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Application of artificial neural network method in medical health field: bibliometric analysis

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ABSTRACT

With the rapid development of artificial intelligence technology, artificial neural network (ANN) has been widely used in medical and health fields. This paper aims to systematically review and analyze the research status, hot spots and development trends of artificial neural networks in the field of medical health through bibliometric analysis. Firstly, we selected 3767 relevant literatures from the Web of Science database and used CiteSpace for data processing and analysis. The results show that in recent years, the research on artificial neural networks in disease diagnosis, personalized medicine, medical image analysis and drug discovery continues to increase, and shows a trend of interdisciplinary and international cooperation. Through keyword co-occurrence analysis, we identified current research hotspots, including deep learning, image processing, tumor detection, and genomics analysis. The analysis of highly cited literature further reveals the influential research results and key technologies. This paper summarizes the main application directions of artificial neural network in the field of medical health, and prospects the future development trend, in order to provide reference for related research.

KEYWORDS

Artificial neural network; Medical and health; research review; CiteSpace; visualization

1 Introduction

With the continuous growth of the global population and the acceleration of the aging process, the field of health care is facing unprecedented challenges and pressures. According to the World Health Organization (WHO), the proportion of older people in the global population is rising dramatically, with people aged 65 and over expected to account for 16% of the global population by 2050. This trend has led to a significant increase in the demand for healthcare resources and services, especially in chronic disease management and long-term care. Chronic diseases such as diabetes, cardiovascular disease and cancer continue to rise, becoming a major threat to global health. These diseases not only seriously affect the quality of life of patients, but also cause a heavy burden on the family and social economy. At the same time, the problem of uneven distribution of medical resources is still serious. Despite significant advances in medical technology and services in developed countries, medical resources remain scarce in developing countries and remote areas, and there are significant gaps in the accessibility and quality of medical services. The high cost of health care is also a problem. The increasing cost of advanced diagnosis and treatment technologies and the research and development of new drugs has led to an increase in health care expenditures

year by year, putting tremendous economic pressure on individuals and public health care systems.

While technological advances have brought new hopes for health care, they also come with complex challenges. Emerging technologies such as genomics, molecular diagnostics, and precision medicine are gradually changing the traditional medical model. However, the practical application of these technologies still faces many problems, such as technical bottlenecks, ethical disputes and data privacy protection. In addition, with the advancement of medical informatization, a large number of electronic medical records and health data emerge. How to effectively manage and analyze these data to improve the efficiency and quality of medical services has become a key issue to be solved.

In this context, artificial intelligence (AI) technologies, especially artificial neural networks (ANN), show great potential and importance. Artificial neural network is a computational model that mimics the biological nervous system. It can realize complex pattern recognition and prediction tasks by training with a large amount of data. Its powerful data processing capabilities and self-learning characteristics make it excellent in a variety of applications in the healthcare field. Firstly, the application of artificial neural network in disease diagnosis has achieved remarkable results. Traditional disease diagnosis often relies on the experience and expertise of doctors, but even experienced doctors have difficulty processing and analyzing large amounts of complex medical data in a short time. Artificial neural networks can accurately identify early symptoms and features of disease through deep learning of large-scale medical images, genomic data, and clinical records. For example, in medical image analysis, convolutional neural network (CNN) can efficiently process X-ray, CT, MRI and other image data, automatically identify diseased areas, and assist doctors in the diagnosis of early cancer, brain disease and cardiovascular disease, significantly improving the accuracy and efficiency of diagnosis. Secondly, personalized medicine is another important application direction of artificial neural networks. Each patient has different genomic information, medical history and lifestyle habits, and traditional one-size-fits-all treatment options often struggle to meet individual needs. By analyzing a patient's comprehensive health data, artificial neural networks can personalize treatment plans for each patient, resulting in improved treatment outcomes and fewer side effects. This precision medicine model can not only optimize the treatment process, but also play an important role in preventing disease; In addition, artificial neural networks also show broad prospects in health monitoring and management. Through wearable devices and sensors, artificial neural networks can monitor patients' physiological indicators (such as heart rate, blood pressure, blood sugar, etc.) in real time, perform data analysis and abnormal detection, and provide health management recommendations and early warnings. For patients with chronic diseases, timely health monitoring and intervention can effectively control the condition, reduce the occurrence of complications, and improve the quality of life.

