Proceedings of the 2nd International Conference on Machine Learning and Automation
DOI: 10.54254/2755-2721/113/2024.MELB18312

Applications of Deep Learning in Medicine

Mingrui Zhong

Detroit Green Technology Institute, Hubei University of Technology, Hubei, China

2211641218@hbut.edu.cn

Abstract. In the current era, with the development of artificial intelligence, deep learning is an essential branch of it. This paper aims to discuss the development history, application status and development prospect of DL model based on deep learning in medical field. Firstly, the advantages of deep learning are powerful data processing capabilities, improved disease prediction accuracy, and the ability to predict disease risk, which contribute to the development of personalized medicine. Deep learning is an attempt to simulate the working principle of the human brain. By training a large amount of data, it automatically learns the complex patterns and structures in the data, and finally realizes the task. By analyzing the examples of deep learning in clinical medicine and its application in medicine. This paper proposes that AI and DL models can help improve the quality of medical services. This paper also suggests that in the future, the unique automation and efficient data processing of deep learning algorithms can be used to improve diagnostic accuracy and speed, and promote the development of precision medicine.

Keywords: Deep learning, medicine, application.

1. Introduction

Because of the rapid progress in artificial intelligence, deep learning has become an important tool in the field of medicine. Deep learning is one of the most important areas in the field of computer vision. It can widely used in the field of medical image analysis, disease diagnosis, drug discovery, and personalized medicine. In this paper, we will look at some of the most important applications of the Deep Learning technique, as well as the potential challenges and the way forward.

For machine learning now, image-based diagnosis has increased in popularity in the field of ophthalmology. In a more complicated task, Gulshan et al showed that DL is capable of classification of diabetic retinopathy, and in line with the Early Treatment of Retinal Retinopathy Study [1], it has been shown that deep learning can be used for diagnosis of conditions by means of training.

Electronic health records have become commonplace in daily life. Several works apply deep learning to predict disease from the clinical status of patients. Miotto et al presented a novel approach based on three layers of stacked-de-noise auto-encoders (SDA), which is based on an EMR model. In, they proposed a new approach for degeneracy prediction, which is based on random forests. The results show that the prediction effect of deep representation is significantly better than that of using raw electronic medical records or traditional representation learning algorithms such as principal component analysis (PCA) and k-means [3]. This proves that deep learning can be combined with algorithms to predict the disease more accurately.

DOI: 10.54254/2755-2721/113/2024.MELB18312

In addition, DL model algorithms can take advantage of a large number of genomic and transcriptome features in the diagnosis of unknown cancers. The genome-wide Pan-Cancer Analysis Alliance (PCAWG) is a combination of DL models that predict the provenance of 24 kinds of cancer separately or in combination with the help of thousands of distinct cellular variants (mutation patterns and driving genes and pathways) in two distinct groups [2]. This confirms the great potential of DL models to predict the molecular characteristics of cancers and classify them into clinically meaningful types.

In summary, this article will analyze the advantages and applications of deep learning and medical clinical practice through literature review and case analysis, hoping to bring help to the further development of deep learning in medicine in the future.

2. Method

A literature search was conducted in PubMed for articles related to deep learning and artificial intelligence based on the scientific methods used in medical research. The purpose of the literature search presented to the reader is to provide the non-technical reader with some explanations of the applications of deep learning in medicine.

3. Overview of deep learning applications

3.1. The advantages of deep learning

The advantages of deep learning in medicine are clear. First of all, deep learning has the powerful ability to process complex data. It can automatically extract meaningful features from high-dimensional and complex data such as medical images, genomic data, and patient electronic medical records, so that we can better understand and make use of this information.

Secondly, deep learning can significantly improve the accuracy of disease diagnosis, especially in medical image analysis. Deep learning models such as convolutional neural network (CNN) can accurately identify and classify complex patterns in images, such as tumors and lesions, so as to provide more accurate diagnosis.

By analyzing a patient's genetic information, lifestyle habits, and historical medical records, we can predict an individual's risk of developing specific diseases, thus providing a basis for early intervention and prevention. In addition, deep learning also plays an important role in the process of drug discovery and development. It can predict and optimize the properties of drug molecules, such as stability and toxicity, and help researchers understand how drugs interact with human cells and proteins, thereby improving the efficiency of drug research and development.

