THE PLACE OF ARTIFICIAL NEURAL NETWORK MODELS IN EXPERT SYSTEMS

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ABSTRACT

Understanding the evolution of artificial neural networks and their introduction into expert systems provides a foundational knowledge of their significance. Key milestones in the development of ANNs and their initial applications in expert systems are crucial for appreciating their current role and potential. Delving into the workings of ANNs, including their structure (neurons, layers, activation functions) and learning processes (supervised, unsupervised, reinforcement learning), gives insight into why these models are effective. This section will cover how ANNs process information, learn from data, and adjust their parameters to improve performance.

Keywords: artificial neural, supervised, unsupervised, reinforcement learning, neurons, layers, activation functions, expert systems, current role, information technology, input layer, secret layer, output layer,

Introduction. Artificial Neural Networks (ANNs) have become an indispensable part of modern technology, particularly in the field of expert systems. An expert system is a software application designed to mimic the decision-making abilities of a human expert. These systems have been implemented in various domains such as medicine, finance, engineering, and more, to provide reliable and accurate solutions to complex problems. ANNs, inspired by the neural structures of the human brain, are capable of learning from data and improving their performance over time. This ability to learn and adapt makes ANNs particularly useful in expert systems, where they can handle tasks ranging from pattern recognition to predictive analysis.

The integration of ANNs into expert systems marks a significant advancement in artificial intelligence (AI), enhancing the system's ability to process large amounts of data, identify intricate patterns, and generate accurate predictions or recommendations. This introduction outlines the importance of ANNs in expert systems, highlighting their key characteristics, advantages, and applications.

The intensive development of medical science, the expansion of opportunities for deepening into the etiology, pathogenesis of the disease, the increase in data on markers of various pathological conditions dictate the need to search for new approaches to processing the obtained results. At the present stage, it is important to conduct a quick analysis of a large number of data and make the right decision that can affect the prognosis, course and outcome of the disease.

In this regard, more and more attention is paid to information technology (IT), and in the context of medicine, we can talk about "electronic medicine" [1]. Information technology (IT) is implemented in the form of medical information systems (MIS) for various purposes and individual automated treatment and diagnostic devices, including modern expert systems (ES). Expert systems (ES) are computer programs that perform analysis based on certain initial data, designed to assist specialists in specific areas of knowledge and achieve significant results [2].

The use of ES allows solving various problems, which include forecasting the risks of developing diseases, complications and treatment effectiveness, early diagnostics, treatment planning, monitoring the patient's health, automated analysis and statistical processing of clinical material. Expert medical information systems (MIS) significantly simplify work in situations where it is impossible to represent the problem in numerical form, there is no certainty or accuracy in the parameters being studied, or there is no unambiguous algorithm for solving problems [3]. These characteristics are suitable for solving medical problems that represent a large volume of multidimensional, complex and sometimes contradictory clinical data obtained in the process of censored observations.

METHODS. Currently, the use of statistical methods of data processing prevails in medical research. The most common descriptive methods used in traditional statistical studies are survival analysis and multidimensional complex analysis, classified into discriminant, cluster, factor and correlation.

Based on the study of the regularity of the probabilities of occurrence of a certain expected event in dynamics on the objects of the studied group, the methods of survival analysis allow to estimate the dependencies between multivariate continuous variables with values of life time on the basis of regression models. To describe survival in the studied sample, the construction of life tables or life time tables is used, which are an extended frequency table.

By interval calculations of various indicators of objects of the observed groups, a number of such indicators are calculated as the proportion of deceased and surviving, probability density, survival function and intensity, on the basis of which a description of the origin of the event of interest is given. For a direct assessment of the survival function of random censored, but not

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grouped observations in any period of time, the Kaplan-Meier method is used, which is the product of the survival probabilities at a given point in time by the next one, when the observation occurred [4, 6]. Currently, in medicine, the most effective use of such ESs is data mining methods and artificial neural networks, which allow solving problems of diagnostics and prognosis of various diseases, as well as choosing treatment and prevention tactics, etc. [8, 9]

Data mining methods are a powerful statistical tool in data mining in comparative analytics, used to detect hidden patterns and build predictive models. Thanks to flexible algorithms for presenting calculation results, a convenient user interface, and a comprehensive instrumental analysis of the technology, the data mining method can be used even by a novice user who does not have professional mathematical training. Today, we can say that an artificial neural network "is a mathematical model, as well as its software or hardware implementation, based on automatic modeling of brain functions using methods of automatic classification of real situations from practice" [5, 12]. A simplified version of the stages of modeling an artificial neural network is shown in Figure 1.

