets that are integrated across several levels. Despite the abundance of available data, only a small fraction is being processed, interpreted, combined, and evaluated. This technology focuses on the examination of how computers may acquire knowledge from data and replicate human cognitive processes. AI and ML provide both an augmentation of learning capacity and the implementation of a decision support system that is reshaping the future of healthcare. This article provides an overview of the applications of artificial intelligence (AI) and machine learning (ML) in the healthcare sector. It focuses on how these technologies are used in clinical, developmental, administrative, and global health settings to enhance the overall healthcare system. The article also discusses the effects and anticipated outcomes of each aspect of healthcare. In addition, the potential future trends and applications of this technology in medical infrastructure have been addressed.

Keywords: medical infrastructure, healthcare records, artificial intelligence, AI in healthcare, deep learning, machine learning, healthcare and AI

1. Introduction

Artificial Intelligence (AI), as shown in Figure 1, was first used in the medical field in 1976. During this time, a computer program was employed to identify the causes of severe abdominal discomfort [1]. Since the first integration of AI in healthcare, a wide range of AI applications have been launched to improve the capabilities and address the limitations of existing medical infrastructure. These implementations encompass aiding in the detection of diseases, such as diabetes or cancer; improving the classification of pathology, such as categorizing radiology scans and identifying electrocardiogram characteristics for cardiac research [2]; and predicting

illnesses using algorithms based on Machine Learning (ML) and Deep Learning (DL) techniques, specifically developed to address challenges like the COVID-19 pandemic [3,4], serving as a prime example. Nevertheless, despite the substantial financial commitment made by the healthcare sector towards technological progress, the implementation and incorporation of these developments in healthcare are still in their early phases [5]. The shortage and fatigue of the workforce, as well as the shift towards long-term care for illnesses, are major issues in the healthcare sector. Therefore, artificial intelligence has the potential to greatly improve the healthcare infrastructure due to its wide range of applications.

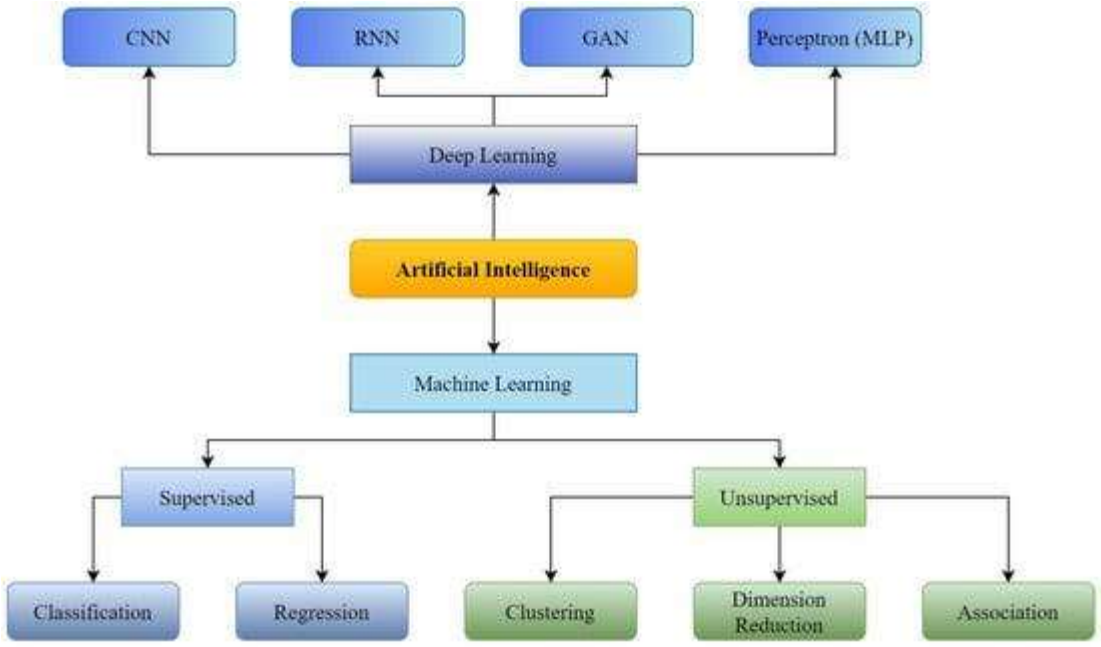

Figure 1. Supervised and unsupervised machine learning are two approaches within the field of deep learning, which includes convolutional neural networks (CNNs), recurrent neural networks (RNNs), and generative adversarial networks (GANs).

