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Modeling Of An Expert System For Making A Diagnosis In The Treatment Of Oncological Diseases

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Abstract *Today, an increase in the incidence of oncological diseases remains a significant problem of modern healthcare. Various categories of the population are at risk of developing this disease. In this regard, timely diagnosis of oncological diseases and their prevention is one of the priorities. Early detection and high diagnostic accuracy contribute to improving the effectiveness of treatment measures and increasing the life expectancy of patients.*
The use of information technologies in the field of medicine is developing rapidly, which contributes to a significant improvement in the quality of diagnosis, treatment and monitoring of patients The modern medical sector has a wide variety of decision support systems designed to optimize clinical processes and improve the accuracy of medical decisions Expert systems are being implemented to improve the accuracy and timeliness of cancer diagnosis, providing support to medical professionals in the clinical decision-making process and contributing to the optimization of patient treatment.The main purpose of this study is to conduct a scientific analysis and systematization of approaches used in expert systems for the diagnosis and treatment of oncological diseases. The key task is to determine the optimal method for developing an expert system that facilitates the most accurate diagnosis of the disease.An urgent problem solved within the framework of this study is the justification of the choice of a methodological approach to building an intelligent system that helps to accelerate and improve the accuracy of data analysis, as well as the formation of recommendations for the treatment of oncological diseases in the Semipalatinsk region.
Keywords*artificial intelligence, analysis, database, diagnostic accuracy, expert system, neural network*

INTRODUCTION

Currently, one of the key health problems is the steady increase in the incidence of malignant neoplasms. This necessitates the development and implementation of effective methods for the prevention, early diagnosis and treatment of this disease.This disease occurs in representatives of various age groups of the population. For this reason, one of the most important tasks is to ensure the early detection of cancer and the implementation of effective preventive measures. Early detection and high diagnostic accuracy are key factors contributing to increasing the effectiveness of therapeutic interventions and prolonging the life expectancy of patients.The introduction and integration of information technologies into medical practice is accompanied by intensive and accelerated development. In modern medical practice, various clinical decision support systems are actively used, aimed at improving the accuracy of diagnosis and optimizing therapeutic strategies for various diseases.Specialized expert systems have been developed to improve the accuracy, objectivity and timeliness of cancer diagnosis, which support clinical decision-making and help optimize treatment processes.

MATERIALS AND METHODS

Within the framework of this study, classical methods of scientific analysis, synthesis, and classification are used to systematize and comprehensively evaluate the methodological approaches under study, which makes it possible to identify structural relationships and determine key parameters of the effectiveness of applied solutions. In the field of malignant neoplasm diagnostics, many expert systems based on various methodological concepts and algorithmic models have been developed and implemented. These systems are designed to support clinical decision-making by improving the

accuracy, objectivity and efficiency of the diagnostic process, which ultimately contributes to improving the quality of medical care and reducing the risk of diagnostic errors.In this study, in addition to the methods of scientific analysis, synthesis and classification technologies are used for a comprehensive study and systematization of the studied material. For the purposes of cancer diagnosis and research, various expert systems have been developed and improved to improve the effectiveness of clinical analysis and decision support.A number of studies have proposed automated diagnostic systems for detecting breast cancer based on the use of associative rules (AR) and neural networks (NN). To validate the effectiveness of the developed models at the testing stage, the triple cross-validation method is used using the appropriate data sets[1]. There are approaches using semantic web and natural language analysis. A list of acceptable tokens is generated, which will be sent to the medical expert system or DDSS for breast cancer diagnosis. The proposed model yielded a 64% improvement over the model that accepts raw input data from patients/users[2].In [3], physical research methods are proposed in expert systems for the diagnosis of oncological diseases. The localization of diseases in the esophagus, stomach, intestines, pancreas, liver is considered [3].There are expert systems for making a diagnosis based on criteria parameters, which also give good results[4].There is also a fuzzy expert system for diagnosing various types of cancer. The use of fuzzy logic methods works well for multiple localities for cancer diagnosis[5]. The paper [6] suggests the use of intelligent screening for the diagnosis and treatment of oncological diseases. Rather than developing traditional statistical models, a knowledge base is being formed by accumulating patterns obtained from analyzing similar situations (in terms of a large number of parameters) with other patients.[6]The approach of building an expert system using a hybrid method is also used. The system was developed by implementing two methods: the direct chain method to track each symptom experienced by the patient in accordance with the conditions when accessing the system, then switching to using the confidence factor method to determine the percentage of confidence that the patient is experiencing a condition/symptom, this is done to ensure the accuracy of the results obtained [7]. Approaches to building an expert classification system by risk groups based on the application of a production model for the formalization of medical knowledge have been proposed. A model of the change in the number of cancer patients based on the mathematical apparatus of continuous Markov chains is shown, which differs in that it is based on a generalized classification system of observables, which is adopted in the oncological service, and the latent period of the disease course was taken into account. An expert classification system by risk groups is shown, which is based on the application of product models for the formalization of medical knowledge, which, in comparison with other systems, allows you to create a personal risk reduction program based on the analysis of all the data obtained[8]. The study analyzes modern methodological approaches used in the development of expert systems designed to diagnose and support the treatment of malignant neoplasms. As a result, both the advantages and limitations of the key approaches were identified, which allowed for their systematization and classification based on the criteria of applicability, taking into account the specific localization of the oncological focus. This differentiated approach contributes to a more accurate adaptation of diagnostic and therapeutic methods to the specifics of each type of malignant disease, increasing the effectiveness of clinical solutions and the quality of medical care.

