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Using Artificial Intelligence Technologies in Healthcare: Review

Mofeda Abdelrrazik Abdelwakil[1], Salem El Khiralla[2], Nura Mohamed.A.[3]

College of Computer Technology- Benghazi

alimady8216@gmail.com [1], salemteacher15@gmail.com [2]

noormhamed945@gmail.com [3]

الملخص

يتجه العالم إلى التحول نحو الذكاء الاصطناعي في الرعاية الصحية، ويرجع ذلك إلى زيادة التضخم في حجم البيانات وتعقيدها، أدى ذلك إلى استخدام تطبيقات الذكاء الصناعي من قِبل مقدمي الرعاية الصحية.

مع زيادة إمكانيات الذكاء الاصطناعي يمكن الآن تطبيقها على البيانات في مجال الرعاية الصحية سواءً كانت هذه البيانات مهيكلة أو غير مهيكلة بحيث يتم استخدام تقنيات الذكاء الاصطناعي طرق التعلم الآلي للبيانات المهيكلة، والتعلم العميق الحديث وأيضاً معالجة اللغة الطبيعية للبيانات غير المهيكلة الذي أعطي تقدم إيجابي في الاكتشاف المبكر لعدة أمراض وكذلك التشخيص والعلاج وإعطاء النتائج، مع استخدام البيئة السحابية لإدارة البيانات أصبحت هذه البيانات متاحة على إطار آني مما سرَع في عمليتي التحليل وإظهار النتائج بدقة أكثر بدلاً من عملية تجميع البيانات التقليدية التي كانت تأخذ فترة من الزمن وبأقل دقة.

Abstract

The quantity and complexity of data in the healthcare industry have increased, justifying the use of artificial intelligence technologies. And indeed, several applications of artificial intelligence have been employed by healthcare providers and life sciences companies in general, which have given a significant leap in this field. Because these apps accomplish tasks faster than humans do, they are now used in medical diagnoses, the proper administration of care, and

the majority of administrative tasks. Now artificial intelligence can be applied to different types of data in healthcare. Modern deep learning, natural language processing, and machine learning algorithms for structured data all use techniques that have a positive impact on disease early detection and improved medical diagnosis.

Keywords : Artificial Intelligent – Machine Learning – Deep Learning – Natural Language Processing – Electronic medical records.

1. Introduction

At the beginning of the twenty-first century, the technological revolution broke out, and the rapid and continuous development in the world of technology and artificial intelligence, which includes genetic algorithms, neural networks, and machine learning has increased. AI uses mainstream technologies to solve problems in many fields such as image recognition, voice recognition, and other massive applications that deal with analyzing large amounts of data. AI has contributed to healthcare, such as clinical and patient applications, by relieving pressure on workers and reducing costs [1]. AI offers a great deal of promise to boost healthcare safety, from increasing diagnostic precision to enhancing treatment planning and predicting medical outcomes. AI is already more effective than radiologists in detecting cancers and guiding researchers on how to set up pricey clinic clusters, so it can perform better than humans in conventional health care. [2]. However, the integration of artificial intelligence technologies into healthcare delivery may lead to amplifying existing risks as well as a range of new risks. For example, failures in widely used programs can quickly affect large numbers of patients; As hypotheses are hidden in underlying data and models, AI systems can lead to dangerous recommendations that are not recommended in healthcare, and obscure AI techniques such as deep learning can make explaining and learning from failure very difficult for practitioners, so accurate prediction will be necessary. [3].

This paper is organized as follows: Section 2 history of AI in healthcare; Section 3 Machine Learning in healthcare; Section 4 Deep learning in healthcare; Section 5 Natural data processing using

deep learning; Section 6 Electronic medical records; Section 7 Approaches for Deep Learning in Healthcare; Section 8 the relationship of automated machine learning in healthcare; Section 9 AI Applications used in healthcare and Section 10 Limitations and Challenges.

2. History of AI in healthcare

Over the past fifty years, technological development has led to the creation of artificial intelligence applications in the realm of medicine, and the first expert system known as Dendral has been used. It was designed for biochemical applications, from which MYCIN was derived, which is considered to be one of the most important applications of AI in medicine. Developers and researchers design AI systems in the medical field to compensate for ambiguous and unclear data based on physicians' experiences. The path from the creation of clinical data through NLP data enrichment and machine learning (ML) data analysis to clinical decision making is illustrated in (figure 1) as a road map. [4].