Artificial intelligence is considerably transforming the medical infrastructure by changing the diagnosis of numerous illnesses via the use of medical imaging from diverse formats such as X-rays, MRI, CT scans, and others. Artificial intelligence can readily identify skin problems, respiratory conditions, organ-related ailments, and viral disorders. Examples of skin illnesses include skin cancer, acne, and rashes. Timely detection of certain dermatological conditions might avert serious future complications. In addition, researchers such as Shoieb et al. [6] categorized skin cancer by using existing data that included photographs of malignancy. Their findings demonstrated a significant improvement in the accuracy and precision of skin diagnostics compared to previous research. Zaher et al. [7] and Charan et al. [8] proposed a methodology for identifying breast cancer using the analysis of radiography images. In addition, lung cancer, similar to skin and breast cancers, is one of the most lethal diseases globally [9,10], resulting in 7.6 million deaths annually worldwide [11].

Furthermore, the one remedy to decrease this figure [12] is the prompt identification of this lethal illness. Several studies [13,14,15,16,17] have suggested artificial intelligence (AI) and machine learning (ML) methods to forecast lung cancer utilizing different data sources. In addition to these uses, researchers have used artificial intelligence (AI) for the identification of malignancy [18], TB [19], and even COVID-19 diagnosis [20], mostly using chest X-rays. The use of medical imaging for illness diagnosis and prognosis is generally recognized and growing due to significant advancements in traditional medical infrastructure.

2. Image data

The image data is capable of being interpreted by machines, enabling the execution of ML and DL algorithms after appropriate preprocessing or quality assurance procedures. In addition, a significant portion of healthcare data, such as clinical laboratory results, physical exams, discharge summaries, and operation notes, often exists in a narrative format, making it shapeless and difficult for computer algorithms to access. In this context, Natural Language Processing (NLP) seeks to extract pertinent information from the existing data set in order to assist in making clinical assessments [21].

Natural Language Processing (NLP) utilizes text processing techniques to identify disease-related terms in medical data, as indicated by previous records [22]. After evaluating their impact on classifying normal and atypical cases, keywords are chosen. As an example, Miller et al. [23] used Natural Language Processing (NLP) to monitor unfavorable incidents in the laboratory setting. Furthermore, NLP pipelines may assist in the identification of diseases. This method has also been used to identify different disease-related characteristics for cerebral aneurysms by analyzing clinical records [24] in order to differentiate between healthy persons and those with cerebral problems.

In addition, Afzal et al. [22] used natural language processing (NLP) to extract terms relevant to peripheral arterial disease from clinical narratives. These were then used to distinguish between people with peripheral arterial disease and those without the condition. Natural Language Processing (NLP) is not only used to gather information on diseases, but it is also being investigated for the purpose of identifying different aspects associated to suicide [25]. This is done by creating a specialized database or vocabulary specifically for analyzing suicide notes. In addition, this field of Artificial Intelligence is used for assessing mental disorders [26], comprehending the clinical process [27,28], categorizing medical prescriptions [29], predicting patient preferences [30,31], forecasting patient risk and stratification [32], developing decision support systems [33], and answering questions [34]. Juhn et al. [35] have developed an autonomous system that effectively alleviates the workload of medical triage. This system collects patient data and employs natural language processing (NLP) to analyze and interpret it. The system assists patients in selecting a consultant and facilitates other time-consuming procedures that are typically encountered in hospital settings.

3. Robotics

Robotics is the field that concentrates on the creation and advancement of robots. When AI is integrated, it produces a sophisticated computer that can be trained to do complex tasks that need extensive cognitive processing and ongoing learning. As a result, another field of AI focuses on teaching a robot to understand the world based on predictable yet general patterns, manipulate objects in complex environments, and interact with people. Surgical robots are machines capable of performing intricate surgical procedures, including minimally invasive and surgeon-less operations. The systems denoted as [36,37] are widely regarded as the most reliable and effective methods of treatment in several laparoscopic procedures, with an estimated annual volume of one million operations. Robotic surgery improves the efficacy, accuracy, and dependability of surgical procedures, resulting in faster recuperation and improved patient results. In addition to surgical activities, healthcare professionals are responsible for many managerial functions.