2 Brief history of development and related research review

2.1 Brief history of development

The earliest studies date back to the 1940s. In 1943, psychologist Mcculloch and mathematician Pitts developed a mathematical model of formal neurons (Mcculloch and Pitts, 1943). This model is generally referred to as M-P neural network model, which is still in use today, and it can be said that the era of artificial neural network research has begun. Based on this, in 2006, deep learning, as a complex machine learning algorithm, made a major breakthrough in the research results of Hinton and Salakhutdinov, which further promoted the deep learning method into the research field. In recent years, through continuous development and application, the relevant models of deep learning methods have been expanded and there are a wide variety of models, and the commonly

used models mainly include CNN, DBN, RNN, GAN and other models. These deep learning methods have been further expanded and studied based on different research objectives and application fields.

In 1949, psychologist Hebb proposed the learning rules of the nervous system, which laid the foundation for the learning algorithms of neural networks (Hebb, 1949). Today, this rule is called the Hebb rule, and many artificial neural network learning still follow this rule.

In 1957, F.Rosenblatt proposed the "Perceptron" model, which for the first time put the study of neural networks from a purely theoretical discussion into engineering practice, and set off the first climax of the study of artificial neural networks (Rosenblatt, 1958).

After the 1960s, the development of digital computers reached its heyday, and people mistakenly thought that digital computers could solve artificial intelligence, expert systems, and pattern recognition problems, thus relaxing the research on "perceptrons". As a result, since the late 1960s, the research of artificial neural networks has entered a low tide.

In 1982, Hopfield, a physicist at the California Institute of Technology, proposed a discrete neural network model, marking a new upsurge in the study of neural networks. In 1984, Hopfield proposed the continuous neural network model (Hopfield, 1984), which opened up a new way of computer application of neural networks.

In 1986, Rumelhart and Meclelland proposed a Back-propagation learning algorithm for multi-layer networks, referred to as BP algorithm (Rumelhart et al., 1986). BP algorithm is one of the most important and widely used artificial neural network algorithms.

Since the mid-1980s, many countries in the world have set off the upsurge of neural network research, it can be said that neural network has become an international research hotspot.

2.2 Method introduction and basic principle

Artificial neural network (ANN) is a nonlinear system composed of a large number of simple neurons, each neuron's structure and function are relatively simple, but the system behavior generated by a large number of neurons is very complex. Artificial neurons form different artificial neural network models in different ways, by changing the way they are connected, the number of neurons, and the number of layers.

The basic structure of the artificial neuron model is shown in Figure 1. In the figure, $X = \left(x_1, x_2, \ldots, x_n\right)^T \in R^n$ represents the input signal of the neuron (and the output signal of other neurons); w_{ij} represents the strength of the connection between neuron i and neuron j, or the weight; θ_j is the threshold of neuron j (that is, the input signal strength must reach a minimum value to generate an output response); y_i is the output of neuron i. Its expression is $y_i = f\left(\sum_{j=i}^{n} w_{ij} x_j + \theta_i\right)$, where $f(\bullet)$ is the transfer function (or activation function), representing the input-output relationship of neurons.

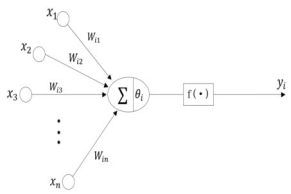

Figure 1 Basic structure of artificial neuron model

For several models in the field of artificial neural networks: The basic structure of Multilayer Perceptron (MLP), backpropagation Neural Network, convolutional neural network, Recursive Neural Network (RNN) is introduced, and their relatively popular applications are briefly outlined.

2.2.1 Multilayer perceptron

Multilayer perceptrons, also known as multilayer feedforward neural networks, as shown in Figure 2, have excellent nonlinear matching and generalization capabilities. Training an MLP to use a backpropagation algorithm can reduce the global error between the MLP output data and the data actually needed.