RESULTS AND DISCUSSION

Neural networks are widely used in various medical tasks, including the detection of pathologies, their classification, diagnosis, and other related processesIn particular, neural networks based on the Hamming network architecture are used to solve a wide range of tasks, including knowledge analysis and structuring, object identification and classification, conceptual modeling, knowledge formalization, creation of specialized scenario databases, training of neural network models and development of prototypes of intelligent systems. These expert systems make it possible to develop artificial intelligence systems for self-learning, analysis, and making recommendations for the treatment of oncological diseases [9-17].

To construct an intelligent system based on neural networks, the following step-by-step approach to solving the problem of analysis and making recommendations is proposed:

1. Knowledge analysis and extraction, identification of key elements, conceptualization and modeling of the obtained data;
2. Creation and formalization of a knowledge model;
3. Creation of a database of script questions, training a neural network using this database;
4. Creation of a prototype of an intelligent system.

Knowledge analysis and acquisition, identification, conceptualization

At this stage of the study, a comprehensive analysis of the subject area was carried out in order to identify and comprehend key tasks, as well as systematize detailed requirements reflecting the main characteristics and features of the object under study. An informal description was formed, which serves as the basis for further modeling. In addition, the central concepts and objects of the subject area, their input and output parameters are defined. As part of the work, a methodological basis for solving the problem was developed, as well as the necessary set of knowledge and information resources to ensure the achievement of research goals. At this stage, data was collected on the medical indicators of patients with lung cancer over the past 5 years in the region and the main assessment indicators were identified. Medical indicators were determined, and answers to the questions that will be included in the questionnaire to create the knowledge base of the intelligent system.An online questionnaire for the diagnosis of lung cancer will be developed in accordance with the provisions of the European Protocol, providing standardized data collection.This questionnaire will also include 2 questions regarding the place of birth and residence of patients in order to take into account the effects of radioactive contamination as a result of nuclear tests.The weight of each answer will be distributed by gradation relative to the total specific gravity for the subsequent construction of a Hamming neural network. It is planned to complete an online questionnaire for more than 1,000 people to obtain reliable data for the implementation of a neural network(fig.1).

Question	Answers				
	1 answer	2 answer	3 answer	4 answer	
Age	30-40	40-50	50-60	60 and above	
	0,2	0,5	0,5	0,5	
Male	Men	Woman			
	1	0,6			
Do you smoke?	Yes	No			
	1	0,5			
Smoking experience	Up to 10 years old	From 10 to 20 years old	From 20 to 30 years old	From 30 and above	
	0,7	0,9	1	1	
How many packs/pieces do you consume per day	Up to 10 pieces	Up to 1 pack	1 pack	1 pack or more	
	0,8	1	1	1	
How many times a year do you get SARS?	1 time	2 times	periodically	not sick	
	0,4	0,5	0,8	0,4	
Oncoanamnesis of parents and close relatives	One of the parents	Both parents have	Close maternal relatives	Close paternal relatives	
	0,9	0,9	0,5	0,5	
Have you had hemoptysis?	Yes	No			
	0,9	0,4			
Do you have shortness of breath or a feeling of lack of air?	periodically	often	during physical exertion		
	0,5	1	1		
Was there a change in the voice?	Yes	No			
	0,8	0,2			
Do you ever have a weakness that is unrelated to anything?	periodically	often	no		
	0,3	0,5	0,2		
Have you been coughing?	not at all	a little	not so little	very strongly	
	0,2	0,2	0,3	0,8	
Have you ever had trouble swallowing?	not at all	a little	not so little	very strongly	
	0,3	0,3	0,4	1	
Have you ever had chest pain?	not at all	a little	not so little	very strongly	
	0,5	0,6	1	1	
Have you ever had pain in your arm or shoulders?	not at all	a little	not so little	very strongly	
	0,5	0,5	0,7	1	
Have you ever had a dry cough?	not at all	a little	not so little	very strongly	
	0,4	0,6	0,8	0,8	
Have you had any unrelated weight loss?	not at all	a little	very strongly		
	0,5	0,5	1		
Have you had a decrease in appetite?	not at all	a little	not so little	very strongly	
	1	1	1	1	
Are you registered with a pulmonologist for other lung diseases?	Yes	No			
	1	0,5			
Place of birth	Region 1	Region 2	Region 3	Region 4	Other
	0,3	0,5	0,8	0,9	0,3
Place of residence	Region 1	Region 2	Region 3	Region 4	Other
	0,3	0,5	0,8	0,9	0,3