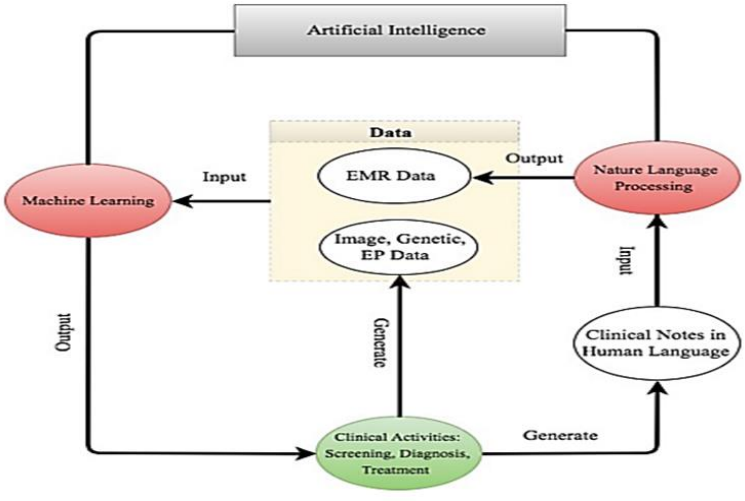

Figure 1 shows the flow from the collection of clinical data via NLP data enrichment, ML data analysis, and clinical decision making.

It is made possible to quickly decide on urgent instances due to highly accurate AI systems that extract crucial, therapeutically

important information from a large amount of data. The combination of the increasing data processing speed, the sheer amount of data, and the sheer power of AI have enabled the rapid development of AI tools and technologies for the healthcare field [5]. To be precise, deep learning (DL) is of great importance to the development of AI tools today. Whereas, DL allows solutions to data that are too complex to be rendered using old machine learning algorithms, since ancient ANNs had only 3-5 layers of connections, while modern DL synthetic networks had more than 10 layers, which makes it compatible with simulating millions of big data. For example, IBM Watson and Google's Deep Mind are currently being used for many healthcare-related applications, since IBM Watson is used in the investigation and detection of diabetes, early detection of cancerous tumors, and the nomination of drugs appropriate to the clinical condition of the disease [6].

3. Machine Learning in Healthcare

Due to its capacity to diagnose numerous diseases early on, machine learning techniques have become crucial in the field of healthcare. And from a previous study, we saw those diseases such as heart disease, breast cancer, diabetes, and thyroid diseases were diagnosed, as naive Bayes provided 86% accuracy for diagnosing heart disease. SVM provided an accuracy of up to 96.40% for diagnosing breast cancer, and CART provides 79% accuracy for detecting diabetes. In the future, there will be attempts to improve the accuracy of predicting breast cancer using different machine-learning algorithms [7].

4. Deep learning in healthcare

Deep learning, a branch of machine learning (ML), has grown exponentially in the past few years, built on computational power and big new data. This field has seen strong developments in the ability of computers to understand and process data, including images, language, and speech. Healthcare is benefiting from deep learning due to the volume of large data, blurry images, and the plethora of medical devices and digital recording systems [8]. For example, CNNs are an algorithm intended to process data at a sampling location and classify images based on it. CNNs have

evolved to become dominant in this field. The most recent research demonstrated astounding outcomes for CNN in difficult-to-diagnose cases. [9].

5. Natural data processing using deep learning

Large data, test results, diagnostic codes, and static combinations of both structured and unstructured big data contained in EHRs are all subject to supervised learning for prediction. Supervision is done by compressing data and then recreating it to predict specific diagnoses. Whereas, deep learning is used with convolutional neural networks to monitor the chronology of events contained in the patient's electronic record in order to predict the future medical condition. As such, it remains uncertain how techniques derived from these data will be generalized to more widespread case sets in the future [10].

6. Electronic medical records

Clinical data management, including its collection, storage, normalization, and tracking, is the basis of the relationship between artificial intelligence and healthcare. In fact, it is the crucial stage in the "cognitive assistant" with the analytical and inferential ability to know the clinical data of the case. Its sifters the data and prepares it to enter the nervous networks and thus conducts deep learning from it to be ready for making critical clinical decisions, for example identifying the case quickly and accurately while predicting its complications in the future [11].

