Explore the Current Application Status of Machine Learning in the Medical Field

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Abstract. The application of machine learning in the medical field can improve the quality and efficiency of medical services and promote the innovative development of healthcare. However, there are still many shortcomings in the development of related fields. This paper explores the current development status of machine learning technology and its application in the medical field and explores the direction of its future development and the defects that can be improved, mainly through the literature research method. This paper finds that many current studies lack mature large-scale datasets as training materials. Similarly, the trained models lack applications in real-world scenarios to validate their prediction or detection performance, and can only be verified in other existing datasets, which requires wider collaboration to enable and improve them. The significance of this study mainly lies in sorting out the current development status of machine learning applications in the medical field in China, illustrating the breadth and limitations of the current applications of AI in the medical field, and providing references and guidance for the future development of related fields.

1 Introduction

The twenty-first century has seen remarkable advances in biology and medicine, nevertheless, there are numerous challenges and difficulties in the field of medicine. The diagnosis, prediction, and treatment of various diseases are still troubling scientists and medical workers. Machine learning, as an effective tool, can help medical researchers solve these complex problems. Therefore, an in-depth study of the application of machine learning in the field of medicine is of great academic value and practical significance.

Machine learning technology is currently one of the trendiest directions in the field of computer science, with the improvement of hardware arithmetic power, artificial intelligence has an extremely wide range of application possibilities and very powerful functionality. At present, many scholars are exploring the application of machine learning in medical imaging. For example, Peng Zefei et al. studied the application of deep learning and imaging histology in the individualized treatment of non-small cell lung cancer [1]. Hu Zhe et al. used machine learning and deep learning in the treatment of Moyamoya Disease [2]. A few studies have focused on applying machine learning to predict the degree of

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patient recovery, such as Jiang Wei et al. who applied it to the prognosis prediction of slow plus acute liver failure [3]. The current applications are primarily used to complement traditional diagnostic and treatment methods.They have limitations such as insufficient prediction success rate and large sample requirements.

The purpose of this paper is to examine the current state of machine learning applications in the medical field and to explore future directions for improvement in terms of algorithms, machine learning processes, and other aspects. The latter paper focuses on the current state of development of machine learning applications; current challenges in the medical field, a few specific examples of machine learning applications; and final recommendations and conclusions, in that order.

2 The current state of development of machine learning applications and challenges in the field of medicine

2.1 Machine Learning and Artificial Intelligence

Generally speaking, Artificial Intelligence solves complicated intellectual problems by imitating human cognitive function, which can significantly improve efficiency and simplify the problem in real application. Machine learning is an important branch of Artificial Intelligence. It's core goal is to build a model and let it automatically learn to find the pattern and trends of a series of data. Typical algorithms applied in machine learning include Logistic Regression, Random Forest, and Dimensional Reduction. Logistic regression uses some kind of function to compress the probability values into a particular range. A random forest can be thought of as a collection of decision trees. Each decision tree in a random forest estimates a classification in a process called voting, and then the classification with the most votes is selected based on each vote of each decision tree. Dimensional reduction refers to the process of reducing the number of random variables to obtain a set of "irrelevant" main variables under limited conditions and can be further subdivided into two major methods: feature selection and feature extraction.

2.2 Steps in Solving Problems Using Machine Learning

The main steps of machine learning include firstly data collection, which involves ensuring that the data is from a reliable source and assessing its quality to reduce the effects of bias or noise. Next, data preprocessing is used, which deals with missing values, outliers, and preliminary feature extraction, standardization, or normalization of data to complete the preparation of data to improve the training efficiency and accuracy of the model, to avoid overfitting and other problems. After that, according to the characteristics of the data, and the purpose of building the model, such as classification, regression, prediction, etc. to choose the appropriate algorithm to start training. After the model is trained, validation sets or cross-validation methods are used to evaluate the performance of the model, including accuracy, mean square error, etc. In addition, hyperparameter tuning can be used to further evaluate the performance of the model. In addition, hyperparameter tuning can further optimize the performance of the model. The model after the complete construction step can then be used to process real data and make predictions or decisions on new data.