Fig. 1 Survey results

The received responses will be processed in the Power BI package. Then a mathematical model will be created in Python, and a database of patient responses in SQl.

Creation of a knowledge model, formalization of knowledge

At this stage, it is planned to formalize questions and answers from the oncoanamnesis card of patients for subsequent data processing by the expert system.

Creating a database of script questions, training a neural network

At this stage, it is planned to create a database of questions and train a neural network based on data obtained from an online patient questionnaire.

Creation of a prototype of an intelligent system.

At this stage, the architecture, structure of the intelligent system, file data exchange, an infological model of the system will be created, a datalogical, physical and logical design of the system will be carried out, and a web application for medical organization employees will be developed (fig.2).

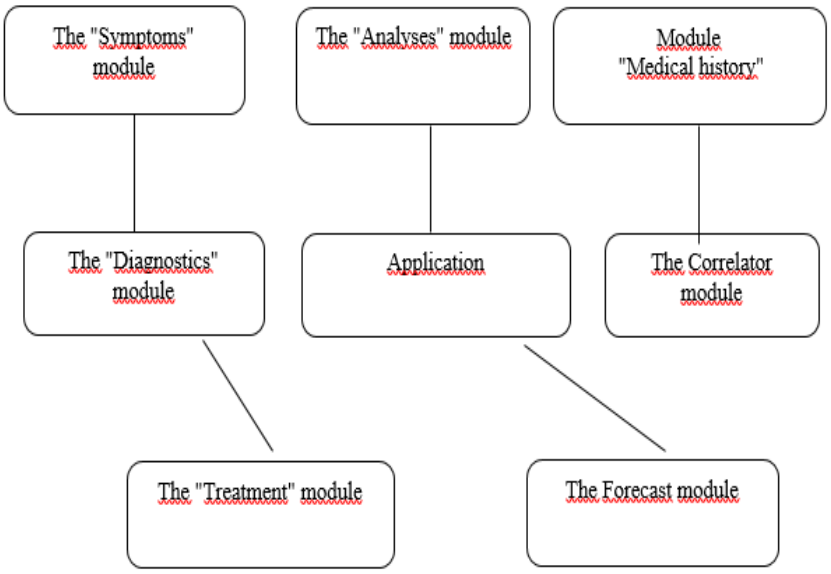

Fig. 2 Functional diagram of the intelligent oncology system

The following algorithm of the neural network learning process is proposed(fig.3):

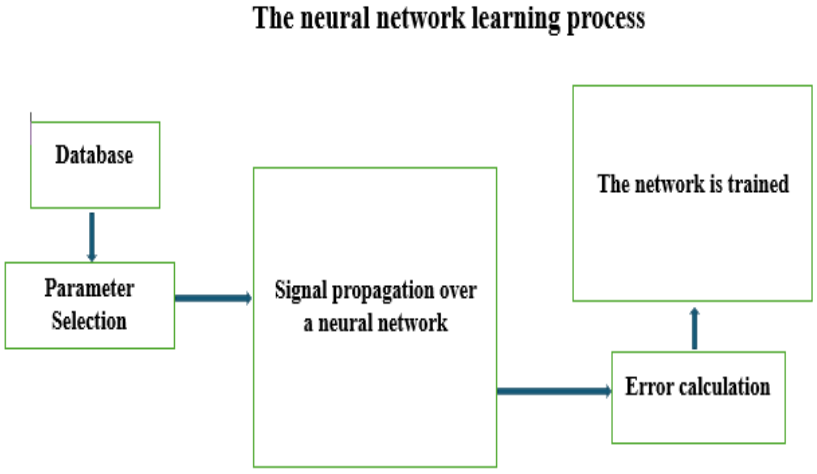

Fig. 3. The learning process of a neural network

The following system structure is proposed(fig.4):

