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Review Article

Essential Elements Required for a Successful AI Application in the Healthcare Industry

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Abstract

In a broad sense, artificial intelligence (AI) is any behavior shown by a computer or other system that is comparable to human behavior. Thanks to a type of artificial intelligence called "machine learning," computers can learn from data without explicit human programming. One of the most significant contemporary developments in international healthcare is the use of artificial intelligence (AI) technologies in medicine. Because artificial intelligence-based technologies enable a dramatic reconstruction of the medical diagnostics system and a commensurate reduction in healthcare costs. A sickness must be classified into the appropriate class of illnesses before therapy can start. The disease type can be categorized based on the feature space of the illness. Machine learning algorithms can help address this challenge. This article covers the essential elements required for a successful AI application in the healthcare industry.

Keywords: *Components, Algorithms, Machine Learning, Healthcare, Artificial intelligence (AI), Chronic Diseases.*

I. INTRODUCTION

Due to the limited flexibility of traditional programming techniques, it is becoming increasingly challenging to manage, analyze, and respond to the daily surge in data production. Systems that can learn from data by identifying patterns and connections across data sets to improve predictions are becoming more and more in demand today. Artificial intelligence's machine learning subfield enables computers to learn from data without explicit human programming [32]. In a broad sense, artificial intelligence (AI) refers to any computer or system behavior that resembles human behavior. The most basic kind of artificial intelligence is the "imitation" of human behavior by computers, which is based on considerable data on previous instances of the same behavior. The same task of utilizing computers to understand human intelligence is connected to artificial intelligence (AI), which is not always restricted to biologically logical approaches. In the twentyfirst century, the field of AI has grown steadily. With dramatic revolutions influenced by both ideas and tactics, the evolution of AI has improved the development of human society in our own time [1]. Deep learning, machine learning, and artificial intelligence are all areas of active research. And it appears that it may soon be able to fully replace human intelligence. The study of artificial intelligence, or AI, is a branch of computer science that focuses on creating intelligent computer systems, or systems that possess the skills that are typically associated with the human mind, such as language comprehension, learning, the capacity for reasoning, problem-solving, etc. Later, a variety of software programs and algorithms started to be referred to as AI; its defining characteristic is that they have the ability to answer some issues in the same way that a human would. For instance, AI is just starting to permeate medicine through speech processing [2], natural language text processing [3], object identification [4], voiceprint recognition [5], robotics [6], handwritten character recognition [7], expert systems [8], and medical diagnostics [9]. There have already been a lot of intriguing computer algorithms and inventions in this field, but they are still a long way from being widely used because they lack clinical evidence of their efficacy. However, it should be acknowledged that narrowly focused artificial

