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ADVANTAGES AND APPLICATIONS OF NEURAL NETWORKS

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ABSTRACT

Prediction is an important task in clinical fields. There has been increased interest in using neural networks (NNs) as a potential alternative to multivariate regression models for predicting clinical outcomes. We applied logistic regression and NNs to a real medical data set to estimate the probabilities of nosocomial infection in patients admitted to intensive care units. Their predictive performances were assessed by data-splitting. We described how to deal with medical data to improve the predictive performance of NNs and discussed the advantages and disadvantages of NNs versus logistic regression for predicting clinical outcomes. If we take appropriate measures against the disadvantages of NNs, NNs will probably outperform multivariate regression models.

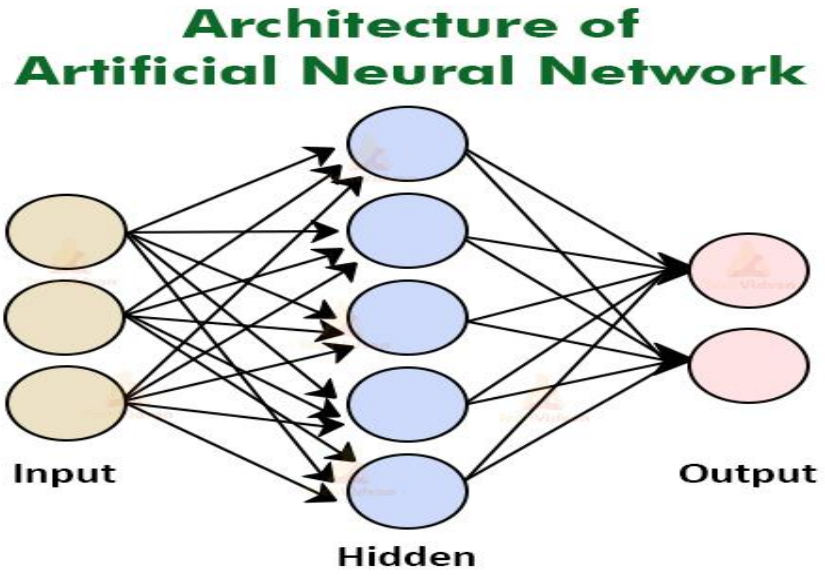
Keywords: neural networks, artificial neural networks, healthcare, medicine, medical diagnostics, mathematical modeling.

INTRODUCTION

Artificial neural networks are the modeling of the human brain with the simplest definition and building blocks are neurons. There are about 100 billion neurons in the human brain. Each neuron has a connection point between 1,000 and 100,000. In the human brain, information is stored in such a way as to be distributed, and we can extract more than one piece of this information when necessary from our memory in parallel. We are not mistaken when we say that a human brain is made up of thousands of very, very powerful parallel processors. In multi-layer artificial neural networks, there are also neurons placed in a similar

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manner to the human brain. Each neuron is connected to other neurons with certain coefficients. During training, information is distributed to these connection points so that the network is learned.



As shown in Figure 1, a neural network consists of three layers: an input layer, an intermediate layer and an output layer. The blue boxes shown here represent the neurons and the arrows represent the connection points. The data set prepared for training at the input layer is shown to the network. The network assigns the weights of the events it learns to the connection points in the intermediate layer[1]. Not every point has to be a value, and some points can be zero. A threshold value is added between the layers so that the zero values at the connection points do not become zero.

ADVANTAGES OF ANN

► Storing information on the entire network: Information such as in traditional programming is stored on the entire network, not on a database. The disappearance of a few pieces of information in one place does not prevent the network from functioning.

► Ability to work with incomplete knowledge: After ANN training, the data may produce output even with incomplete information. The loss of performance here depends on the importance of the missing information.

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► Having fault tolerance: Corruption of one or more cells of ANN does not prevent it from generating output. This feature makes the networks fault tolerant.

