Research on Intelligent Medical Engineering Analysis and Decision Based on Deep Learning

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ABSTRACT

With the increasing amount of medical data and the high dimensional and diversified complex information, based on artificial intelligence and machine learning, a new way is provided that is multi-source, heterogeneous, high dimensional, real-time, multi-scale, dynamic, and uncertain. Driven by medical and health big data and using deep learning theories and methods, this paper proposes a new mode of "multi-modal fusion-association mining-analysis and prediction-intelligent decision" for intelligent medicine analysis and decision making. First, research on "multi-modal fusion method of medical big data based on deep learning" explores a new method of medical big data fusion in complex environment. Second, research on "dynamic change rules and analysis and prediction methods of medical big data based on deep learning" explores a new method for medical big data fusion in complex environment. Third, research on "intelligent medicine decision method" explores a new intelligent medicine decision method.

KEYWORDS

Analysis and Prediction, Association Mining, Deep Learning, Healthcare, Intelligent Decision, Intelligent Medical, Medical Big Data, Multi-Modal Fusion

INTRODUCTION

With the continuous promotion of "Healthy China's 2030" national decision, medical and health big data is gradually regarded as an important fundamental strategic resource by the country. Under the influence of big data and artificial intelligence technology, clinical application, scientific research, public health, decision-making, and industrial development will be the direction of improvement in

the whole medical field in the future (B. H. Liu et al., 2018). It gives new meaning and connotation to medical information intelligent analysis and decision. The use of artificial intelligence and machine learning theories and methods cannot only find hidden relationships and connections from medical big data, but also the content rules and mechanisms of scientific intelligence are deeply understood and mined in medical big data. The future events of medical big data are predicted to take scientific control methods so that the performance of medical big data can be deeply optimized. Therefore, intelligent analysis and decision-making based on artificial intelligence and machine learning has become a new scientific challenge, and it is crucial to carry out relevant theoretical research.

A new technological revolution marked by medical big data, artificial intelligence, and biotechnology is creating a new medical model change. In the clinical diagnosis and treatment process, the essence of individual patients and their disease can be more thoroughly, accurately, and comprehensively captured. To obtain accurate diagnosis for decision-making and treatment, the key is to realize the process of mass-medical scientific analysis and application of big data (Huang, 2017). The combination of emerging artificial intelligence technology and traditional medicine is reshaping methods of diagnosis, treatment, and industry models in the medical and healthcare field. The intelligent medical diagnosis and treatment mode is considered a new data-driven medical service mode that brings new opportunities for the diagnosis and treatment of complex diseases such as cancer. Intelligent medical information analysis and diagnosis technology can provide good reference diagnoses for doctors to greatly improve their work efficiency, to provide personalized treatment plans for patients more accurately, and to improve patient satisfaction. Therefore, this research has wide application prospects.

Intelligent medicine is an emerging disease prevention and treatment method based on the understanding of individual genes, environment, and lifestyle. It can realize the personalized diagnosis and treatment of diseases and patients, improve medical levels and resources allocation efficiency, and promote the transformation of the medical service modes (Shen, 2019). In the national key research and development program's "Special Application Guide for Intelligent Medicine," it is clearly pointed out that it is necessary to carry out application demonstrations of intelligent medicine, such as telemedicine and mobile medicine. The goal is to complete homogeneity within the system, ensure the implementation quality of intelligent medicine, and promote accurate prevention and personalized diagnosis and treatment programs. Nowadays, machine learning is used to predict the development trend of a disease by modeling patient data. When a disease has a bad development trend, corresponding preventive measures are taken in time to effectively prevent the deterioration of the disease and improve the cure rate.

Intelligent medical image analysis is used in biomedical research and clinical diagnosis. Research interests include image segmentation, classification, and retrieval, etc. The main goal is to automatically extract important physiological and pathological information or knowledge from massive medical image data in order to realize the precise analysis of medical images and detection, and effectively reduce missed diagnoses. It will provide important and powerful support for clinical diagnosis, treatment, nursing, and medical research.