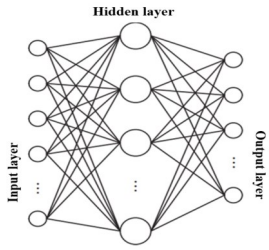

Figure 2 MLP structure diagram

Because MLP has very good nonlinear mapping ability, high parallelism and global optimization characteristics, it has made good achievements in image processing, prediction system, pattern recognition and so on.Although MLP architecture has many advantages, it is relatively inefficient in high dimensional space, which can lead to overfitting in model training. Moreover, the existence of hidden layer increases the number of hyperparameters, which makes the training process need to deal with a high computation amount under the condition of slow convergence. In the traditional MLP real value model, the data input that a single neuron can receive is a single real number, which usually fails to achieve satisfactory results when it performs multidimensional signal input.

Aiming at the problems existing in MLP, different improved algorithms are proposed. Garcia-Pedrajas et al proposed a co-evolution of Generalized Multilayer Perceptron (GMLP) (Garcia-Pedrajas N et al., 2004). The model is based on the collaboration of different subgroups of modules, each of which is a generalized multi-layer perceptron. Compared to standard multi-layer perceptrons, the GMLP-based network architecture has a relatively small number of nodes and connections, allowing very complex surfaces to be defined with fewer nodes. At the same time, the evolution of smaller networks can improve the interpretability of the network. Inspired by the characteristics of glia in the brain, Ikuta et al. proposed a multilayer perceptron with glial network, in which the glial network is only connected to the second hidden layer of the MLP. Computer simulation results confirmed that the MLP with glial network has better performance than the standard MLP. Confers a position dependence on neurons in MLP (Ikuta C et al., 2011). Li et al. proposed a multi-layer perceptron expansion model RGA-MLP based on Reduced Geometric Algebra (RGA). The traditional MLP model treated the signal of each dimension as a real number and processed it separately. The input, output, activation functions, and operators in the RGA-based model are all extended to the RGA domain using commutative multiplication rules, and the RGA version of backpropagation is used to train neural networks for multidimensional signal processing, treating multiple channels as a unit rather than a single component. Higher classification accuracy, faster convergence, and lower computational complexity can be achieved (Li Y P and Cao WM, 2019).

Masulli and Penna applied the incremental Input Dimension (IID) algorithm based on principal component analysis to MLP to improve the learning rate of multi-layer perceptrons (Masulli F and Penna M, 1996). Martinez-Morales et al proposed an MLP-MOACO model to optimize MLP parameters through multi-objective ant colony optimization algorithm, calculate engine pollutant correlation coefficient and estimate engine exhaust emissions (Martinez-morales J et al., 2019). Mosavi et al. proposed the MLP-GWO model, which combined Gray Wolf algorithm with the standard MLP model and applied it to soil conductivity prediction. Experimental results showed that

the hybrid MLP-GWO model could obtain more accurate connection weights in the hidden layer than the standard MLP model. This improves prediction accuracy (Mosavi A and Samadianfard S, 2021). Based on Adaboost algorithm and MLP neural network, Liu et al proposed four different hybrid methods for high-precision multi-step wind speed prediction, and proved that Adaboost algorithm can effectively improve the performance of MLP neural network (Liu H et al., 2015).

2.2.2 BP neural network

The network architecture of BP neural network model (backpropagation algorithm) is multi-layer, which is essentially a local optimization technique of gradient descent, related to backward error correction of network weights. The multi-layer structure of BP neural network makes the output of the model more accurate, but there are still some defects in BP neural network. For nonlinear separable problems such as XOR, BP neural network may fail to find the global optimal solution due to the local minimum value, and the mean square error MSE is too large in the face of large sample data, resulting in difficult convergence. Wang Lihong et al. combined traditional BP to form the AdaBoost-BP model. The AdaBoost algorithm was trained to calculate the error rate and weight of the first BP model, and the weight was used as the weight parameter of the next BP network. The iterative calculation was carried out according to the similar pattern. When applied to short-term sales forecast, the average prediction error of this method is 18.89%, which is significantly improved compared with the 53.23% accuracy of traditional BP network. However, this model has a large error when faced with a large time span of sample data, and can effectively predict the recent sales change under the sample data of only 5 days.

