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A REVIEW OF DEEP LEARNING IN MEDICAL PRACTICE

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ABSTRACT:
DEEP LEARNING HAS BEEN USED FREQUENTLY IN MEDICAL IMAGING TASKS SINCE ITS CREATION, AND HAS SEEN NOTABLE IMPROVEMENT IN A VARIETY OF MEDICAL IMAGING APPLICATIONS, CONSEQUENTLY PUSHING US INTO THE AI ERA. IT IS UNIVERSALLY BELIEVED THAT AI'S ABILITY TO SUCCEED IS MAINLY DUE TO THE PRESENCE OF LARGE DATA SETS WITH DESCRIPTION ON A PARTICULAR APPLICATION AND THE ADVANCEMENT IN COMPUTING PERFORMANCE. MEDICAL IMAGING FACES PARTICULAR DIFFICULTIES THAT DEEP LEARNING TECHNIQUES MUST RESOLVE. OUR PAPER OUTLINES THE CLINICAL NEEDS AND TECHNOLOGICAL CHALLENGES THAT FACE MEDICAL IMAGING, AS WELL AS HOW DEEP LEARNING METHODS ARE PROGRESSING THE AREA.

KEY WORDS: DEEP LEARNING, ARTIFICIAL INTELLIGENCE, MACHINE LEARNING, MEDICAL PRACTICE, MEDICAL IMAGE ANALYSIS

INTRODUCTION

In the digital era, data is being collected at an incredible speed, and the healthcare field is no exception[12]. To make sense of these big data, clinicians are increasingly collaborating

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with computer scientists and other allied disciplines to make use of artificial intelligence (AI) techniques that can help detect signals from noise[13]. Deep learning is a subset of AI which is formally defined as "computational models that are composed of multiple processing layers to learn representations of data with multiple levels of abstraction"[14]. Convolutional neural networks (CNNs) in deep learning are distinguished from conventional machine learning by their ability to create their representations required for pattern recognition, without involving domain expertise to structure the data and design feature extractors[15].

To look at it another way, the algorithm has learned for itself which features are necessary for classification, instead of making humans tell it the features to use. The areas of medical imaging have seen explosive growth in deep learning science, with an increasingly rising number of studies[16].

Certain media reports that suggest improved performance by doctors have fueled media and press hype for rapid implementation[17].

In this era of algorithms, ML/DL systems have revolutionized several industries including manufacturing, transportation, and governance. DL has delivered cutting-edge output in a variety of fields over the last few years, for example in computer vision, text analytics, and speech processing. There is an extensive implementation of ML/DL algorithms in different domains, and hence this technology has become an integral part of our everyday life. As of now, ML/DL algorithms are already impacting healthcare in a major way—a market that has historically been insulated from large-scale technological disruptions. The recent performance of ML/DL techniques in such diverse areas as medical image recognition of organs (lungs, heart, etc.), classifying interstitial lung diseases, detecting lung nodules, medical image reconstruction, and brain tumor segmentation is proven to be useful[18].

New image analysis techniques allow doctors to better understand the quality of an image. Segmentation, a method to separate the regions of interest, is used in medical treatments such as disease detection, tracking the progression of the disease, and monitoring a patient. Integrating AI into medical image analysis will improve or accelerate the operation of image segmentation techniques. But current approaches are only applicable to particular organs. Recently, multitasking approaches were used to build a machine learning system with multiple applications[19].

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OVERVIEW OF DEEP LEARNING METHODS

To properly understand deep learning, we need to first comprehend other principles like artificial intelligence and machine learning. Artificial intelligence is a collection of computer algorithms that are capable of carrying out difficult operations or tasks requiring intellectual ability. Machine learning is a sub-set of algorithms of artificial intelligence which can learn from the data provided and do not need any pre-defined reasoning rules to accomplish these complex tasks[20].

Deep learning is a form of machine learning, a subset of machine learning, that utilizes neural networks composed of numerous simple interconnected units. Deep learning models have multiple layers of units linked to each other in order to construct highly complicated expressions of the input data (e.g., images)[21].