Finally, deep learning can realize personalized medicine. By analyzing the patient's genetic information, living habits, and environmental factors, we can provide personalized treatment plans for each patient, improve the treatment effect, and reduce unnecessary treatment and side effects. In general, deep learning provides a powerful tool for the medical field to improve the accuracy and efficiency of diagnosis and treatment, enable personalized medicine, and accelerate drug discovery and development.

3.2. The application principle of deep learning

Deep learning is a subfield of machine learning that attempts to simulate the working principle of the human brain by training large amounts of data to automatically learn complex patterns and structures in the data. Among them is a DL model, usually referred to as a Deep Learning model, which consists of multiple layers, including an input layer, a hidden layer, and an output layer. Deep learning models learn and recognize complex patterns by simulating the connections between neurons in the human brain. Each layer of the DL model contains a certain number of computational units that transform the data received from the previous layer and then pass the results to the next layer.

DOI: 10.54254/2755-2721/113/2024.MELB18312

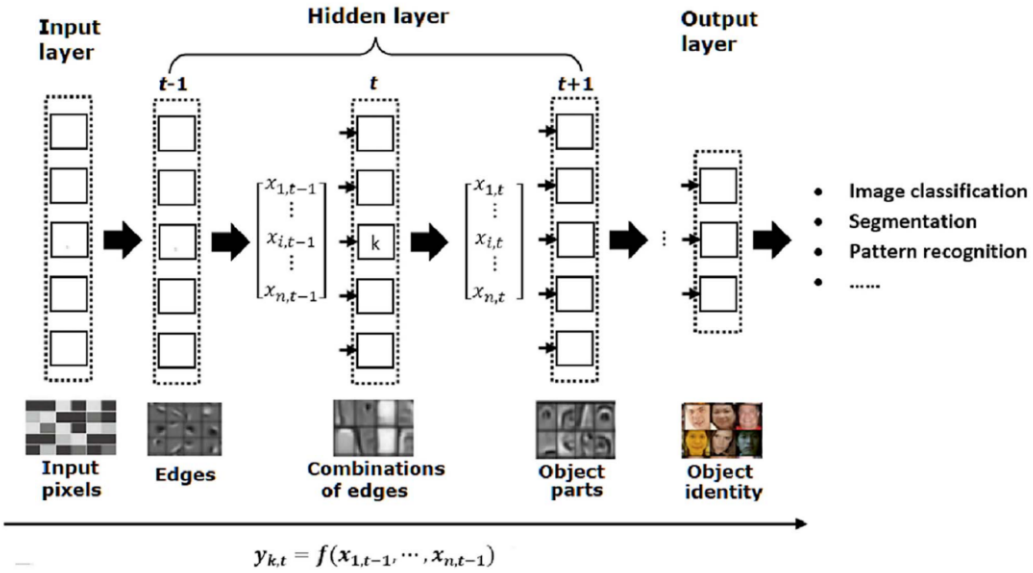

Figure 1. Illustration of the layer-by-layer processing in DL consisting of an input layer, multiple hidden layers and an output layer [4].

In the training process of deep learning models, we will supply a lot of input data to the model, along with the appropriate target output and the model will adjust the weights in the neural network to make the output of the model as close as possible to the target output. This process is commonly referred to as "back propagation" and "gradient descent". With the progress of training, the model will gradually learn how to map the input data to the correct output, so as to achieve the goal of recognizing images, understanding natural language, predicting data, and so on.

Deep learning models include Convolutional Neural Network (CNN), whose working principle is mainly based on convolutional operation, which is especially suitable for processing data in the form of grids such as images. The CNN works through a series of convolutional layers, pooling layers (downsampling) , and fully connected layers. The convolutional layer extracts local features on the input data through a sliding window (convolution kernel), the pooling layer is responsible for reducing the dimensionality of the data to reduce the computational load and the risk of overfitting, and the fully connected layer is used to integrate the learned features at a high level and output the final classification or regression results. Multiple sequential convolution, kernel, and pooling steps produce a large number of data layers, which are converted into a one-way array by a process called flattening [5]. Tasks such as medical image analysis and natural language processing can be implemented.