intelligence will firmly take its position given how swiftly this subject has progressed over the past few years and the fact that computers are now outperforming people in solving specific medical problems, which will rise significantly. All areas of human activity—including medicine and healthcare—have been affected by AI technologies. The medical professional must stay current with the most recent developments in medical science. A doctor cannot treat patients, rest, update knowledge, and maintain it in his thoughts at the same time, hence they cannot perform this task as quickly as AI [25, 30-31]. AI can keep all the information gathered and regularly update research data. The adoption of such technology will simplify life for medical professionals. In fact, one of the most significant aspects of healthcare that AI technologies may aid with is the treatment of chronic diseases. Broadly speaking, chronic diseases are problems that last for a year or longer and necessitate continuing medical care, restrict daily activities, or both. The main causes of death and disability worldwide are chronic illnesses such renal disease, heart disease, cancer, and diabetes. The annual investment in AI had a modest decline in 2018, however it was only momentary. The majority of total corporate investments in AI are private. The amount invested in artificial intelligence initiatives for the healthcare industry worldwide in 2021 increased to $11.2 billion from $8 billion in 2020. The Stanford Institute for Human-Centered Artificial Intelligence released such statistics in March 2022. The study found that from 2017 to 2021, the "attractive" businesses for private investment in the artificial intelligence market were those related to medicine and healthcare. During this time, core projects received a total investment of more than $28.9 billion [10]. Automation and increasing the precision of diagnostics are two crucial topics. The classification of diseases is one method for increasing the precision of diagnosis. AI in the form of machine learning (ML) [11] enables the classification of illness kinds that are similar to one another in terms of a parametric factor. And one of the fundamental machine learning algorithms used for classification is K-Nearest Neighbor (KNN) [12]. A neural network can also be used to tackle the categorization problem [13]. High-performance hardware is needed for deep learning algorithms that use huge datasets, such as heterogeneous computing systems [14] or parallel computing techniques. At the moment, parallel and distributed computing technologies [15, 16] can also be used to overcome this issue. The major goal of this study is to choose significant parametric variables from the gathered disease data that produce more F1-score outcomes. For classification, two forms of coronary heart disease were chosen. It is suggested to use the KNN algorithm for categorizing coronary heart disease. It can be viewed as an algorithm that, when used with the training dataset, generates predictions based on the characteristics of other data points that are present adjacent to it [22]. In medical data mining, hidden patterns in datasets are discovered. For the early diagnosis of cardiac disease, a supervised algorithm like KNN is employed. The most well-known, successful, and efficient algorithm for pattern recognition is KNN, a frequently used lazy classification algorithm. The distance measure and K value both affect how accurate KNN is. Cosine and Euclidean distance are two other methods for calculating the separation between two instances. KNN determines its closest neighbors and determines a class by majority vote in order to evaluate a fresh unknown sample [17]. When the training sample is large, lazy learning techniques like the KNN classifier can be expensive to use because they need to store the whole training sample. In order to reduce storage and processing needs, the compressed closest neighbor classifier incrementally caches a portion of the sample [18]. Due to its ease of use and relatively quick convergence speed, KNN is growing in popularity [19]. Medical information technology has advanced toward intelligence as a result of the quick growth of information technology. For the intellectualization of medical information, the classification of large data in health care is extremely important. The KNN classification technique is straightforward, which has led to its widespread application in numerous disciplines [20]. One area of healthcare that might be categorized is coronary heart disease (CHD). The Center for Specialized Cardiology's medical personnel and the CHD statistics were both discussed. The CHD dataset was collected from the National Center for Health Statistics (NCHS) [21]. The main developments in machine learning will be discussed in this paper, including automated data analysis for patient health records and data-driven prediction. The advancements in computer-aided diagnosis, medication discovery, and personalized medicine will also be contrasted [23]. It is impossible to stress the importance of using big data analytics and machine learning to improve patient outcomes and healthcare performance. With the use of these technologies, healthcare professionals are now able to gain useful insights from big datasets that were previously unexplored, opening up a whole new world of opportunities. By utilizing these information, medical professionals can decide more intelligently about tailored medicine, treatment plans, and resource allocation, ultimately improving patient outcomes and making the healthcare system more effective. Healthcare professionals may now more easily spot trends, correlations, and risk factors thanks to the ability to analyze enormous amounts of healthcare data. This information enables early disease detection, disease prevention, and patient-specific treatment approaches [24]. In this opinion piece, we will examine AI's enormous influence on medicine while noting both its possible advantages and impending difficulties [27]. The application of AI and ML in healthcare has grown in importance, creating new opportunities for innovation, precision medicine, and better decision-making. It is essential to investigate the potential, difficulties, and ethical ramifications of integrating AI and ML into healthcare as we set out on this transformative journey. The field of diagnostics is one of the primary areas where AI and ML have demonstrated tremendous promise. These technologies can swiftly and precisely find trends, spot anomalies, and help with disease diagnosis by analyzing enormous amounts of medical data. The early diagnosis of diseases like cancer and better patient outcomes are made possible by AI-powered algorithms' outstanding accuracy in analyzing medical images like X-rays and MRIs [28]. A general taxonomy of machine learning algorithms is presented in this overview, which is followed by a more in-depth explanation of each algorithm class, its function and capabilities, and examples of applications, particularly in geriatric

medicine. Additional emphasis is placed on the implications for clinical practice, the difficulties associated with depending on devices with limited interpretability, and the advancements made in overcoming the latter through the creation of explainable machine learning [29]. Examining how machine learning technologies might enhance healthcare operations management is the goal of this study. To accomplish this research goal, a machine-learning-based model to address a specific medical issue is created. This study specifically uses the CNN (convolutional neural network) technique to propose an AI solution for diagnosing malaria infection. A total of 24,958 photos were used for deep learning training using malaria microscopy image data from the NIH National Library of Medicine, and 2600 images were chosen for final testing of the suggested diagnostic architecture. The empirical findings show that, with minimal misclassification and performance metrics of precision (0.97), recall (0.99), and f1-score (0.98) for parasite cells and precision (0.99), recall (0.97), and f1-score (0.98) for uninfected cells, the CNN diagnostic model correctly identified the majority of malaria-infected and non-infected cases. The CNN diagnostic solution processed a large number of cases quickly and with a 97.81% accuracy that could be relied upon. The k-fold cross-validation test was used to further validate the performance of this CNN model. These findings imply that machine learning-based diagnostic techniques have an edge over traditional manual diagnostic techniques when it comes to enhancing operational capacities in the healthcare sector in terms of diagnostic quality, processing expenses, lead times, and productivity. In addition, by lowering the probability of unneeded medical disputes connected to diagnostic errors, a machine-learning diagnosis system is more likely to improve the financial viability of healthcare operations. Propositions with a research framework are offered to examine the effects of machine learning on healthcare operations management for safety and quality of life in international communities as an extension for future research [33].