In view of the defect that BP network is prone to fall into local optimality when gradient descent is used, Ng et al proposed an improved backpropagation algorithm, GBP, modified the partial derivative of the activation function to increase the error signal of backpropagation, normalized the learning rate of the algorithm to improve and accelerate the convergence speed. Computer simulation results confirm that the Generalized Backpropagation (GBP) network has a much faster global convergence rate than the original BP network. Using the learning rate of 0.5 and momentum of 0.7 in regression problems, the traditional model needs more than 6000 iterations. However, a GBP using six hidden cells only requires an average of 1471 iterations (NG S C et al., 1999). Silaban et al. applied BFGS quasi-Newtonian to BP neural networks, tested seven architectures on glass datasets using classical backpropagation and BFGS backpropagation, and proposed that BP neural networks with BFGS improved the convergence of the learning process, with an average improved convergence rate of 98.34%, and that when BFGS was used together with BP, Accuracy will improve (Silaban H et al., 2017).

Zhu et al. combined with Rumelhart's dynamic adjustment of the learning rate by adding inertial pulses, they could adjust the learning rate to a larger value to improve the learning speed of the model, and influence the connection threshold and weight parameters of nodes through the learning rate to eliminate invalid iteration in the learning process of BP network. By combining the two, they proposed an improved algorithm for optimizing BP network. The local minimum and slow convergence rate of traditional BP network are improved to determine membership function and applied to fuzzy diagnosis of steam condensation equipment (Zhu Q and Li J, 2014). Sang applied the comparative analysis of BP neural network and support vector machine optimized by genetic algorithm to the credit risk assessment of supply chain finance, and the results showed that BP neural network could better identify and classify enterprises at different levels with high classification accuracy (Sang B, 2021). Miao et al proposed that combining the back propagation algorithm and RBP algorithm for fuzzy modeling can effectively avoid potential problems such as dead zone and sudden change of decision surface in the fuzzy process (Miao Z N and Zheng H J,

2011). Jin et al propose an Improved fuzzy optimal BP neural network model based on the financial benefit analysis of a power transmission and transformation investment project of a power grid enterprise in Sichuan Province, and use the Improved Gravitational Search Algorithm (IGSA) to optimize the fuzzy optimal BP neural network. The experimental results show that the cost-benefit analysis of BP neural network can predict the conditions for a project to reach break-even and financial returns in a certain range of changes (Jin X et al., 2021).

2.2.3 Convolutional neural network

Convolutional neural network (CNN) is a common model structure in machine learning, and has achieved good results in image classification recognition, semantic segmentation, machine translation and so on. The traditional CNN structure consists of four layers: convolution layer, pooling layer, fully connected layer and output layer.

Convolutional neural networks are widely used in the image field and have made great achievements. Especially in the aspect of image recognition, after a series of operations of convolutional neural network, the machine can recognize the image feature information very accurately. Lou et al. applied VGG16 combined with convolutional neural network CNN to face recognition, collected discarded image information and applied it to the original CNN, and the improved model obtained significantly improved the performance and image recognition rate compared with ICA algorithm and traditional convolutional neural network (Lou G X and Shi H Z, 2020). Zhang et al. used CNN for fault detection. The first step of traditional fault detection is to process signals, and then put features into a classifier for classification. The intelligent diagnostic detection algorithm based on convolutional neural network CNN is used to convert the original input signals into two-dimensional image data, and the interference of experience on feature extraction is eliminated. Then, the effectiveness of the algorithm is verified by bearing data, and the experiment proves that the algorithm can adapt well to the changes of workload (Zhang J Q et al., 2020). Deng et al. proposed a novel region-based CNN (R-CNN) crack detector with a deformable module. By comparing FasterR-CNN, R-FCN and FPN-based FasterR-CNN, It is concluded that FPN-based Faster RCNN shows the highest classification accuracy due to FPN multi-scale feature extraction, and this model can be used to improve the detection accuracy of surface cracks (Deng L et al., 2020). Cao et al. designed three deep CNN structures for learning discernible emotional features from raw audio clips and Meir spectrograms, combining two heterogeneous neural networks using a combined deep network, taking advantage of the strengths of each network and ultimately improving overall performance (Cao R et al., 2018).

