Chapter 13
Deep Learning and Analysis of Cardiovascular Imaging

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ABSTRACT

Artificial intelligence in the healthcare field has gotten the attention of professionals and researchers because the automated analysis of medical images can enhance diagnosis and therapy considerably. Deep learning (DL) puts forwards tools to deal with this kind of problem. Data science is presumable to address significant changes in the study of cardiovascular imaging allowing change appreciably in the next years encouraged by this learning. For medical professionals, it is fundamental to keep track of the development to make sure that it can have a significant impact on clinical practice. DL in medical image analysis is an interdisciplinary area that requires the support of medical experience and computer techniques. Nevertheless, the optimal clinical application of DL needs tricky formulation of problems, selection of the most proper algorithms and data, and balanced interpretation of outcomes. A current challenge comes from echocardiography. The need for human interpretation has restricted echocardiography's capability for precision medicine.

INTRODUCTION

In 1950, Alan Turing set out the idea of using computers to simulate intelligent behaviour. John McCarthy in 1956 put the term Artificial Intelligence (AI) as "the science and engineering of making intelligent machines" (Kaul et al., 2020).

AI presents different subfields as Machine Learning (ML), Deep Learning (DL), and computer vision (Kaul et al., 2020). It covers medical fields for differing purposes (Becker, 2019). AI in medicine has made progress over the past five decades. The developments of ML and DL have increased the chances

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for personalized medicine (Kaul et al., 2020). Helping the medical field in diagnosing diseases, patient treatment, reducing errors, etc (Giovanni & Olivier, 2020). In addition, it can enhance diagnostic rigour, efficiency, disease, therapeutic monitoring and overall patient clinical results (Kaul et al., 2020). In the field of medicine, ML can be put in an application to clinical decision-making to individualize patient attention instead of following a static algorithm (Kaul et al., 2020).

Holzinger et al. (2019) have pointed out that medical practice understandable AI is required for different motives such as education, research and clinical decision-making. Modern AI methods can aid medical professionals. They must possess the pieces of knowledge to understand and trail the machine's decision. Nowadays, the current computers have enabled the advances in medical AI applications have risen due to the considerably improved computing power and the extensive amount of digital data available. Their applications may manage the enormous amount of data generated in medicine and discover patterns that would be contrarily concealed (Secinaro et al., 2021).

AI points to changing medical applications; however, many practical implementations are in early stages, needing further investigation and development. Furthermore, healthcare care can improve if medical professionals get used to these advances (Amisha, 2019).

According to Becker (2019), AI and its likely implications have begun to be contemplated more seriously in the education of future physicians. In fact, some studies have reported that most medical students concur that AI will make better certain medical areas and it should be incorporated in medical training.

Some determined settings in clinical practice profit from the application of AI, such as the diagnosis of disease based on histopathological examination or medical imaging, among others (Giovanni & Olivier, 2020).

Some current applications of AI in cardiology are the early detection of atrial fibrillation and the prediction of the risk of cardiovascular diseases such as acute coronary syndrome and heart failure (Giovanni & Olivier, 2020).

ML has progressed to DL, and it is made up of algorithms to generate Artificial Neural Networks (ANNs) that can acquire knowledge of making decisions on their own. Computer vision is the procedure by which a computer obtains information and knowledge from a set of images or videos (Kaul et al., 2020).

Medical applications are a huge challenge for AI, ML and DL. Medical decisions must cope with data sets in arbitrarily high-dimensional spaces. These are often affected by uncertainty, noise, inaccurate and missing data, etc. A dare of future medicine is modelling the complexity of patients to fit medical decisions and therapies. Until the visual analysis of the data, tricky situations, especially in the fusion, integration and mapping of heterogeneous data must be coped with. AI in the setting of medicine must consider that different data may derive an appropriate result. Thus, medical professionals must have a chance to understand how and why a decision has been made about the corresponding machine. Methods and models are required to establish the machine decision-making process and to derive and understand the learning and knowledge mining process (Holzinger et al., 2019).

This chapter is focused on DL and cardiovascular image analysis in research and clinics. First, it is described deep neural networks used in this field such as Recurrent Neural Networks (RNNs), Convolutional Neural Networks (CNNs), Fully Convolutional Networks (FCNs), Generative Adversarial Networks (GANs) and Stacked Autoencoders (SAEs). Second, it is introduced DL applications in different areas in cardiovascular image analysis, such as image classification, object detection, image segmentation. Third, the principal imaging modes that have been used in cardiology have been studied. Fourth, it is dealt with the role of DL in echocardiography. Finally, the conclusions discuss open challenges and future research.