The principle of deep learning is based on various deep learning techniques, all of which recruit large numbers of simple interconnected units to perform simple tasks. Rather than using pre-programmed instructions, deep learning algorithms are capable of learning from vast volumes of data. Tasks performed by these algorithms include classifying and locating objects in images, decoding language, and playing games. However, the popularity of these deep learning, convolutional neural networks, which have been around for decades, has only emerged in the last five years and has identified these models as dominant in their field, a mostly unrealistic concept for an algorithm used in the application of artificial intelligence.

Recent years have seen deep learning algorithms exceed other approaches in AI efficiency and, in certain tasks, they have shown performance that is superior to that of humans.

There are three possible explanations for the recent success of deep learning algorithms: access to large quantities of data, increasing computing capacity, and rapid algorithm growth. These datasets are abundant: there are plenty of large datasets of images, and this makes it possible to display how basic concepts of deep learning work and then stimulate the creation of new datasets and algorithms. The ease in implementing algorithms, as well as low-cost graphical processing units, have allowed for larger scientific and technological communities to get involved, and this has led to the development of even more efficient algorithms, advancing the field even further.

Artificial neural networks are, by far, the most widely used deep learning models. One thing that all deep learning approaches have in common is that they highlight feature learning: learning representations of data automatically. The main difference between deep learning approaches and "classical" machine learning is that deep learning approaches require more "classical" machine learning to reach their full potential.

During the same training process, identifying features and completing a task are merged under one question, and this calls for a significant change in both of these tasks.

Medical imaging reveals the interest in deep learning mainly by convolutional neural networks (CNNs). This ensures that the photos and other organized data are displayed successfully.

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These features generally had to be developed manually or by less effective models of the machine-learning before it became possible to use CNN efficiently.

When features directly acquired from the information were used, many of the image's hand-created features typically stayed alongside the other side, as they were almost invaluable in comparison with feature detectors found by CNNs.

CNNs are the dominant approach in the field of radiology concerning different profound learning algorithms, particularly because picture interpretation is a significant part of use cases, and the success of CNNs in this field is proven considerable.

Fine-tuning and transfer learning are typical techniques used in this situation. The second task consists of pretraining a profound learning model for such a task with enough data to practice (most commonly, the ImageNet dataset). This is particularly significant in the medical field, as a large lack of unlabeled knowledge and profound learning algorithms are infamous for their "hunger for data."[22]

APPLICATIONS IN MEDICAL IMAGE ANALYSIS

As deep learning's primary strength has been in image processing, applications in the medical field have quickly become visible. Radiology image recognition algorithms have shown some resistance due to the time taken to acquire the necessary expertise within the medical field believe that an imaging group does exist, but limited availability of large medical imaging datasets. However, productivity in the industry has improved significantly in the last few years. Deep learning is now embraced by both researchers and physicians, who agree it would be a significant role in radiology, ophthalmology, cardiology, dermatology, and many other medical domains[23].

Intelligent software is expected to help radiologists and physicians in conducting tests on patients soon, and ML will revolutionize medical science and practice. ML/DL models are promising for clinical medicine because they've already performed at human-level efficiency in clinical pathology[24]. Along with these technical advances, machine learning and deep learning are capable of delivering highly accurate predictive outcomes and helping to bring in human-centered intelligent solutions[25]. Although offering various advantages, such as the opportunity to offer remote healthcare services to rural and low-income communities, these innovations will revitalize the healthcare industry[26].

ML techniques are used for efficient and accurate extraction of information from medical images obtained using various imaging methods like MRI, computed tomography (CT), ultrasound, and positron emissions tomography (PET), etc. These methods provide valuable anatomical and functional information on various organ systems and play an essential role in the detection/location and assessment of irregularities. Clinicians and radiologists rely on medical image analysis to support them in a much more accurate

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diagnosis and prognosis of diseases. Medical image processing consists of a wide range of tasks, such as identification, classification, segmentation, retrieval, reconstruction, and image registration. Medical image diagnosis systems could be another innovation of next-generation healthcare systems[27].

X-ray, computed tomography (CT), magnetic-resonance imaging (MRI), positron emission tomography (PET), retinal photography, histology slides, and dermoscopy are techniques of digital medical images. Modalities that investigate various organs (such as CT, MRI) are called multiapplication modalities, while those that focus on particular organs are called organ-specific modalities (retinal photography, dermoscopy). Data is being generated in varying quantities for each analysis. While a histology slide can have a small size, of a few megabytes, MRI images can be massive since MRI scans are several hundred megabytes each. This has a technical impact on the pre-processing of the data, as well as on the algorithm design, given limitations in processors and memory[28].

