OPPORTUNITIES FOR THE USE OF EXPERT SYSTEMS IN HEALTH CARE

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Recently, the importance of information support for a wide variety of medical technologies has increased. It becomes a critical development factor in almost all areas of knowledge, so the development and implementation of information systems is one of the most urgent tasks today [1]. An analysis of the use of personal computers in medical institutions shows that they are not used effectively enough: most are used for processing text documentation, storing and processing databases, maintaining statistics and financial calculations. A separate specialized part of the machines is used in conjunction with various diagnostic and therapeutic devices.

Most of the most important areas of medical and diagnostic technologies practically do not use modern computer capabilities. First of all, it is the diagnosis, the appointment of therapeutic measures, the prediction of the course of diseases and their outcomes. The reasons for this are complex and debated. The main reasons for the insufficient use of computer technologies in medicine are a poorly developed technical base, low computer literacy of technology participants, etc. The psychological aspect of the use of computer applications is of great importance. This is a serious reason related to the nature of the doctor's work. The doctor is a researcher, and his work is creative, but he is directly responsible for the result of his activities. When deciding on a diagnosis or treatment, he relies on the knowledge and experience, his own and colleagues who are his authority. In this case, it is very important to justify the decision, if it is prompted from outside.

Modern technical capabilities make it possible to reach a qualitatively new level of presentation of the course of the disease, namely, visually, based on mathematical laws, spatially model the typical development of the pathological process in a particular disease. Even now, at the present stage of development of medicine, information loads reach the limits of human capabilities. A dilemma arises: either one has to sacrifice the completeness of the analysis of information, or it is necessary to use various methods of decision support more widely. Expert computer medical systems allow the doctor not only to check their own diagnostic assumptions, but also to turn to the machine for advice in difficult diagnostic cases. The field of study of expert systems (ES) is called “knowledge engineering”. This term was introduced by E. Feigenbaum, and in its interpretation it means “the introduction of principles and tools from the field of artificial intelligence into solving difficult applied problems that require expert

knowledge". In other words, expert systems are used to solve non-formalized problems, which include tasks that have one or more of the following characteristics: tasks cannot be presented in numerical form; initial data and knowledge about the subject area are ambiguous, inaccurate, inconsistent; goals cannot be expressed using a well-defined objective function; there is no unique algorithmic solution to the problem.

All of the above characteristics are the best suited for solving medical problems, since in most cases they are represented by a large amount of multidimensional, confusing, and sometimes conflicting clinical data. ES allow solving problems of diagnostics, differential diagnostics, prognosis, choice of treatment strategy and tactics, etc. Of expert medical systems, a special place is occupied by self-learning intelligent systems (SIS). They are based on methods for automatic classification of situations from real practice, or on methods of learning by example. The most striking example of SIS are artificial neural networks.

Artificial neural networks (ANNs) are a non-linear system that can classify data much better than commonly used linear methods. When applied to medical diagnostics, ANNs make it possible to significantly increase the specificity of the method without reducing its sensitivity. ANN is a structure for processing cognitive information based on the modeling of brain functions. The basis of each ANN is relatively simple, in most cases, the same type of elements (cells) that imitate the work of brain neurons. Each neuron is characterized by its current state, by analogy with the nerve cells of the brain, which can be excited or inhibited. An artificial neuron has a group of synapses – unidirectional input connections connected to the outputs of other neurons, and also has an axon – an output connection of a given neuron, from which a signal (excitation or inhibition) enters the synapses of the next neurons [1]. ANN is characterized by the principle of parallel processing of signals, which is achieved by combining in a certain way a large number of neurons into so-called layers and connecting neurons of different layers. Theoretically, the number of layers and the number of neurons in each layer can be arbitrary, but in fact it is limited by computer resources: the more complex the ANN, the larger the tasks. The strength of synaptic connections is modified in the process of extracting knowledge from the training data set (learning mode), and then used when obtaining a result on new data (execution mode).