Mask R-CNN is an improvement on Faster R-CNN and is one of the most famous image segmentation models. RoIAlign is used to replace RoIPool in Faster R-CNN to ensure the correspondence between input and output. Hu et al. used CNN for image diagnosis. After the CT images were manually labeled by experts, the proposed Mask R-CNN was used to automatically cut the lungs in the CT images. In the experiment, the combination of Mask R-CNN and K-means obtained the best segmentation effect compared with other methods, the segmentation accuracy reached 97.68%±3.42%, and the average running time was 11.2s (Hu Q H, 2020). Hyojin et al. applied Mask R-CNN to the BDD dataset to extract a model of the drivable region to support the autonomous driving system, and the training on the BDD dataset proved that the accuracy was higher than the existing dataset MS COCO (Hyojin J and Soosun C, 2020). Although the traditional CNN model is widely used in the image field, its disadvantages are also obvious. The deep convolutional network extracts more local information, and the deep convolutional network has large computational requirements and fixed input image size, so it has limitations in the application of embedded devices.

2.2.4 Recurrent neural networks

Recurrent neural network (RNN) is a kind of artificial neural network based on sequence modeling, which can transmit data information horizontally between neurons and partially express the correlation between data, as shown in Figure 3. The characteristic of RNN is that the neurons in the hidden layer are connected to each other, so that the time-related input information in the sliding window can be sequentially transmitted, and the time correlation between distant events in the time dimension can be considered.

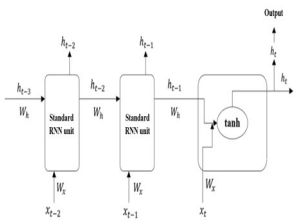

Figure 3 RNN structure diagram

The hidden layer structure of recurrent neural network RNN makes it widely used in time series prediction. Wei et al. applied MLP, RNN, LSTM and GRU to pore water pressure (PWP) respectively, and concluded that the model with RNN structure is more accurate than MLP in time series data. In particular, LSTM and GRU can describe the time-lag between input and response, which is more accurate and reliable than standard RNNS (Wei X et al., 2021). Ling et al. apply RNN to fault prediction of nuclear power machinery and propose an intelligent fault prediction method that transmits data after dimensionality reduction of principal component analysis (PCA) to a complete RNN model and generates alerts 60h and 44h in advance based on speed and vibration signals, respectively. Experimental results show that the RNN model can effectively identify faults during creep (Ling J et al., 2020). Stender et al. combined CNN and RNN for brake noise detection and prediction, and found that the combined model could overcome the limitations of traditional methods. In the first part, CNN showed superior detection quality and feature extraction performance; in the second part, RNN relied on the instantaneous spectrum characteristics of noise. The precision and accuracy of brake noise prediction using this model is very high, and the model shows great potential for sound detection (Stender M et al., 2021). Bai et al. used RNN in intelligent libraries to predict readers' perceived needs at different stages through readers' borrowing records and borrowing behaviors, and to provide readers with book purchase and personalized services. CRFID was combined with RNN in the model. The actual data recorded by the library proves that the model is feasible to perceive the needs of readers at different stages (Bai R Q et al., 2020). Traditional RNN will produce gradient disappearance, and the accuracy will be greatly reduced when dealing with long-term data dependence, input and output data sequences do not match, and missing information caused by parameter sharing of the model may have an impact on the timing characteristics. RNN encodes the previously hidden state of each node as the historical information of the entire model, but ignores the independent relationship between each node.

3 Data sources and research methods

3.1 Data source

There are many researches on the application of artificial neural network method in medical field, but there are few researches on bibliometric analysis, including co-citation analysis, hot topics, emergency detection and emerging trends. Therefore, next, the bibliometrics method is adopted to

solve the above problems and provide a general overview of the mathematical research method. By downloading and CiteSpace analysis of 3,767 papers from Web of science for nearly a decade (i.e., 2014-2024) after screening, we intuitively show the main conclusions of the countries, institutions, sources and keywords that are most productive in neural network research in the field of healthcare. The new trend of artificial neural network method research is artificial intelligence, exploratory proposition, comprehensive evaluation.