In general, the application principle of deep learning and deep learning models is mainly to automatically learn and understand the complicated mode and the model can be used to perform various tasks, including image recognition, voice recognition, and natural language processing, predictive analysis, etc. Among them, convolutional neural network (CNN) is an important model in deep learning, which extracts features in local regions through convolution operation, reduces the feature dimension through pooling operation, and then integrates features through the fully connected layer. It is especially suitable for processing grid-form data such as images.

3.3. Applications of deep learning in medicine

Machine learning has been a powerful tool for diagnosing and evaluating a patient's condition. Deep learning is particularly suitable for processing and analyzing medical images, such as X-rays, CT scans, MRI, and ultrasound images. Through training, deep learning models can identify and diagnose various lesions and abnormal states, from tumors to fractures, and improve the accuracy and efficiency of diagnosis. Time-series medical records such as electroencephalography and magnetoencephalography

DOI: 10.54254/2755-2721/113/2024.MELB18312

can also be analyzed using deep learning methods. Most of these models are based on the coding characteristics of a given signal or source, and they are used to classify and interpret emotional information.

Deep learning techniques have been applied to gene sequence analysis to help scientists better understand how genetic factors affect the occurrence and development of diseases, and how genetic information can be used to customize personalized treatment programs. Based on the NIH Integrated Network-Based Cellular Signatures (LINCS) initiative, Chen et al presented D-GEX, a deep-learning approach with dropout as regularization, and D-GEX, which is a learning algorithm with dropout as regularization. Compared with Linear Regression (LR), this method has a significant advantage in predicting precision of microarrays and RNA-seq methods [6].

3.4. Guiding ideas and prospects of deep learning

The guiding idea of deep learning is to build a neural network with a multi-layer structure, so that the model can automatically learn and abstract complex features from a large amount of data. The end-to-end learning method is used to directly process the raw data to the final output, reducing the need for manual feature engineering. This process focuses on adjusting model parameters through iterative optimization to improve generalization ability, and using transfer learning and multi-task learning techniques to improve the efficiency and adaptability of the model.

4. Summary

In the medical field, artificial intelligence (AI) and deep learning (DL) models of data science are widely used in disease diagnosis, image analysis, personalized treatment, and other aspects. Convolutional neural network (CNN) has a good performance in medical image analysis. It can automatically detect lesions in X-ray films, MRI, and CT scans, such as cancer and tumor diseases. Through AI and DL models, medical diagnosis will be more accurate and rapid, which will help to improve the quality of medical services and patient prognosis.

In my opinion, deep learning algorithms can be used in disease prediction and personalized treatment, and their unique automation and efficient data processing can increase diagnostic precision and speed. At the same time, deep learning can be used to train more accurate models that can perform well in analyzing more complex medical data, which can help discover potential disease patterns and risk factors and promote the development of precision medicine.

References

[1] Choi, Rene Y., Coyner, Aaron S., Kalpathy-Cramer, Jayashree., Chiang, Michael F., & Chiang, Michael F.. (2020). Introduction to Machine Learning, Neural Networks, and Deep Learning. Translational vision science & technology, 9(2), 14.

[2] Tran, Khoa A., Tran, Khoa A., Kondrashova, Olga., Bradley, Andrew., & Williams, Elizabeth D.. (2021). Deep learning in cancer diagnosis, prognosis and treatment selection. Genome medicine, 13(1), 152.

[3] Miotto, Riccardo., Wang, Fei., Wang, Shuang., Jiang, Xiaoqian., & Dudley, Joel T.. (2018). Deep learning for healthcare: review, opportunities and challenges. Briefings in bioinformatics, 19(6), 1236-1246.

[4] Wang, Haiying., Pujos-Guillot, Estelle., Comte, Bl&ine., de Mir&a, Joao Luis., & Spiwok, Vojtech.. (2021). Deep learning in systems medicine. Briefings in bioinformatics, 22(2), 1543-1559.

[5] Currie, Geoff., Hawk, K Elizabeth., Rohren, Eric., Vial, Alanna., & Klein, Ran.. (2019). Machine Learning and Deep Learning in Medical Imaging: Intelligent Imaging. Journal of medical imaging and radiation sciences, 50(4), 477-487.

[6] Cao, Chensi., Liu, Feng., Tan, Hai., Song, Deshou., & Shu, Wenjie.. (2018). Deep Learning and Its Applications in Biomedicine. Genomics, proteomics & bioinformatics, 16(1), 17-3.