II. KEY COMPONENTS NEEDED FOR AN EFFECTIVE AI IMPLEMENTATION IN THE HEALTHCARE SPACE

1. **Transparency**
   Transparency is the most important element that success requires. Furthermore, transparency fosters trust, which is another reason it's so crucial. It is practically useless if physicians and other healthcare executives cannot rely on the technology to provide accurate and trustworthy insights.
2. **Learnability**
   Providing feedback and allowing end users and doctors to be directly involved in the solution's improvement is one strategy to foster that confidence. First, this contributes to transparency by giving them a better understanding of the algorithm's internal workings. Second, the algorithm will unavoidably get better. Third, there is a greater likelihood of buy-in when physicians perceive themselves as part of the growth process.
3. **Tied to a Value Component**
   The path forward with anything is neither technology for technology's sake or data for data's sake. Any AI solution must be connected to a value component, or a statistic that significantly and positively alters the organization's objectives. Often, the ideal approach is to begin at the problem, have a thorough understanding of it, then work your way backward. Rather than developing it first and then determining how to use it, the solution ought to be founded on a precisely defined problem and the data required for that specific challenge.
4. **Targets**
   These AI solutions must have well-defined goals in addition to being connected to a value component. Metrics are fun to discuss, but targets and goals are frequently forgotten. Readmission rates may be the statistic, while a particular percentage may be the goal. Furthermore, it restricts the solution to small changes and lowers the ceiling of change, even though benefits are still feasible without it. But when there are well-defined goals, the team can test important presumptions and push the boundaries of what is feasible. This is the starting point of revolutionary change.
5. **Intangible Goals**
   It’s easy when you start to delve into the data realm to forget the intangibles. Remember, not everything meaningful is measurable, and that’s a critical thing to focus on here. What we need to do is get to the relentless obsession of understanding what really means something to people across functional, social, and emotional dimensions of progress. It’s a tall task, but the truly transformative solutions and business models are born out of a deep understanding of these measures [39].

III. Benefits of AI in the Health Sector

AI is currently being extensively tested in hospitals for drug discovery as well as diagnosis and symptom prediction. Here are some of its most promising prospects:

1. Diagnostic Assessment

Electronic health records (EHRs), radiography, CT scans, and magnetic resonance images all produce large volumes of data that AI can analyze. AI systems can assist with early symptom forecasts by analyzing data from patients, identifying trends, and identifying relationships.

2. Virtual Health Assistants

Virtual health assistants are in charge of carrying out a range of duties, including returning normal patient calls and

emails, monitoring medical records, safeguarding private patient information, setting up doctor appointments, and reminding patients to schedule follow-up appointments. Because it offers patients a personalized experience in managing their health and responding to their questions, it is one of the most beneficial AI applications in healthcare.

3. Treatment of Rare Diseases

In order to speed up the discovery and development of cutting-edge breakthrough medications and vaccines and revolutionize the delivery of healthcare, BERG, an AI-based clinical-stage biotech platform, aims to map diseases. It combines interrogative biology with research and development (R&D) to enable medical professionals to create durable products for people battling rare diseases.

4. Targeted Treatment

Benevolent AI, a prominent clinical-stage AI-enabled drug development business, was able to offer the proper treatment to the required patients at the correct time with the use of technologies like deep learning and AI, leading to tailored treatment of patients with helpful insights. The company is currently focused on developing portable remedies for uncommon diseases and securing licensing for its medications.

5. Drug Discovery

Artificial intelligence uses neural networks to evaluate drug candidates' characteristics and bioactivity. With the aid of AI systems, researchers can determine the optimal therapeutic targets to investigate for specific diseases. The healthcare sector has seen an increase in speed and a decrease in investment in drug discovery as a result. It has proven important in clinical trials in the selection of the correct candidates [34].

APPLYING AI IN THE HEALTHCARE SECTOR: DIFFICULTIES

1. Data Privacy and Security: Large volumes of patient data are needed for the application of AI in healthcare, which presents issues with data security and privacy. Ensuring that patient data is safeguarded against unauthorized access and that patients have authority over its usage is crucial.

2. Bias in the Data: If the training data for AI systems is not representative of the people they will be used to assist, then the systems may become prejudiced. This could provide unfair or erroneous results, especially for underrepresented communities.

3. Lack of Transparency: Because it might be challenging to decipher how an AI system arrived at a given choice, many of them are referred to as "black boxes". Physicians and other medical experts may find it challenging to trust the outcomes of an AI system due to this lack of transparency.

4. Regulation and Governance: At the moment, there aren't many precise laws and policies governing the application of AI in healthcare. Patients may find it challenging to know what to anticipate when interacting with an AI system, and healthcare institutions may find it challenging to employ the technology appropriately.

5. Lack of Understanding: It's possible that many patients and healthcare professionals are unaware of AI's limitations and how it functions. This may result in irrational expectations and misplaced faith in technology [35].

V. CONCLUSION

This article discusses how machine learning techniques are being used in the healthcare industry to manage massive volumes of patient data and cut down on the time, money, and resources needed for its analysis. Due to evidence that these technologies enhance hospital experiences for patients and are more accurate than diagnoses given by licensed physicians, they are currently in high demand [37]. It was also emphasized that as these instruments are designed to work in conjunction with doctors, training is required before they can be used for their intended purpose. The advantages of AI for the medical field are highlighted [36]. The challenges of implementing AI are also thoroughly discussed [38].

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