3.2 Research method

Before using CiteSpace, it is necessary to analyze the steps to build a database. Then, through CiteSpace, the output countries and regions, institutions, hot spots, research trends, keywords and flashpoints of various papers in the field of energy security research can be identified, and several different visualizations can be generated. There are two steps to building a database for CiteSpace analysis. The first step is to select the database. The co-citation network indicated by the selection of references for the article should also be included in the database. In order to fully capture the knowledge graph and evolution process of the energy security discipline, we chose Web of science (WOS) as the data source for bibliometric analysis because WOS is a huge platform that provides readers with a channel including core databases such as the Science Citation Index. Researchers should pay more attention to the validity and representativeness of keywords and conduct checks to assess the relevance returned by each study. Through the research on the topic "Application of artificial neural networks in the field of health care", a total of 3,767 articles (published between 2014 and 2024) were retained. There are two main reasons for choosing the research period for this study: (1) Many publications with important theoretical and practical contributions were published after 2014; (2) This study focuses on the latest research in artificial neural network methods and therefore considers the latest papers in this research field. After selecting the database, in order to observe the change trend of publications and citation frequency, the publications and citation frequency related to the application of neural network method in the medical field from 2014 to 2024 were analyzed. Secondly, CiteSpace is used to sort out the evolution of neural network methods. The analysis process includes the classification of knowledge clusters in the field of neural network research and a timeline analysis of the origin, development and current status of important keywords. According to the occurrence frequency of keywords in the article, hot research topics and emerging trends of neural networks in deep learning in the medical field can be found. The next step is to identify the regions and institutions that are most productive in using neural network approaches to research health care. For example, a comparative analysis of the evolution of knowledge between 2014 and 2024 can be performed. The main authors, sources and research directions are then listed. This helps to identify the main influencing factors of the evolution of the knowledge graph of artificial neural networks.

4 Data analysis

4.1 Analysis of annual publication volume of literature

As shown in Figure 4, the number of publications on medical related research using artificial neural network methods in the past ten years from 2014 to 2024 is shown. It is clear that with the passage of time, there is a growing literature on the application of artificial neural network methods. In order to analyze the change of publishing volume, this paper divides the whole period into two stages: the development period and the rapid growth period. The number of articles published before 2019 grew slowly. Although some researchers claim that neural network methods have a

significant impact on the economy and the environment, most articles are broad analyses of the environment rather than in-depth applications of neural network methods. With the outbreak of the new coronavirus in late 2019 and early 2020, people began to put life safety and health in the first place, and realized the importance of medical health in real life.

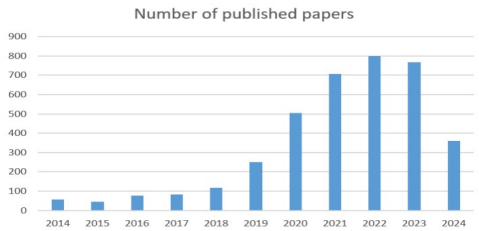

Figure 4 Number of research papers on the application of artificial neural networks in the medical field from 2014 to 2024

4.2 Analysis of issuing institution

Through visual analysis of the publishing institution, the publishing network of the institution and the cooperative relationship between the institution and the institution can be obtained. Based on the analysis, the distribution of artificial neural network in different institutions can be obtained in this paper. In CiteSpace, "author" was changed to "institution", and other conditions remained unchanged, and the institutional co-occurrence knowledge graph was obtained, as shown in Figure 5. In the knowledge graph, the larger the name of the institution, the more the number of published papers of the institution. The number of published papers of the institution reflects the scientific research ability and level of the institution in the field, as well as its focus on the research topic. In order to clarify the data, the top ten issuing institutions were counted, as shown in Table 1.

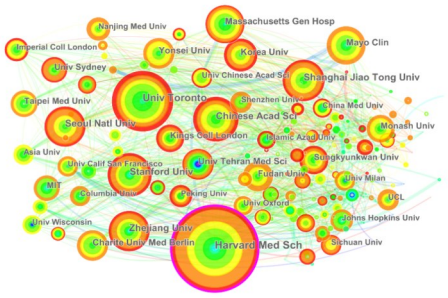

Figure 5 Collinear knowledge map of mechanism

Table 1 Top 10 artificial neural network research institutions from 2012 to 2022

number	Number of publication	institution
1	111	Harvard Medical School
2	81	University of Toronto
3	62	University of Chinese Academy of Sciences
4	62	Stanford University
5	57	Shanghai Jiao Tong University
6	56	Zhejiang University
7	55	Seoul National University
8	54	Massachusetts General Hospital
9	52	Mayo clinic
10	48	Tehran University of Medical Sciences

The data shows that quite a number of institutions are studying the application of artificial neural network methods in the medical field, and promoting the development of neural network methods is also conducive to the development of the medical field. But from the knowledge graph, we can also learn that there is a collaborative relationship between institutions, which refer to each other to study neural networks. It can be seen that in our country, most of the institutions are divided by regional units, which also causes cross-institutional, interdisciplinary and cross-regional cooperation in related fields to be improved, therefore, cooperation in this field still needs to be further strengthened, more exchanges between institutions, which can also promote the development of institutions and promote the transfer of knowledge.