BACKGROUND AND LITERATURE REVIEW

Medical imaging has gradually become an effective means of disease screening and lesion localization, but mass image data requires professional imaging doctors to spend a lot of time and energy to analyze and generate reports (Han, 2019). Computer-aided diagnosis and treatment technologies are aided by machine vision algorithms. Artificial intelligence technology of medical image automatic analysis can be used as the basis of the research and development of intelligent medical diagnostic systems. It can help doctors to accurately target lesions, improve diagnostic efficiency, and reduce the rate of misdiagnosis, especially in remote and underdeveloped areas where medical professionals are scarce and equipment is poor. It can serve as a reliable basis for disease diagnosis. Deep learning

algorithms are well suited to take advantage of the complex and heterogeneous data types obtained in modern clinical practice to learn the extremely complex relationship between features and labels, so as to assist doctors to make relevant analyses and predictions. By learning the case data of a large number of patients, the deep learning model can obtain information far beyond the clinical practice experience of individual doctors. This can help doctors predict future events from the height of experts and even identify patients who are at high risk or need additional medical services. However, there are great challenges and difficulties in intelligent medical image analysis, mainly because of the following three points.

First, the number of data sets with different classifications of the same type of disease is generally unbalanced. Due to the differences in equipment and medical staff professionalism and imaging standards in different regions, the quality of the obtained medical images is uneven. Some images are relatively poor in quality, with a lot of noise, blurred edges, and the background of the images is complex and inconsistent, thus it is very difficult to extract features and analyze them (Zhang, 2019).

Second, label annotation of massive medical images is a task with a large workload, which requires manual annotation by high-level professional medical staff. In addition, due to the hospital's protection of patient privacy and security, and scarce and non-standard data labeling, the designed image analysis algorithm can easily lack generalization and robustness. Additionally, the same algorithm often produces different results on the images generated by different devices, and there is a certain distance to achieve accurate and a reliable clinical application stage.

Third, different from traditional natural image segmentation, medical images have multi-modal image channels with complex noise. Higher image accuracy and real-time performance are required. These have always been difficult problems in the field of computer vision.

The following is an analysis of the research from three aspects: 1). multi-modal fusion of medical big data, 2). intelligent analysis of medical big data, and 3). intelligent decision-making of medical big data.

Multi-Modal Fusion of Medical Big Data

Multi-modal fusion technology is a very popular research in the field of machine learning. The ability to process and understand multi-modal information is realized through machine learning, and the model can be processed and associated through multi-modal learning.

Early multi-modal fusion technology was mostly used in the military field, and later it was gradually applied in the field of biometric recognition. Machine learning based on multi-modal fusion is the development direction of artificial intelligence. Deep multi-modal learning often provides much improved performance for problems involving multi-modal data. Li (2019) mentioned that the combined analysis of multi-modal MRI images provides the possibility to uncover the relationship between brain structural changes and brain functional changes. In addition, the comprehensive image information provided by this combined analysis is important to explore the working principle of the brain. Wang et al. (2018) proposed a multi-modal medical image clustering method, which integrated texture features and unique morphological features of medical images, and the effectiveness of this method was verified through experiments. Various modes are integrated to realize information supplement. The accuracy of prediction results and the robustness of prediction models are improved. The final results are more reliable.

Summarizing the current research status in this field, due to the large volume of individual multi-omics, radiomics, various phenotypes, and biological markers data, there are still technical bottlenecks to achieve comprehensive overall analysis. For example, how to identify and eliminate noise data so as to obtain real and effective individualized data is still difficult to realize. Today's intelligent medical model needs advanced technologies for data processing and analysis, such as big data and artificial intelligence technology to develop and study the true law of data itself, and to explore the potential value inside the data. Therefore, it is urgent to propose a new method for multi-modal fusion of medical big data.