AI's implementation in this field has lower flexibility compared to acute treatments, but it may provide significant productivity. Hospitals need administrative duties to be performed efficiently, as shown by the fact that a nurse typically dedicates around 25% of her employment tenure to such chores [38]. This objective is very likely to be linked to the technology of robotic process automation. It is used in diverse medical systems, including user registration, medical documentation, payment flow management, and clinical record-keeping [39]. In addition to patient contacts, mental well-being, telemedicine, and chatbots are often used in several additional medical situations.

Enhancing research and development is crucial for bolstering healthcare infrastructure, since it plays a vital role in its strengthening. Machine learning algorithms, including deep learning, have been applied in various drug discovery processes. These processes include physio-chemical analysis, poly-pharmacology, drug repositioning, quantitative structure-activity relationship analysis, pharmacophore modeling, drug monitoring and identification, toxicity prediction, ligand-based virtual screening, structure-based virtual screening, and peptide synthesis activities [40]. Furthermore, the use of pharmacogenetics and molecular biomarker technologies can accurately predict the effectiveness of drugs and the responses they may cause in individuals, which is crucial for advancing precision medicine [41].

Several influential research [42] have been carried out to revolutionize traditional drug design, including the participation of DeepMind at Google and AlphaFold. AlphaFold is an artificial intelligence tool that has been trained on spatial information of protein binding domains to predict the three-dimensional structure of a protein based on its amino acid sequence. Artificial intelligence (AI) has emerged as a highly efficient tool in modern technology due to its ability to optimize time and financial resources. The quick discovery and development of pharmaceuticals have the potential to save millions of lives under critical situations such as a pandemic. This can be achieved by improving the entire infrastructure, decreasing development costs, and increasing the effectiveness of drugs [43].

Moreover, the provision of inaccurate dose is a common problem in this industry that not only results in financial losses up to millions of dollars, but also undermines the whole infrastructure by elevating the death rate via unintended and lethal side effects [45]. Due to the increasing prevalence of artificial intelligence (AI), many scientists are now using machine learning (ML) and deep learning (DL) approaches to determine the most effective doses for medications. Shen et al. [43] developed an AI-driven system named AI-PRS to identify the optimal dosages and combinations of medications for HIV treatment via the use of antiretroviral therapy. Julkunen et al. [44] developed comboFM, a novel machine learning technique used to identify the best combination and dosage of medications in pre-clinical studies, specifically in the context of cancer cells. CombinationFM use factorization machines, which are a machine learning framework, to evaluate multi-dimensional data and identify the most effective combinations and dosages of drugs. Xue et al. [45] have also discovered an appropriate bioactive substance and examined the administration of the medication.