The most important difference between the ANN method and all other forecasting methods is the possibility of designing expert systems by the medical specialist himself, who can transfer his individual experience, the experience of his colleagues to the neural network, or train the network on real data obtained through observations. Neural networks are able to make decisions based on the hidden patterns they discover in multidimensional data. A positive distinguishing feature of ANNs is that they are not programmed, i.e. do not use any inference rules to make a diagnosis, but learn to

do so by example. According to the literature, ANNs can demonstrate amazing properties inherent in the human brain, including finding patterns in confusing data. Neural networks have found application in many areas of technology, where they are used to solve numerous applied problems: astronautics, automotive industry, banking, insurance, military affairs, robotics, data transmission, etc. Another equally important property of a neural network is the ability to learn and generalization of the acquired knowledge. The network has features of the so-called artificial intelligence. Trained on a limited set of training samples, it generalizes the accumulated information and develops the expected response in relation to the data that was not processed during the training process.

Despite a significant number of already known practical applications of artificial neural networks, the possibilities of their further use for signal processing have not been fully studied, and it can be assumed that neural networks will be a tool for the development of information technology for many years to come. The main expert system, which is increasingly used in solving problems of classification and forecasting, including in medicine, is the technology of analysis and data mining "Data Mining". They are implemented in a user-friendly interface and allow even a novice user to conduct research. The structure of the "Data Mining" system in the section of solving problems of classification and forecasting, in addition to artificial neural networks, most often includes: the support vector machine (support vector machine), the method of decision trees (decision trees), the "nearest neighbor" method, Bayesian classification, etc. Among these methods, the most interesting is the support vector machine (SVM) [1].

SVM is an initial classification method that solves a given problem by constructing hyperplanes in a multidimensional space that separate groups of observations with different class labels. The method searches for samples located on the boundaries between two classes, that is, support vectors. Examples of the use of expert systems in medicine cannot be called isolated, they are used in many areas of healthcare. It is noteworthy that the vast majority of works were carried out by foreign researchers, they mainly concern the use of ANN capabilities in various clinical situations. In surgery P.L. Liew et al. based on the ANN, created a system for predicting the risk of developing cholelithiasis in overweight people. The authors retrospectively studied anthropomorphometric, anamnestic, clinical and laboratory data of 117 obese patients operated on during the period from February 1999 to October 2022. An ANN trained by the backpropagation algorithm was built.

Thirty input variables were taken into account, including clinical data (gender, age, body mass index, comorbidities), laboratory parameters, and histological examination results. The predictive value of the ANN was compared with a logistic regression model trained on the same database. The ANN showed better predictive

value and lower error than the logistic regression model. The most important risk factors, according to both methods, were diastolic blood pressure, premorbid background, impaired glucose metabolism and increased blood cholesterol levels.

P. Bassi et al. predicted a 5-year survival rate for patients who underwent radical cystectomy for bladder cancer [1]. To achieve this goal, an ANN and a logistic regression model (MLR) were developed and compared. It was found that the only statistically significant predictors of five-year survival were the stage of the tumor and the presence or absence of germination in neighboring organs. The sensitivity and specificity of MLR were 68.4% and 82.8%, respectively; INS - 62.7% and 86.1%. The positive predictive value of MLR was 78.6%, the INS was 76.2%, and the negative predictive value was 73.9% and 76.5%, respectively.

The index of diagnostic accuracy of MLR is 75.9%, INS is 76.4%. Thus, the predictive value of the ANN turned out to be comparable to the MLR, but the neural network still showed certain advantages: the ANN is based on easy-to-use, intuitive software that allows you to identify non-linear relationships between variables, therefore it is more preferable for forecasting. S. Stephan et al. used ANN for automated analysis of prostate biopsy [2]. The technique is based on the detection of total prostate-specific antigen (PSA) and the percentage of free PSA. Sensitivity was 95%, specificity was 34%. When the neural network was supplemented with a logistic regression model, the specificity increased to 95%. F.K. Chun et al. used ANN to identify risk groups for prostate cancer compared to MLR [1]. ANN has also demonstrated more accurate predictive capabilities. Modern technical capabilities make it possible to reach a qualitatively new level of representation of the course of the disease, namely: on the basis of expert automated technologies, to model the typical development of the pathological process. Expert computer medical systems allow the doctor not only to check their own diagnostic assumptions, but also to turn to the machine for advice in difficult diagnostic cases.

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