Intelligent Analysis of Medical Big Data

The National Institutes of Health (NIH) was the first to store and share vast amounts of human genetic variation data on a public service platform. The National Institutes of Health then launched the BD2K and took the initiative to research healthcare data by analyzing and processing technologies, and a healthcare big data center was created (Tao, 2019). The Harvard-led team was the first to attempt to combine fMRI scans and deep learning into a project that can predict the progression of Alzheimer's disease in patients with MCI. FMRI scans of patients at rest reveal the flickering of electrical signals in the brain and how these regions are related to each other to predict Alzheimer's disease (Yang, 2018).

Ren et al. (2017) proposed a provincial medical and health care big data platform, which was composed of an application interaction layer, a data acquisition and exchange layer, a data storage layer, a data analysis layer, an infrastructure layer, and a security operation and maintenance layer. After studying traditional clinical data centers, Zheng et al. (2016) proposed a medical and health care data analysis platform based on big data, which utilizes technologies such as big data analysis and storage, including distributed storage and data mining, and it is verified that the platform architecture was suitable for the application characteristics of medical and health big data.

Summarizing the current research status in this field, the current research on intelligent analysis of medical big data mainly focuses on the method of constructing an analysis platform based on medical big data, and mining the correlation between system performance and parameters. As the medical information system becomes increasingly more complex, the amount of data and the dimension of the data become increasingly larger, thus traditional analysis methods will encounter "dimension disaster" data association difficulties. It is difficult to accurately describe all the characteristics of the system and other problems. It can be a more effective analysis method of intelligent medicine to further reveal the change rule of biological information by studying the fusion method of medical big data and deep association mining between sample data, so as to support the decision optimization of intelligent medicine.

Intelligent Medical Big Data Decision-Making

To provide reference for disease diagnosis, it is necessary to extract valuable and meaningful association diagnostic rules from massive medical data. Therefore, it is essential to analyze medical data with the characteristics of large amount, complexity, and correlation for auxiliary diagnosis.

Yang and Chen (2015) analyzed the medical records and relevant clinical information of lung cancer patients based on the decision tree algorithm and Apriori algorithm, to provide a reliable basis for staging the diagnosis of lung cancer patients (Yang & Chen, 2015). Shi (2012) realized automatic interactive detection of coronary heart disease patients with unstable angina pectoris based on decision tree. Xu et al. (2020) used resampling technology to embed decision tree to predict clinical medicine. Zhao et al. (2019) constructed a diagnosis model of hypertension based on the neural network and decision tree models. Through the study of decision tree, W. B. Liu et al. (2018) optimized the medical treatment process of hospitalized burn patients and mined out association rules for the treatment of burns.

In recent years, as a rapidly developing machine learning technology, significant breakthroughs by deep learning have been made in the fields of image classification, speech recognition, natural language processing, etc., and it has been gradually introduced into the field of EEG analysis to achieve better performance. The deep learning model can automatically gradually obtain complex and powerful feature expression from the original data. It simplifies the process of data preprocessing and artificial feature extraction, constructs an efficient end-to-end classification system, and improves the generalization ability of the model. For example, deep learning is applied to epilepsy detection to construct an epilepsy detection model based on the convolutional neural network. Tsiouris et al. (2018) manually extracted the correlation characteristics of EEG channels and graphical theoretical features of epileptic EEG, and used the long short-term memory neural

network algorithm to predict epileptic seizures; the highest sensitivity of 99.28% was obtained by testing patients in the CHB-MIT dataset. Tang et al. (2020) proposed a patient-specific, seizure onset detection method based on a full exploration of auxiliary supplementary spectral-temporal information in EEG signals. An average sensitivity, latency, and false detection rate of 97.2%, 1.10s, and 0.64/h were achieved on Boston Children's Hospital and the Massachusetts Institute of Technology's (CHB-MIT) Scalp EEG database.

Summarizing the current research status in this field, the previous medical information intelligent decision-making methods are faced with problems such as poor data fusion effect and excessive computing resource consumption. The fundamental reason is that they fail to break through the design mode of "big data association-analysis and prediction-intelligent decision." In order to break through this bottleneck, this paper uses deep learning theory and methods to excavate biological information and further optimize intelligent medicine with the new mode of "multi-mode fusion-association mining-analysis and prediction-intelligent decision."