4.3 Analysis of issuing Country

In order to clarify the collaboration between countries/regions from 2014 to 2024, taking the application of medical methods as the research object, we used the bibliometric tool CiteSpace to build a country/region collaboration network, and the results are shown in Figure 6.

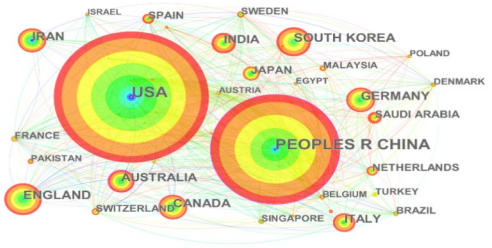

Figure 6 National collinear Knowledge Map

In Figure 6, publications in 28 countries are shown, the node size represents the number of publications after standardization, and the link represents the collaboration between the two countries connected. Among them, China, the United States and the United Kingdom ranked the top three. The closer the connection, the more cooperation between the two countries. Therefore, China is the most cooperative country in this field.

4.4 Keyword frequency analysis

Click keyword analysis in CiteSpace to get the keyword co-occurrence knowledge graph, as shown in Figure 6-3. In the keyword co-occurrence knowledge graph, it can be clearly seen that the labels of the two phrases "machine learning" and "convolutional neural network" are in the front, and the higher the serial number is, the more it indicates the centrality of the keyword degree. Therefore, it can be seen from the figure that "algorithm", "prevalence", "computer aided diagnosis" and "survival analysis" are key words co-occurrence of keywords.

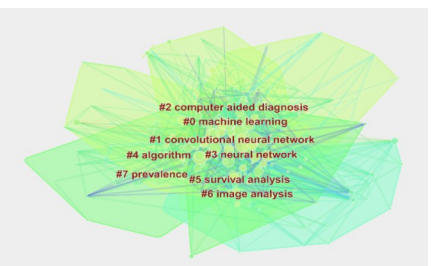

Figure 7 Keywords clustering map

Next, a time slice is used for cluster analysis. According to the obtained data, it can be seen that the cluster structure divided is significant and the clustering is reasonable. According to the analysis of the data, the ten largest keywords after clustering are classified and listed in Figure 7. At the same time, a time series diagram is generated on CiteSpace software. Time series diagram is a kind of time series diagram that takes year as the time axis and shows the change characteristics of keywords with the year (time).

5 Discuss

With the continuous progress of artificial intelligence technology, artificial neural network (ANN) is increasingly widely and deeply applied in the field of medical health. By means of bibliometric analysis, this paper systematically reviews the research results in this field in recent years, analyzes the current research trend, predicts the future development direction, and puts forward specific suggestions to provide reference for further research.

5.1 Research trend

5.1.1 Disease diagnosis

Disease diagnosis is an important direction of the application of ANN in the medical and health field. Literature analysis shows that in recent years, the research on medical image analysis based on convolutional neural network (CNN) has occupied a large proportion. A large number of studies are devoted to using CNN to automate the identification and classification of lesion areas on X-ray, CT, MRI and other image data to assist doctors in early disease screening and diagnosis. In addition, genomic data analysis is also an important research area. Deep neural networks (DNNS), through deep learning of large-scale genomic data, are able to identify complex patterns of genetic variation and can be used to predict disease risk and develop personalized treatments.

5.1.2 Personalized medicine

Personalized medicine is one of the research hotspots in recent years. The application of ANN in the formulation of personalized treatment plans is gradually increasing. Through the integration of patients' genome data, medical history, lifestyle and other multidimensional data, ANN can predict the effects and side effects of different treatment plans and optimize the treatment process.