2.3 Advantages of Machine Learning in Medicine

Many diseases cannot be quickly diagnosed by traditional medicine and pathology due to the lack of development of contemporary medicine, such as the diagnosis of early-stage

cancer, which is the biggest challenge in human medicine, and the diagnosis and prevention of ischemic heart disease. Machine learning-based image recognition technology and analytical prediction technology can help to predict the probability of success in the latency period of such diseases and assist in the treatment of such diseases. In addition, machine learning has the potential to be widely used in public medicine and infectious disease prevention and treatment, such as resource allocation and epidemic prevention decision-making.

3 Specific applications of machine learning in the medical field

3.1 Diagnostics

Currently, machine learning techniques are often used in medical imaging and help doctors make diagnoses. For example, convolutional neural networks can automatically learn disease features from raw image data and recognize subtle patterns and abnormalities in the disease process. This greatly reduces the tedious process of manual feature engineering. In addition, generative adversarial networks can be used as an auxiliary tool to improve the quality of medical images, serving to reduce noise, improve image resolution, etc., and enhance the reliability of diagnosis [4].

For instance, chest X-rays (CXR) images are important tools in the early diagnosis of lung diseases, but lesion features may be masked due to problems such as soft tissue overlap. The application of deep learning technology can provide the possibility of early diagnosis of lung diseases and improve the success rate of discrimination [5]. The process of this model construction can be divided into the following steps: firstly, data is collected to establish a dataset, in which a large number of CXR images corresponding to multiple diseases need to be collected. After that, it is the data preprocessing stage, and the main feature of this step is that, since CXR is a gray-scale image and covers more human organs and tissues except lungs, it is extremely important to screen out the chest region directly related to the suspected disease and eliminate the shadows and other irrelevant information in the image, which mainly includes two methods, namely, digital image processing and pre-feature extraction. Among them, the digital image processing method is to adjust the image size, resolution, contrast, and other key parameters using image transformation, normalization, data enhancement, and other means to improve the quality of the image. The pre-feature extraction method, on the other hand, is to reconstruct the rib model using a support vector machine and to subtract the reconstructed rib model from the original CXR image after utilizing Xuanfa, to accurately separate the lung region from the CXR image and reduce the interfering factors in the image. The combination of similar methods can achieve prediction success rates exceeding 90% in controlled test groups.

However, similar current prediction models still have significant limitations. First, different regions produce different CXR images due to different imaging clarity and specifications of the equipment, which puts higher demands on the data preprocessing session. Second, current machine learning models are mainly limited to CXR images and computed tomography (CT) scanstaken by patients and do not take into account other non-imaging information in multimodality, such as medical history, lifestyle habits, and other important information for routine diagnosis, which is not conducive to the improvement of prediction efficiency. Finally, the previous good prediction accuracy is based on a fixed test data set, there is no perfect means to verify the prediction accuracy of the model in the actual diagnosis process and ensure the accuracy of the verification results, so it can not replace the manual testing, but can only be used as an auxiliary technology to help the doctor's judgment.

3.2 Anticipation

The applications of machine learning techniques in medical prediction mainly include heart disease risk prediction [6]; assessing the risk of tumor deterioration or metastasis [7]; and evaluating the efficacy of previous treatments and the recovery of patients. These are all questions that make it more difficult for traditional medicine to come up with a clear answer directly through cases, diagnostic results, and other information. At the same time, their prediction or prognosis can greatly enhance the likelihood of successful treatment, and it is necessary to build models using machine learning techniques.

When constructing a heart disease risk prediction model, it is necessary to design the dataset by combining a variety of causative factors, including habits (smoking, drinking, etc.), physiological indicators (obesity, hypertension, etc.), and genetic factors, etc. The key point in collecting data is that the dataset needs to include so many causative factors. In the process of data collection and dataset building, the key point is that the dataset needs to encompass a wide range of causative factors, and the lack of samples for any one of them may affect the reliability of the final assessment results of the model. The data preprocessing session is mainly limited to dealing with missing values and outliers, such as using the arithmetic mean for approximate substitution, etc. The preprocessing session also includes the division of the training and test sets. In terms of training algorithms, since it is a prediction task, supervised machine learning has the best performance, mainly including logistic regression, support vector machine, decision tree, and other algorithms. Finally, the prediction performance of machine learning is evaluated to determine the strengths and weaknesses of the models and provide guiding recommendations for heart disease prediction.