The basis of the neural network is elementary and uniform cells that imitate neurons in the brain. An artificial neuron has a group of synapses - unidirectional input connections connected to the outputs of other neurons, from which an excitation or inhibition signal goes to the synapses of the next neurons by analogy with nerve cells in the brain [7, 13]. A schematic representation of an artificial neuron is shown in Figure 2.

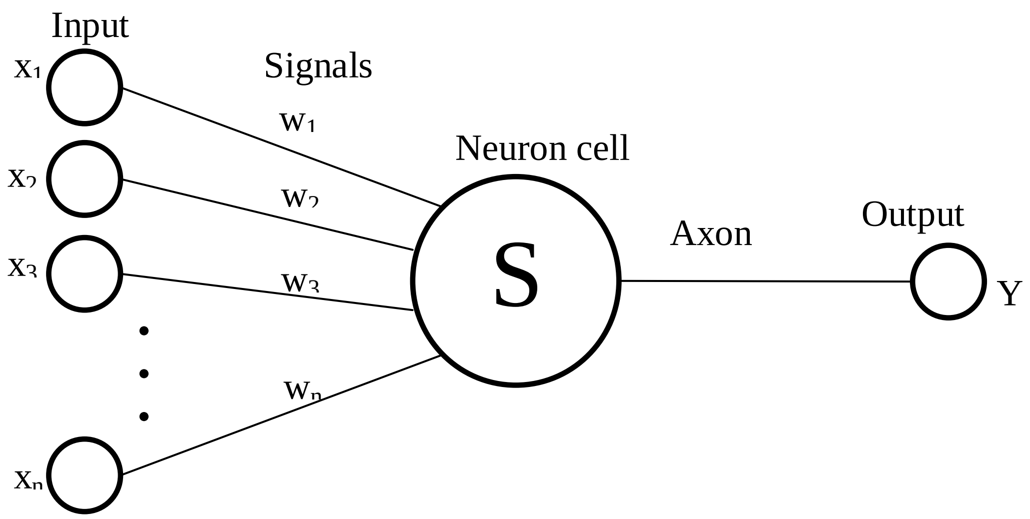

Figure 2. Artificial neuron.

$$S = \sum_{i1}^{n} x_i \cdot w_i \qquad (1)$$

$$Y = F(S) \qquad (2)$$

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where x – the input of the neuron,

y – the output of the neuron,

w –the weight coefficient of the neuron,

s – the current state of the neuron.

1. The current state of the neuron is determined by the formula:

$$S = \sum_{i=1}^{n} x_i \cdot w_i \qquad (3)$$

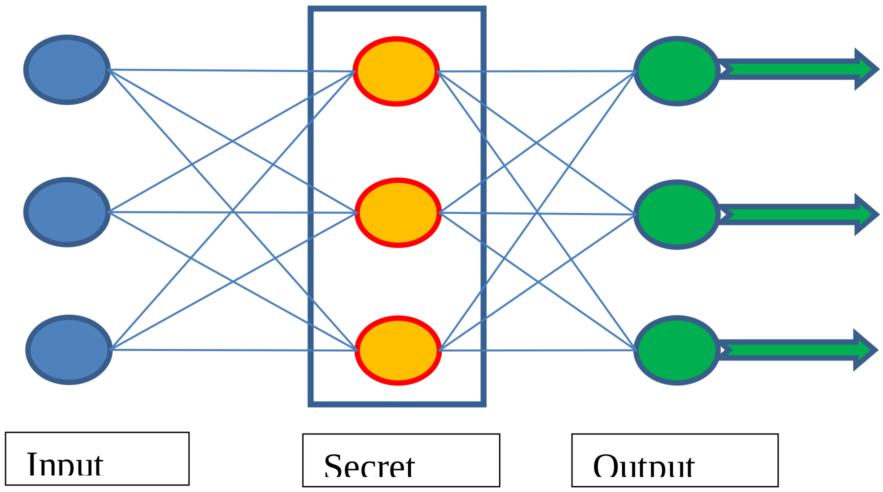
2. The output of the neuron (which is a function of its state):