► Having a distributed memory: In order for ANN to be able to learn, it is necessary to determine the examples and to teach the network according to the desired output by showing these examples to the network[2]. The network's success is directly proportional to the selected instances, and if the event cannot be shown to the network in all its aspects, the network can produce false output

► Gradual corruption: A network slows over time and undergoes relative degradation. The network problem does not immediately corrode immediately.

► Ability to make machine learning: Artificial neural networks learn events and make decisions by commenting on similar events.

► Parallel processing capability: Artificial neural networks have numerical strength that can perform more than one job at the same time.

DISADVANTAGES OF ANN

► Hardware dependence: Artificial neural networks require processors with parallel processing power, in accordance with their structure. For this reason, the realization of the equipment is dependent.

► Unexplained behavior of the network: This is the most important problem of ANN. When ANN produces a probing solution, it does not give a clue as to why and how. This reduces trust in the network.

► Determination of proper network structure: There is no specific rule for determining the structure of artificial neur networks. Appropriate network structure is achieved through experience and trial and error.

► Difficulty of showing the problem to the network: ANNs can work with numerical information. Problems have to be translated into numerical values before being introduced to ANN. The display mechanism to be determined here will directly influence the performance of the network. This depends on the user's ability.

► The duration of the network is unknown: The network is reduced to a certain value of the error on the sample means that the training has been completed. This value does not give us optimum results.

►Science artificial neural networks that have stepped into the world in the mid-20th century are rapidly developing. In our present day, we have examined the advantages of artificial neural networks and the problems encountered in the

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course of their use. It should not be forgotten that the disadvantages of ANN networks, which are a developing science branch, are eliminated one by one and their advantages are increasing day by day. This means that artificial neural networks will become an indispensable part of our lives increasingly important

In the field of pulmonology, CNT is used for the differential diagnosis of interstitial lung disease, acute pulmonary thromboembolism. L. S. Makarova and E. G. In Semeryakova, the results of the differential diagnosis of bronchial asthma are presented using two methods: neural networks and discriminant analysis. In this study, the model created using discriminant analysis showed good results[3]. Diagnosis of patients on the basis of multilayered perceptron gave unsatisfactory results. The authors attribute this to the lack of patterns and examples in teaching. O. V. Alekseeva and co-authors proposed a method of differential diagnosis of recurrent bronchopulmonary pathology in children using neural network analysis. Testing of neural network systems developed by the authors showed a very high level of predictive ability - 95 and 92%.

Neural network technologies have also been used to diagnose diseases of the gastrointestinal tract. R Maclin, J. Dempsey, S. Kazmierczak, and others used neural network technology to differentially diagnose liver disease in their research work. P. I. Mironov and co-authors investigated the potential of CNT in predicting the development of abdominal sepsis in patients with severe acute pancreatitis. The study used a three-tiered network of training using an error-based processing algorithm based on data from 100 patients, and when its sensitivity was 63.3%, the specificity of CNT showed a high index of -88.2%[4]. This shows that the neural network model used allows patients with high accuracy to predict the development of abdominal sepsis that falls into this category. There are a number of studies devoted to the analysis of the possibility of using CNT to diagnose diseases of the spine and bone system. P.N. Afonin and co-authors used neural network technology to predict the direct and long-term outcomes of treatment of patients with spinal hematogenous osteomyelitis. In both cases, the networks are structured in the form perceptor.

An algorithm for genetic selection of input traits was used in the CNT construction process. 5 indicators were selected as the initial parameters of the network to predict the outcome of treatment of spinal osteomyelitis, and 18 indicators were selected to predict the severity of the deterioration of vital signs in the long run. The accuracy of the prognosis reached 92.3% for the direct discharge period (at the time of discharge from the hospital) and 90.6% for the long-term period (1 year after the end of treatment). A. Efimov and co-authors proposed a neural network