The limitations of the existing research are that medical samples and data sets containing multiple pathogenic factors are scarce, requiring medical institutions to collect case samples on a large scale and over a long period. Secondly, the performance metrics of training accuracy and recall of the models are not good enough to be used as a conclusive medical prediction tool, but only as a reference. These points need to be improved by long-term research.

3.3 Treatment

Mature medical treatments based on deep learning are relatively few, and most of the application scenarios are based on image histology to segment medical images to target tumors in the patient's body for subsequent surgery or drug therapy [8]. For example, a convolutional neural network is used to segment medical images during nasopharyngeal cancer radiation therapy [9]. In each layer of the neural network, a convolutional layer is used to extract the features of the input image, an activation function is used to nonlinearize it, and then a pooling layer is used to reduce the parameters of the next layer of the neural network while preserving the features of the network, usually using maximum pooling or average pooling. After training, usually in the field of medical image segmentation, parameters such as the Dice similarity coefficient, MIoU, and ASSD are used to evaluate the results of segmentation. The study shows that the model built with a neural network has a Dice similarity coefficient of 81.58, which is 28.8% higher than the traditional support vector machine (SVM)-based method, and has a lower ASSD parameter, which indicates that the segmentation results are closer to the segmentation results manually labeled by doctors, and the performance is higher than that of the traditional method. The current research in the related field is more mature and belongs to the simple application of deep learning. In addition, machine learning has broad application prospects in the field of medical treatment, including the construction of real-time assessment of the patient's

physical condition in hospitals, analyzing the state of healing of the detection system [10]. It can automatically analyze the patient's living habits, to help doctors put forward to improve the treatment advice to accelerate the healing of the device [11]. As well as the author's participation in the previous one can automatically detect the loss of frequency bands of the patients with hearing loss and targeted enhancement of the corresponding frequency of the external sound. The author previously participated in a hearing aid program for the elderly that can automatically detect the frequency bands lost by patients with hearing loss and enhance the external sound of the corresponding frequency in a targeted manner. In the future, machine learning technology will benefit more patients and reduce the workload of doctors.

4 Suggestions

Machine learning techniques are currently very widely used in the medical field, however, their further development is limited by many factors. First, many studies lack mature large-scale datasets as training materials, and similarly, trained models lack real-world scenarios to validate their prediction or detection performance, and can only be validated in other existing datasets, which is not only dependent on the efforts of one medical institution or hospital, but also requires broader cooperation to facilitate and improve. As researchers in this field, many doctors have a wealth of knowledge in the medical field, but in many studies, they are limited by the lack of knowledge in computer and machine learning technology, and will only use more basic machine learning algorithms, and less use of more advanced neural network learning or deep learning, which to a certain extent affects the possibility of the overfitting of the models they build, which is not conducive to the large-scale application of the model, the computer field and the medical field. This is not conducive to the large-scale application of the models, which can be improved by interdisciplinary collaboration between those working in the computer field and those in the medical field. Recently, a relevant report from China's National Health Commission pointed out that artificial intelligence is an important direction for the development of China's medical and healthcare system in the future, and described several major application scenarios, which shows that this field has a very broad development space, and deserves the attention and investment of more researchers.

5 Conclusion

In this paper, we have explored the current development of machine learning technology and its application in the medical field and explored its future development direction and the defects that can be improved, mainly through the literature research method.

The main findings of this paper are: the limitation of the existing research is that medical samples and datasets containing multiple disease-causing factors are scarce, requiring medical institutions to collect case samples on a large scale and over a long period. Secondly, the performance metrics of training accuracy and recall of the current models are not satisfactory enough to be used as a conclusive medical prediction tool, but only as a reference opinion. These points need long-term research to improve. Although many doctors have rich knowledge of the medical field, in many studies, they are limited by their lack of knowledge of computers and machine learning technology, and only use basic machine learning algorithms, but less use of more advanced neural network learning or deep learning, which to a certain extent affects the possibility of their constructed models overfitting, which is not conducive to the large-scale application of the models.

The significance of this study mainly lies in sorting out the development status of

Chinese machine learning applications in the field of medicine, illustrating the breadth and limitations of the current application of artificial intelligence in the field of medicine, and providing a reference and guidance for the future development of related fields.

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