Once an irregularity has been identified, it is important to establish the diagnosis and the effects of the disease management process. In order to assess how to best handle the situation, a significant number of features must be implemented. Scale, position, attenuation, signal strength, boundaries, heterogeneity, and others may all be characteristics of features. Sometimes, simple criteria have been determined and evaluated to manage focal problems. Although some types of abnormalities follow simple guidelines for making the diagnostic and disease management decision, for other types of abnormalities, management algorithms are very complex.

Thanks to the capabilities of deep learning algorithms, doctors can now review and use a large number of features, many previously ignored by radiologists, and draw an accurate conclusion in a fraction of the time needed for a human interpreter. more promisingly, these algorithms might be able to.

Classifying vast volumes of existing imaging data while correlating characteristics with downstream health results is an arduous and time-consuming process that currently needs human interpretation.

In order to identify and characterize thyroid nodules, thyroid ultrasound has been used both as a detection and classification method. To allow radiologists to more accurately and efficiently diagnose thyroid nodules, deep learning CAD systems have been proposed. Ko[29] et al. developed a deep convolutional neural network to research the malignancy of thyroid nodules and compared the testing findings with those of radiologists who are experienced in the field.

Ma[30] et al. merged two CNNs into a single CAD program. In the first CNN section, processed US pictures, CNN segmented the nodules, and in the second CNN, the nodules were classified. In comparison to conventional deep learning systems, this approach achieved better performance despite training for longer (more than 106 hours).

Hassan et al. used the sparse autoencoder to extract the liver US image representation, and they applied the softmax layer to differentiate liver diseases and was able to achieve

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higher accuracy than support vector machines[31] Also, there is a high emphasis placed on the classification of liver fibrosis. Meng et al. used the VGGNet and FCN to separate degrees of liver fibrosis[32]. In order to satisfy the short supply of samples, Meng et al. used the transfer learning (TL) process. The team then divided the liver fibrosis level into three distinct stages: stage 1 to stage 3 (S1 to S3), and stage 4 to stage 6 (S4 to S6) (S4). The method's accuracy was 93.90%.

Due to the success of machine learning, one of the first clinical uses of deep learning on image data was on brain MRI scans to predict Alzheimer's disease and its manifestations[33]. Other medical domains use CNNs to predict a classifier of low-field knee MRI scans to automatically segment cartilage and predict the risk of osteoarthritis. This approach achieved better performance than a state-of-the-art system that used manually selected 3D multi-scale features despite using 2D images. Using deep learning, multiple sclerosis lesions in multi-channel 3D MRI were divided[34] and the differentiation of benign and malignant breast nodules was possible using ultrasound images[35]. The research performed by Gulshan et al.[36] implemented CNNs to classify diabetic retinopathy in retinal fundus photos, achieving a high sensitivity and specificity (97% sensitivity and 100% specificity) for certified ophthalmologist annotations in approximately 10,000 test images.

Since the COVID-19 encourages large-scale clinical and imaging data collection and dissemination activities, AI opportunities are growing substantially. Both machine learning and deep learning are included under the academic field of artificial intelligence, which aims to change and create intelligent entities. Deep learning is achieved by computer algorithms designed artificial neurons and a deep architecture referred to as a deep neural network, which is layered with various data processing layers[37].

Deep learning will certainly be requested to accurately detect and classify COVID-19 on radiological imaging. Additionally, deep learning for the segmentation of COVID-19 lung lesions can also be useful in clinical applications.

Based on radiological imaging, it is obvious that deep learning may have a significant impact on the identification and classification of COVID-19 chest radiography. Additionally,

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deep learning for the segmentation of COVID-19 lung lesions can also be useful in clinical applications[38].

For example, segmentation masks can direct the physician's attention towards the presence of COVID-19 pneumonia lesions, and are capable of assessing and precisely monitoring the extent of lung parenchymal disease. In a previous study, Wang et al.[39] used a deep learning model to perform COVID-19 segmentation on CT scans and obtained a Dice coefficient of 0.80 on a test range of 130 scans. In order to segment ground-glass opacity and consolidation, Fan et al.[40] trained a deep learning model to accomplish this task. For this model, they obtained a Dice coefficient of 0.62 and 0.46 on each task, accordingly.