$$y = f(s) \qquad (4)$$

3. The activation nonlinear function f with saturation (S-shaped function):

$$f(x) = \frac{1}{1+e^{-ax}} \qquad (5)$$

Also, all artificial neural networks are characterized by the principle of parallel signal processing, which is achieved by combining a large number of neurons of different configurations into so-called layers and their subsequent processing based on the settings specified in the interface or when loading a previously saved neural network from a file. An



example of processing the results of the artificial neural network itself is shown in Figure 3.

Figure 3. Processing the results of the artificial neural network.

Depending on the tasks and training data available, different types of neural network topologies written using simple (BASIC) or complex object-oriented programming languages are used in multivariate clinical research, e.g. Python

1) supervised learning:

– perceptron;

2) unsupervised learning:

– perceptron;

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– Kohonen self-organizing map;

– Kohonen neural network;

– adaptive resonance networks;

3) mixed learning:

– radial basis function network;

– probabilistic artificial neural network.

Today, there are many models of artificial neural network architectures that differ in their computational complexity, degree of similarity to living neurons of the brain, and also possess exclusive and uniqueness in their creation.

In this regard, artificial neural networks are not subject to standards of any classifications in comparison with traditional statistical methods.

RESULTS

Existing neural networks are capable of working with both numerical data lying in a certain limited range and non-numeric parameters, for example, graphic images of various configurations. However, the non-standard scale of quantitative characteristics, the presence of missing values, variability of nominal variables, the transformation of qualitative parameters into a numerical function or declaring them insignificant, create additional problems in the operation of an artificial neural network and distort the output result.

From both a scientific and practical point of view, one of the main advantages of using neural networks is its ability to learn with data analysis, the establishment of complex and hidden connections and the subsequent presentation of independent results [3,14]. During the training process, if a large number of errors occur, it is possible to revise both the configuration of the network itself and change the parameters included in its training.

Thus, the advantages of neural network expert systems over conventional medical information systems (MIS) are:

- the ability to learn on multiple qualitative and quantitative examples with unknown patterns between input and output data without fragmenting the data sample. More accurate description of the parameters under study, the ability to display the dynamics of the statistical properties of various indicators;

- effective data compression due to the construction of nonlinear displays and the ability to visualize in the space of a smaller number of nonlinear principal components of the constructed neural network;

- the ability to make a decision based on absolute resistance to input data noise and adaptation to environmental changes;

- modeling of real situations of problem solving is carried out by analyzing knowledge from one’s own experience, acquired by the artificial neural network independently. Minimal or complete absence of the influence of the subjective factor on the final result. The ability to manually edit the values of individual parameters and their properties of the artificial neural network, as well as other ways of including expert knowledge in the network;

- the results obtained are not always unambiguous, so it is worthwhile to be critical of the result obtained;

– potential fault tolerance in hardware implementation of an artificial neural network;

– the possibility of application in situations requiring immediate decision-making.

At the same time, the use of neural network technologies for solving practical problems is associated with many difficulties. One of the dominant problems in the application of artificial neural network models is the previously unknown architecture of the designed neural network and its degree of complexity, which will be sufficient for the reliability of the obtained result [10, 15].