RESEARCH DESIGN

The first thing to be solved is the processing and analysis methods for medical big data. Data processing and analysis of intelligent medicine is the basic supporting technology of intelligent medicine and precision medicine. Artificial intelligence and machine learning have gradually formed a complete theoretical system and methods. Relevant theories and application results can provide references for this paper. This paper presents the overall design as shown in Figure 1.
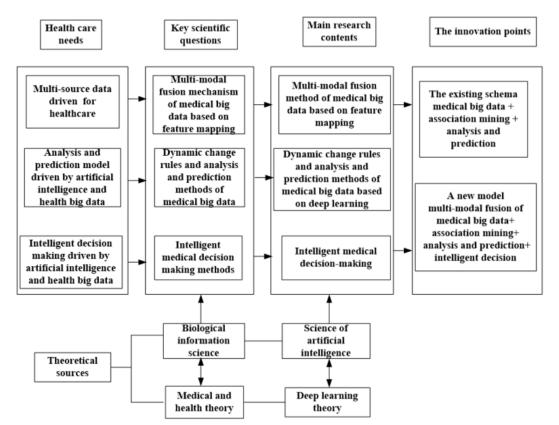
Figure 1. Global Design Image

METHODOLOGY

By collecting massive patient groups of data in electronic health records information, basic scientific findings, clinical finding data, and unified sources, high dimension and more heterogeneous medical data are formed. Considering the uncertain and dynamic characteristic, through analysis and mining data by means of deep learning, an intelligent medical knowledge network is formed. The interrelation between data information is revealed, and a multi-modal fusion and perceptual fusion of medical big data is also realized.

Based on the analysis and decision of intelligent medicine, the dynamic change law of intelligent medicine analysis process is explored, the intelligent analysis and prediction method is studied, and the traditional intelligent decision and analysis mode of medical information is broken through, and a new deep learning intelligent medical decision-making method is proposed. Through the research in this paper, a new method of medical information intelligent analysis and decision-making based on the mode of "multi-modal fusion-association mining-analysis and prediction-intelligent decision" is proposed to realize the optimization of intelligent medical analysis and decision-making in complex medical information environments.

Focusing on the issue of "Research on intelligent medical analysis and decision-making," there are three levels of multi-mode fusion, analysis, and prediction, and intelligent decision-making in medical big data processing.

RESEARCH METHODS

First, research on "multi-modal fusion method of medical big data based on deep learning" is to explore a new method of medical big data fusion in complex environments.

Multi-Modal Fusion Method Based on Feature Mapping

The difference between patients centered on the deep learning model of medical big data is not obvious, and the classification is difficult. Methods such as "multi-modal feature mapping" and "multi-source health data perception fusion" are studied to solve the problems of differences.

Second, research on "dynamic change rules and analysis and prediction methods of medical big data based on Deep learning" is to explore a new method for medical big data fusion in complex environment.

The Dynamic Change Rules, Analysis, and Prediction Method
of Medical Big Data Based on Deep Learning

The structural characteristics of the deep learning network model are deeply analyzed and extended to the medical big data modeling. The structure of the deep neural network with the characteristics of autonomous learning needs to be researched. The generation optimization method of related parameters and weights needs to be designed, and the improved method of biological information analysis and prediction needs to be studied.

Third, research on "intelligent medicine decision method" is to explore a new intelligent medicine decision method.

Intelligent Medical Decision-Making Methods

The design mode of "analysis and prediction + intelligent decision" is studied to optimize the performance of medical big data system. In addition, the intelligent decision system includes data processing, acquisition of classification rules, model evaluation, and disease prediction.

CONCLUSION

With the increasing amount of medical data and the high dimensional and diversified complex information, based on artificial intelligence and machine learning, a new way is provided with the characteristics of multi-source, heterogeneous, high dimensional, real-time, multi-scale, dynamic, and uncertain. Driven by medical and health big data and using deep learning theories and methods, this paper proposes a new mode of "multi-modal fusion-association mining-analysis and prediction-intelligent decision" for intelligent medicine analysis and decision-making to realize the optimization of intelligent medical analysis and decision-making.

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