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algorithm to describe the condition of patients according to the stages of osteoporosis with 95.2% accuracy. In neurology, SNT is used to diagnose and classify neurodegenerative diseases such as Alzheimer's, Parkinson's, Huntington's. D. Mantzaris et al. proposed a method for assessing cognitive impairment in Alzheimer's disease based on EEG analysis using CNT in conjunction with a genetic algorithm. F. Berte et al. used different architectures of CNT to diagnose the type of dementia in patients. In this study, 6 types of dementia were distinguished: moderate cognitive impairment of mental activity, Alzheimer's disease, frontotemporal dementia, cognitive impairment of the vascular system, coexistence of Alzheimer's disease with vascular cognitive impairment, and frontotemporal dementia with vascular cognitive impairment[5]. The model with the best predictive ability turned out to be a potential neural network consisting of layers of input (30 neurons), latent (65 neurons), and output (6 neurons). This CNT allowed predicting the type of dementia in patients with 97.25% accuracy. It should be noted that the neural network in the form of a multilayered perceptron also showed good results: the accuracy of predicting the type of dementia was 95.60% M. Quintana et al. [40] CNT was used to classify patients into groups: healthy, moderately cognitive impaired, and patients with Alzheimer's disease. As a classifier, a multilayer percepton was used, which included 3 layers: input (12 neurons), latent (4 neurons), and output (1 neuron). The sigmoid is selected as the activation function. The CNT error was trained using a feedback algorithm. In the first phase, the network was trained on patient data in all three groups. As a result, perceptron was found to classify patients correctly in 66.67% of cases. In the second phase, data from healthy patients and a group of patients with moderate cognitive impairment were used to train the network. As a result, the network clearly classified patients in 98.33% of cases. In the final stage, the network was trained based on data from a group of healthy patients and patients with Alzheimer's disease. In this case, the classification accuracy reached 100%. A. Lins et al. used CNT to select parameters that could predict the development of moderate cognitive impairment and dementia in elderly patients. The authors suggested a neural network model using the following parameters as diagnostic factors: gender, age, training level, training time, and scores obtained during the testing period. N. S. Reznichenko has been working on the application of the experience of using CNT to diagnose attention deficit hyperactivity disorder. Twenty-five children in the network were trained using data from psychological maps. The diagnostic accuracy was 70%. The author concludes that the developed neural network model can be used to diagnose hyperactivity attention deficit disorder[6].

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CONCLUSION

N. S. Reznichenko and S. N. Shilov noted that increasing the size of the training sample and that the network gave more accurate performance after retraining of the network, and that the SNT gave an accurate prognosis in 89% of cases. The use of neural network technology gradually began to be applied in the field of psychology. For example, M. A. Berebin and S. V. Pashkov studied the possibility of using CNT in the prognosis and differential diagnosis of mental adaptation disorders among law enforcement officers. In this paper, the network is organized as a three-layered perceptor with sigmoid transmission functions of neurons. The first layer of the network consisted of 13 neurons, the second (latent) - of 13 neurons, and the output layer of 2 neurons, which corresponds to the number of diagnostic classes of the level of mental adaptation. After training, the CNT was tested and the prediction accuracy was 100%. E.. V. Slavutskaya and L. A. Slavutsky proposed a neural network algorithm to assess gender differences in the emotional-volitional and intellectual areas of 10–11-year-old schoolchildren[7]. In this study, the authors used a two-layer network with direct signal transmission and reverse error propagation. The results obtained show the effectiveness of the use of CNT, as this approach allows the correct identification of the most important psychological traits that determine the gender differences of the subjects. Thus, the most appropriate types of CNT structures designed to address medical diagnostic and prognostic problems are sigmoid activation functions and percepton, which allow the patient to provide information about the input and output at this diagnosis. Error redistribution algorithms and genetic algorithms are often used to train multilayer perceptrons in the diagnosis of various diseases. It should be noted that CNT can be used as mathematical models of the subject area under consideration. By changing the input parameters of the neural network model and observing the behavior of the output signals, you can study the field area, identify and verify the medical patterns obtained during CNT training.

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