4. The advancement of AI and ML in the field of medical infrastructure

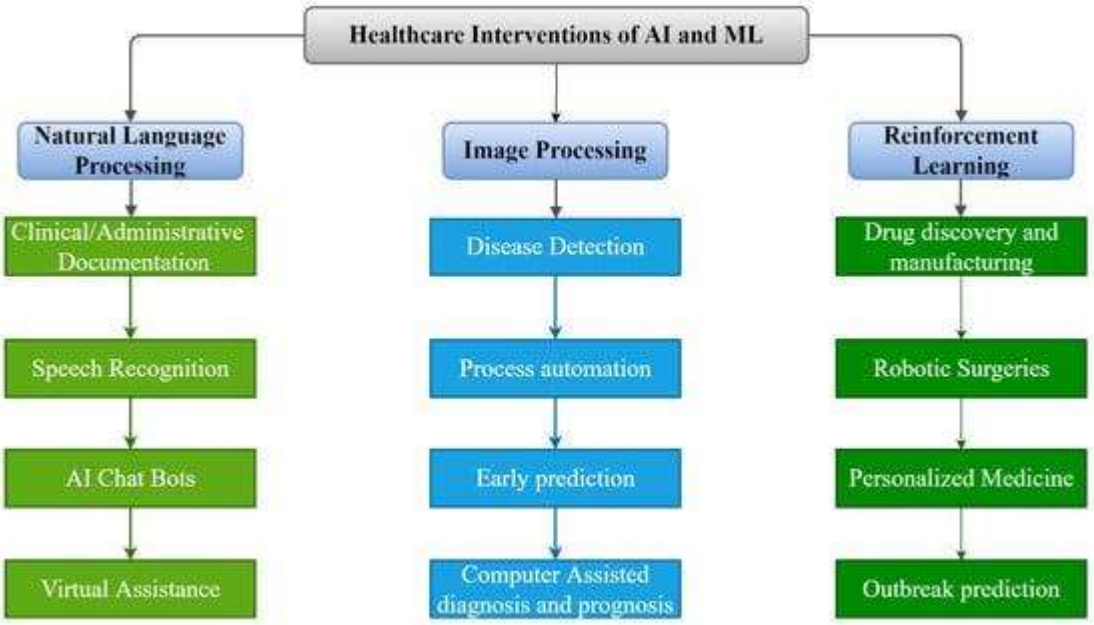

Figure 2 demonstrates the many potential uses of AI and ML algorithms in creating effective solutions to enhance the healthcare infrastructure. AI has had a significant and transformative effect on the medical infrastructure in the last fifty years. The application range of AI and ML has expanded, enabling personalized therapy instead of treatment based on algorithms. It is possible to construct predictive models that may forecast future illnesses, treatment responses, and even preventative medicine using such models [46]. Artificial intelligence has the potential to enhance the healthcare infrastructure by enhancing the precision of diagnoses, optimizing clinical operations and workflow, improving the accuracy of medical procedures, monitoring treatment effectiveness, and ultimately increasing overall patient happiness. The development of AI and ML in medicine is shown in the following timeline.

The use of medical data and other electronic resources has facilitated the application of technologies such as DeepQA to provide expert medical recommendations and relevant information. It offered fresh possibilities for making treatment choices based on empirical data [47]. Bakkar et al. [48] successfully found the binding of RNA proteins using IBM Watson in 2017. The accessibility of digitized medicine has increased as a result of this driving force, together with advancements in computer hardware and software applications. Chatbots have been significantly transformed by Natural Language Processing, enabling them to participate in substantial and meaningful dialogues. In 2011, Apple's Siri, a virtual assistant, used this methodology. Amazon also used a same methodology for their virtual assistant, known as Alexa. Pharmabot and Mandy are chatbots that were created in 2015 and 2017, respectively, with the purpose of assisting young patients and their parents in gaining a clearer comprehension of their prescriptions [49,50].

Convolutional neural networks (CNNs) are extensively used in image processing for the purpose of feature recognition and learning. CNN employs many layers to analyze a picture and identify certain patterns in order to create customized filters. Various CNN algorithms, including Le-NET, AlexNet, VGG, GoogLeNet, and ResNet, are already easily available [51]. These models are valuable for analyzing medical images and may be used in other sectors to enhance the entire infrastructure by empowering every component of the healthcare industry. MetaAI is a prominent research organization that focuses on using AI and ML algorithms for various applications such as Computer Vision, Conversational AI, Integrity, Natural Language Processing, Ranking and Recommendations, Systems Research, Speech and Audio, Robotics, and Graphics. MetaAI, along with other major tech companies like Google, Amazon, and Microsoft, invest significant resources in these areas. Research may be found in several healthcare fields, such as Google's investigation into illness diagnosis in eyes using external photos, and Microsoft's exploration of biomedical natural language processing [52,53]. These advanced research studies focus on healthcare as they verify large-scale databases and their variety.

5. Summary

This paper provides a thorough analysis of the applications and effects of using Artificial Intelligence and Machine Learning in healthcare infrastructure. We observed the utilization of Artificial Intelligence (AI) and Machine Learning (ML) in the medical field, encompassing many applications such as diagnosis, prognosis, research and development, procedures, and administrative activities. This paper also offers a concise overview of the historical development and practicality of AI and ML approaches in enhancing healthcare. The text explores the fundamental contributions that Artificial Intelligence and Machine Learning have made in this domain by empowering robots to mimic human behavior or exhibit intelligent capabilities. Additionally, this research incorporates case studies and quantitative analysis to comprehensively comprehend the underlying purpose from an infrastructural standpoint. This approach offers a distinct comprehension of the use of sophisticated technology in healthcare,

considering the perspectives of both patients and hospitals. Multiple research and prominent technology firms have shown the transformative potential of artificial intelligence (AI) and machine learning (ML) in revolutionizing the healthcare industry. Implementing this technology on a worldwide scale in the present situation would be difficult due to the need for substantial financial and monetary assistance to stabilize it and replace existing methods. Nevertheless, via more investigation and a sufficient amount of time, it may be feasible to diminish healthcare expenses and enhance the general robustness of the medical industry by delving into the possibilities of these technologies.

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