7. Approaches for Deep Learning in Healthcare

The outcomes of deep learning and intelligent neural networks, which input is taken from electronic records, are raising the bar of validity in the early diagnosis of diseases as a result of the extraordinary advancement of technology. [12]. Although neural networks simulate the neurons in the human brain, where the human brain uses basic information that grows and learns from events over time to become accumulated experiences, quite the opposite with intelligent neural networks, its learning is subject to supervision [13]. While the question still remains about the mechanism of the human brain, and with the work of research, discoveries, and the

development of genetic algorithms, the efficiency of deep learning will increase dramatically in the coming years, and its application to the healthcare field will increase rapidly [14].

8. The relationship of automated machine learning in healthcare

The genetic algorithms are an automatic learning process, but the selection of the most appropriate ones requires human expertise, and the experimentation process depends on data, software resources, devices, and human resources with experience in statistics and mathematics to be programmed to reach the selection of the optimal algorithm for highly efficient ML. It uses Auto ML self-learning algorithms to predict examinations of clinical cases [15]. It is used in discovering diseases, choosing appropriate medications, and predicting the exacerbation of the clinical situation, based on the electronic records that are entered into the artificial network, and the accuracy of its results was 98.51% [16]. Within the framework of scientific research, the results of the past two decades have been the overlap of AI applications with clinical medicine, and this is illustrated in Figure 2 [17].

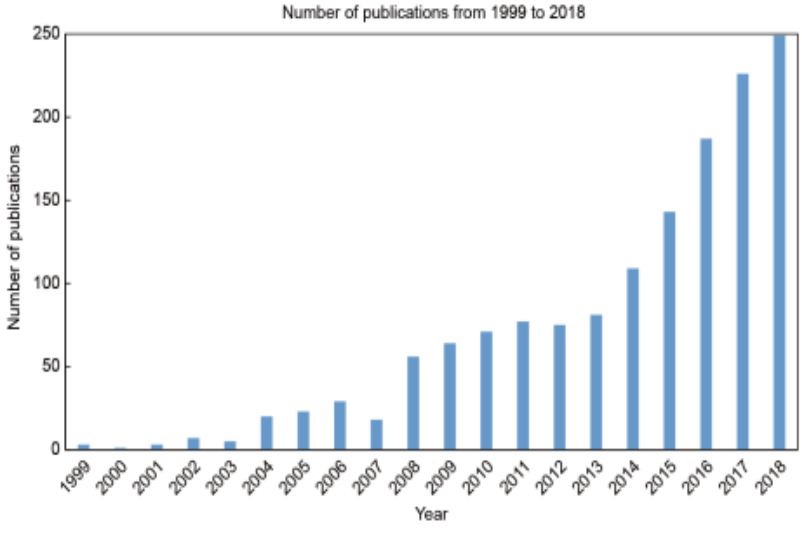

Figure 2 shows the increase in use of AI applications in healthcare.

In order to use micro-tools during procedures that a human surgeon is unable to use, a robot can be deployed which accelerates the patient's recovery up to 21% faster than the human surgeon do [18]. This technology relies on Natural Language Processing (NLP), which relies on converting speech into texts and feeding them to neural networks to obtain the most accurate proportion of the processed text. Table 1 shows the NLP systems developed for use in healthcare [19].

System Name	Brief Description
ASLForm	It is an adaptive learning system that has some fundamental rules for finding a target text. As a user selects output, it continuously and simultaneously updates.
COAT	It is a clinical note-processing system that is rule-based and uses machine learning (through WEKA) components with the integration of MetaMap Transfer.
LEXIMER	It was implemented to render medical imaging and has the findings from CT and MRI reports.
Barrett et al. (unnamed)	It can identify 17 serious sentinel events such as sepsis, dyspnea, and delirium in palliative carte consul: letters.
Martinez et al. (unnamed)	It takes NegEx, Genia Tagger, and MetaMap as input and can classify cancer staging pathology reports.
Otal et al. 2013 (unnamed)	It can detect T cancer staging and classification. It uses WEKA.
Wiereke et al. 2015 (unnamed)	It can extract results from breast pathology reports, and if high NPV and high PPV classifiers do not agree, then it is sent for manual review.

ML has also excelled in sorting magnetic resonance images (MRI), CT scans, and others, and it detects abnormalities in images and gives more accurate results, making it easier to take appropriate decisions for the clinical case, Figure 3 illustrates the classification of medical images that assist physicians and radiologists in medical diagnosis [20].