5.1.3 Drug discovery

The research in the field of drug discovery mainly focuses on two aspects: drug screening and drug reuse. ANN has shown significant advantages in simulating drug molecule-target interaction and predicting drug activity and toxicity. Deep learning models can speed up the new drug screening process and reduce research and development costs. In addition, drug reuse research is increasing, and by analyzing data on existing drugs, ANN can identify new indications for drugs and open up new avenues of treatment.

5.1.4 Health monitoring and management

With the popularity of wearable devices and smart sensors, health monitoring and management has become an important area of ANN applications. By analyzing physiological data such as heart rate, blood pressure and blood sugar, ANN provides health management suggestions and abnormal

early warning to realize the application in real-time health monitoring. Studies have shown that the application of ANN in chronic disease management can effectively control disease development, reduce complications and improve patients' quality of life.

5.1.5 Medical decision support

Medical decision support System (CDSS) is another important application of ANN in healthcare. ANN can integrate electronic medical records, laboratory results, imaging data and other data sources to provide diagnostic recommendations and treatment options. Sutton et al. (2020) demonstrated the significant effect of ANN-based CDSS systems in improving the accuracy and efficiency of medical decision making, reducing the occurrence of misdiagnosis and missed diagnosis.

5.2 Future research direction

The future research direction of artificial neural network (ANN) in the field of medical health has broad prospect and far-reaching influence. First of all, personalized medicine is an important research direction. With ANN, large amounts of patient data, including genomic information, medical records, and lifestyle habits, can be analyzed to provide highly personalized diagnosis and treatment. This can not only improve the effectiveness of treatment, but also reduce unnecessary medical costs and side effects. Second, disease prediction and early diagnosis is also a key area. ANN enables deep learning from vast amounts of medical images and clinical data to identify small signs of early disease, especially in chronic diseases such as cancer, heart disease and diabetes. This will greatly improve the chances of early intervention, resulting in significant improvements in patient survival and quality of life. In addition, the development of smart medical devices is another important direction. By integrating ANN into wearables and other smart hardware, patients' physiological parameters can be monitored in real time, anomalies can be automatically detected and alerts can be issued in time. This will not only help people with chronic diseases better manage their illnesses, but also provide timely information in emergency situations, saving lives. Moreover, drug research and development will also benefit from ANN. By simulating and analyzing complex biological systems and chemical reactions, ANN can significantly shorten the research and development cycle of new drugs, reduce research and development costs, and improve the success rate of drugs. In the field of medical image analysis, ANN has demonstrated its strong potential. Future research can further improve the accuracy and efficiency of its application in different types of images (such as X-ray, CT, MRI, etc.), and even realize automated full-process image diagnosis. In addition, ANN can be used for text analysis to extract valuable information from large amounts of medical literature and electronic medical records to aid clinical decision-making and medical research. Through natural language processing, ANN can help doctors quickly access the latest research results and the best treatment options, thereby improving the quality of medical care. Ethics and privacy protection are important issues that must be faced in the application of ANN in the medical and health field. Future research is needed to further optimize ANN's algorithms and models while ensuring data security and patient privacy to avoid the risk of data leakage and abuse. At the same time, transparent and explainable ANN systems need to be established so that the clinical decision-making process can be traced and understood, thereby increasing the trust of doctors and patients.

In general, ANN's future research in the field of health care covers a variety of aspects, from personalized medicine, disease prediction, smart devices, drug development to medical imaging and text analysis. Through continuous technological innovation and interdisciplinary collaboration,

ANN is expected to play an increasingly important role in improving the quality of healthcare services, reducing healthcare costs and improving patient health. However, with the development of technology, there is also a need to continuously pay attention to and address the relevant ethical and privacy issues to ensure that the application of technology can truly benefit human health.

6 Closing remarks

Artificial Neural Networks (ANN) is a computational model based on the structure and function of biological nervous system, which has the advantages of self-adaptability, nonlinear, parallel processing, etc., and is widely used in pattern recognition, prediction, control and other fields. The application of artificial neural network in the field of health care has a broad prospect, and future research needs to be deeply explored in the aspects of multi-modal data fusion, model interpretation and transparency, data privacy and security, personalized medicine deepening, new network architecture exploration and interdisciplinary cooperation. Through these efforts, the application effect of artificial neural networks in the field of medical health can be further improved, the development of medical technology can be promoted, and more accurate and efficient medical services can be provided to patients.

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