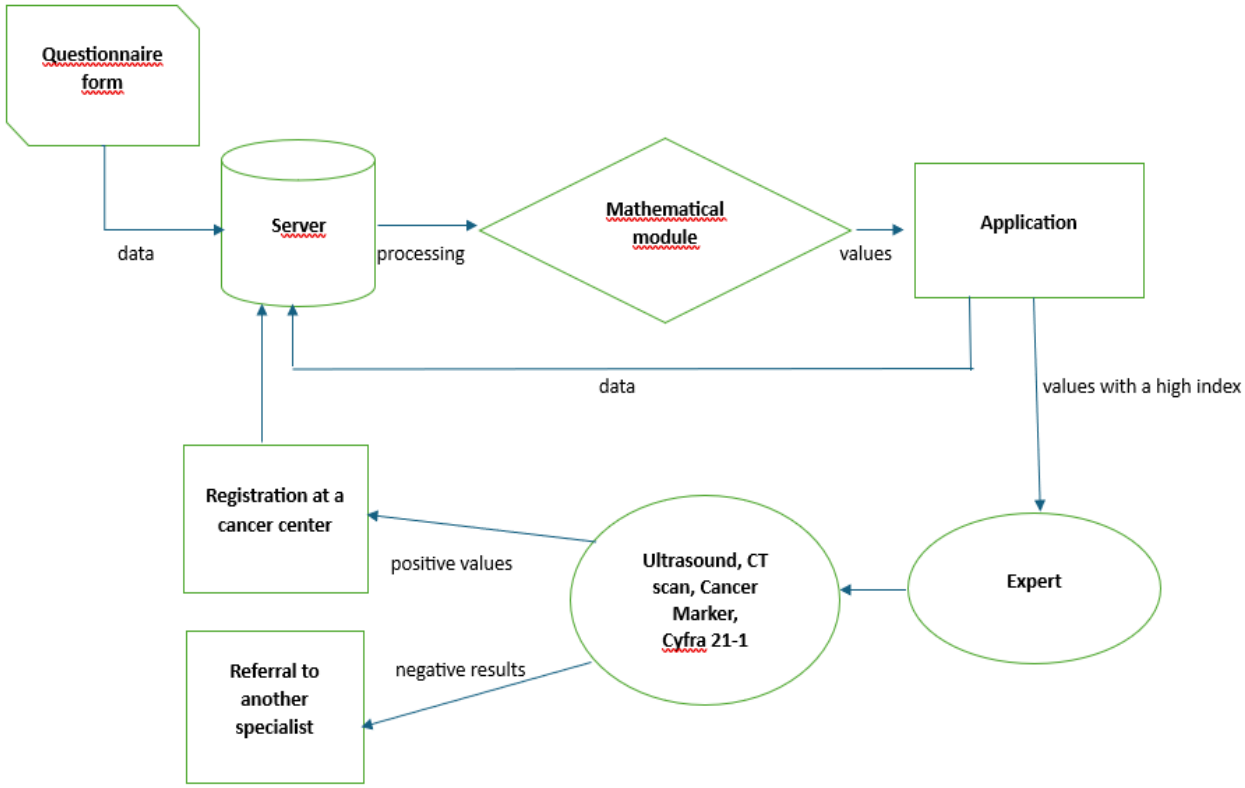

Fig. 4. System architecture

This study implements a set of methodological approaches, including methods of scientific analysis and synthesis, ensuring the systematic study and integration of the data under study. The analysis of strategies used in the development of expert systems for diagnostics in oncological therapy is carried out. The key advantages and disadvantages of the main approaches are identified. The most appropriate and preferred approach, widely used today in expert systems, was the use of neural networks based on the principles of Hopfield networks.

CONCLUSION

This study presents a comprehensive analysis of modern methodological approaches used in the development of expert systems for the diagnosis and therapy of malignant neoplasms. Special attention is paid to evaluating the effectiveness of these approaches in clinical practice, which makes it possible to identify their practical significance and potential for improving the quality of medical care for cancer patients. The key advantages and limitations of the main methods are characterized. The study provides a classification of methods used in expert systems that are aimed at diagnosing oncological diseases.

The results obtained made it possible to identify the most effective and adaptive approaches used in various oncological pathologies, which forms the methodological basis for the development of a prototype information and diagnostic system.The use of neural networks has been identified as the most optimal and promising approach, which is currently used in modern expert systems. Neural networks can effectively solve the following tasks: knowledge analysis and acquisition, identification, conceptualization, building a knowledge model, formalizing knowledge, creating a repository of question scenarios, training neural networks, building a prototype of an intelligent system. These expert systems make it possible to develop artificial intelligence systems for self-learning, analyzing, and making recommendations on cancer treatment for a wide range of tumor locations.

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