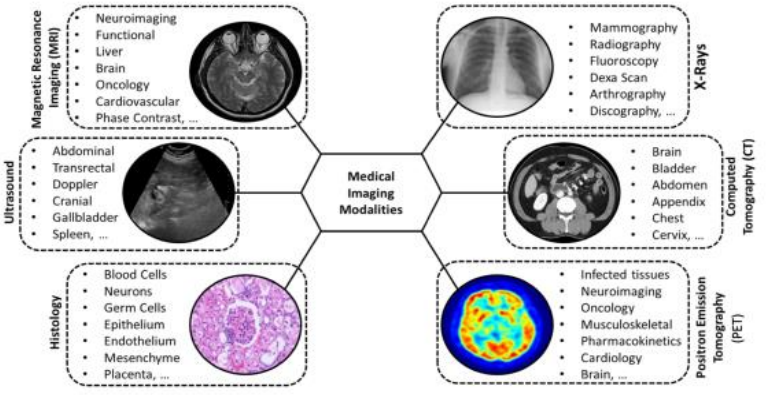

Figure 3: Classification of medical imaging.

9. AI Applications used in healthcare

A South Korean company SK Telecom has released the AI speaker "Aria" which is a smart device that operates through the human voice. When the user is unable to use other devices due to physical impairment, numerous mishaps, or being elderly, Aria can place emergency calls. Once the user says the word "Aria, please help", Aria contacts the care center or the concerned family members for emergencies. There is also a safety platform that provides security services in South Korea. If the center decides that it is an emergency, it will report the incident by calling 119 (the emergency number in South Korea). This platform has already saved many elderly people who live alone.

Today, many startups want to provide healthcare solutions and services using AI-based technologies and applications such as: (e.g., Freenome, an AI genomics biotech company in San Francisco; Recursion Pharmaceuticals in Salt Lake City; and Benevolent AI in the UK; etc.) [21].

10. Limitations and Challenges

Despite the fact that using artificial intelligence applications has become crucial in the age of big data, there are obstacles and constraints that prohibit its best use. For example, deep learning requires a large amount of data about patients, which often cannot

be obtained due to patients' privacy concerns about sharing their data. Also, the data received from healthcare institutions is incomplete, which negatively impacts the effectiveness of applying artificial intelligence [22]. In addition, one of the main ethical challenges that must be addressed for the optimal use of AI in healthcare is informed consent for use, safety and transparency, and data privacy. This is followed by an analysis of legal challenges for some countries, such as liability, data protection, privacy, cyber security, and intellectual property law. These key factors will help to successfully create an AI-driven healthcare system that gains public trust to achieve a desirable societal goal that benefits all [23]. Moreover, collecting patients' data and photos to test AI algorithms becomes difficult due to the dispersion of medical data across numerous EHRs and IT platforms. Another challenge is that due to interoperability issues, medical data from one institution could not be interoperable with other systems. The healthcare industry must focus on methods for standardizing medical data in order to expand the amount of data available for testing AI systems. Despite impressive possibilities, the real deployment of AI-enabled solutions in clinical practice is still limited. Besides privacy challenges, AI technology also presents technical and methodological shortcomings.AI in healthcare does not yet have sufficiently established methodology, prospective research, or peer-reviewed studies. The bulk of research have used historical patient medical records and have been retrospective in nature. Yet, for doctors to fully understand the true benefit of AI diagnosis in real-world settings, prospective research is necessary to examine existing patients over time. Also, doctors should keep an eye on their patients' health by combining physical exams with telehealth visits and remote monitoring technology in order to conduct trustworthy prospective research [24].

Conclusion

As demonstrated in this review, the use of AI applications, DL, ML, and NLP has become an integral part of advanced medical diagnoses. The technology of Natural Language Processing (NLP) helps to obtain the most accurate proportion of the processed text to

be used effectively in healthcare. Deep learning can analyze images, videos, and unstructured data in ways machine learning can't easily do. The level of accuracy in the early diagnosis of diseases is rising as a result of deep learning and intelligent neural networks. Electronic health records could contribute to the development of this field and to reducing the time required for a clinician to establish an accurate and rapid diagnosis. Robotic assistants have also been used in healthcare to respond quickly to patients who may not have time on their side. The robot has been used in delicate and critical surgeries, in se precise tools that a human surgeon cannot use in operations, accelerating patient recovery up to 21% faster than a human surgeon. In conclusion, it can be inferred that the proper use of AI-based diagnostic systems is expected to greatly reduce the burden of human resources and improve efficiency. AI-based applications can be of great importance in providing healthcare solutions. However, despite the promising results obtained using AI applications in healthcare, there remain several unsolved challenges, such as the need for a huge amount of data that may not be obtainable due to some privacy concerns, insufficient information provided by healthcare institutions, and some legal issues.

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