Mei, et al.[41] used AI algorithms to combine chest CT results with clinical signs, exposure history, and laboratory testing to identify patients who were tested positive for COVID-19. SARS-CoV-2 was observed in 415 (46.3 %) of 905 patients, who were selected using real-time RT–PCR and next-generation sequencing RT–PCR. The AI system outperformed a senior thoracic radiologist in a research set of 279 patients, with an AUROC of 0.92. In order to improve the identification of patients who were positive for COVID-19 via RT-PCR, the AI system also improved the detection of patients who were positive for COVID-19 via RT-PCR, but who had regular CT scans, correctly identifying 17 of 25 (68 %) patients, while radiologists incorrectly identified all of these patients as COVID-19 negative[42].

In the study by Zhang et al.[43], the researchers developed an AI system for the diagnosis of COVID-19 pneumonia using CT chest images. While the method had similar effects to practicing radiologists with extensive clinical experience, it also could support and improve the skills of novice radiologists. Also, a clinical prognostic model was developed based on their AI framework that uses CT parameters and clinical data. This further reinforces the claim that AI can be used to help clinical management. In terms of the development into serious or critical illness resulting in ICU admission, mechanical ventilation, or death, the high-risk category had a composite score of 0.5. More significantly, they are able to provide an approximate period to this progression.

Even though chest x-rays and CT scans were mostly utilized for imaging patients with COVID-19 pneumonia, lung ultrasound has also been found to be useful in assessing and tracking the effects of the virus that causes SARS-CoV-2 (known as SARS-CoV-2) on the lung parenchyma[44].

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Based on the fact that the test is performed bedside, there is no radiation and there is no need to move the patient because the exam can be completed at the bedside. In Roy et al.[45], several deep learning models were developed and tested to detect COVID-19-associated patterns on lung ultrasound scans.

In addition to outputting the magnitude of lung disease on a 4-point scale, their models simultaneously present pathological areas on each lung ultrasound scan. Roy et al. believe that their model can be used to measure disease severity while also prioritizing patients with COVID-19[46] in the emergency department.

FUTURE OF DEEP LEARNING IN MEDICAL FIELD

Deep learning plays a significant role in future medical practice. It is widely recognized. Some expect that it will perform daily tasks leaving more time for physicians to concentrate on the problems of the intellect. Some people assume that clinicians and algorithms of deep learning could collaborate to produce a superior performance to either alone. Some claim that deep learning algorithms would eventually find clinicians redundant, at least in terms of image interpretation.

There will be additional obstacles, such as the patients' assumption that a physician should not play a role in interpreting the images (regardless of performance). Another challenge will be legal issues. A rather practical matter is how deep learning algorithms can be incorporated into the medical work process in order to enhance, rather than interrupt, medical practice.

Deep learning integration in medical practice also raises legal and ethical questions. Primarily: who will be held responsible for the computer's mistakes? Although this is a complicated issue, it has been experimented with in the past as other innovations have been implemented, such as elevators and vehicles. Artificial intelligence can permeate different sectors of human operation, so the type of questions raised here will be explored and possible solutions built shortly[47].

Even though the pandemic is already changing current medical procedures and data transfer across the world, one aspect that becomes clear is that AI will continue to be at the center of these initiatives. The increasing use of chest imaging techniques to act as primary, secondary, or adjunctive diagnostics is only going to increase rapidly. Algorithms based on artificial intelligence may assist in predictive ability, predicting time to clinical regression or recovery[48].

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CONCLUSIONS

In this paper, we have clarified the concepts of deep learning and how they can be applied in clinical practice, with a particular focus on the recent research within the area. And now we've talked about the success and condition of the industry. Additionally, we have also evaluated the magnitude to which DL can revolutionize the medical; workflow in all aspects, and how DL techniques have been successfully applied in a wide variety of other applications other than the commonly described image interpretation tasks. Finally, we have addressed several problems and concerns relevant to the application of deep learning in medical practice. All the evidence points to deep learning as an important part of medical practice. It will be an extremely exciting time in the field during which several questions that are presented in this article can be clarified with the support of machine learning and clinicians working together.

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