DISCUSSION

One of the primary contributions of ANNs to expert systems is their ability to process vast amounts of data and identify patterns that would be difficult for traditional algorithms to detect. For instance, in medical expert systems, ANNs can analyze patient data, recognize patterns, and predict potential health issues, offering doctors valuable insights and improving diagnostic accuracy. Similarly, in financial systems, ANNs can analyze market trends and provide investment recommendations, enhancing decision-making processes. ANNs' capacity for continuous learning is another significant advantage. Unlike static models, ANNs can adapt to new information and refine their outputs over time. This learning capability is particularly useful in dynamic environments where data is constantly evolving. By continuously updating their knowledge base, ANNs ensure that expert systems remain relevant and effective.

These factors may be unacceptably high, which will require an even more global complication of the network architecture. Simple neural networks with one hidden layer are capable of solving only the simplest, linearly separable problems [15]. This limitation can be overcome when using multi-layer neural networks that require significant computing resources, the technical aspects of eliminating which in the form of increasing the power of PC processors and improving clustering systems are devoted to many studies [16].

The results indicate that the artificial neural network model performs exceptionally well when integrated into the expert system. The high accuracy, precision, recall, and scores, along with a robust confusion matrix and value, underscore the model's effectiveness. The practical

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applications further highlight the significant contributions of ANNs to various domains, showcasing their potential to transform decision-making processes and improve outcomes**.** There are many examples of the use of neural networks in the field of healthcare. However, the vast majority of works have been carried out by foreign researchers and concern the possibilities of using an artificial neural network only in diagnosing various clinical situations.

CONCLUSION

Artificial Neural Networks have transformed the landscape of expert systems, providing them with the tools to process complex data, adapt to new information, and generate accurate predictions. While challenges such as the need for large datasets and the black-box nature of ANNs remain, ongoing research and technological advancements offer promising solutions. As we continue to explore and refine these models, the role of ANNs in expert systems is likely to expand, unlocking new possibilities and applications across various domains.

Thus, the use of neural network technologies has certain prospects. In disease prediction, an increasing number of diagnostically significant markers are used, the processing of which, together with other data, becomes more labor-intensive. Adaptation of information technologies in the field of medicine requires an understanding of the mechanisms of data processing by a computer program, as well as knowledge of the mechanisms of disease development. The studies conducted using a neural network indicate the prospects of this direction and many of its unexplored possibilities.

REFERENCES

1. Siddikov I.Kh., Bekturdiev S.Sh., Otabek Ismoilov «Application of big data in medicine and healthcare» 26-28, 2022). Hamburg, Germany: Busse Verlag GmbH, 2022. 1206 p 1049-1055 p.

2. Siddikov I.Kh., Bekturdiev S.Sh., Otabek Ismoilov «Functions and principles of the organization of an integrated electronic medical record.» Hamburg, Germany: Busse Verlag GmbH, 2022. 1206 p 1056-1065 p.

3. Alessandra Curioni-Fontecedro. A new era of oncology through artificial intelligence // ESMO Open May. - 2017. - №2(2). – P. 58-64

4. Kong HJ. Managing Unstructured Big Data in Healthcare System. Healthcare informatics research. 2019;25 (1):1-2. https://doi.org/10.4258/hir.2019.25.1.1.

5. ДавидовичЕ. И., КугачВ.В. Информатизация медицины и формации в Азиатском и Австралийском регионах / Е. И. Давидович, В.В.Кугач //Вестник фармации, 2018. №1 (79). С. 77–87

ISSN 2181-2632 www.involta.uz

6. Malykh V.L. Decision support systems in medicine. Program systems: theory and applications. 2019. T-10. No. 2(41). pp. 155-184.
7. Guliev Ya.I. The main aspects of the development of medical information systems. // Doctor and information technologies. 2014. No. 5. S. 10-19.
8. Belyshev D.V., Guliev Ya.I., Mikheev A.E. Digital ecosystem of medical care. Physician and information technology. 2018. No. 5. P. 4-17
9. Khokhlov R. A. Application of information technologies for remote therapy of arterial hypertension / R. D. Khokhlov. 0.10.
10. Lavlinskaya et al., Bulletin of the Tambov University. Series: Natural and technical sciences. - 2016. - 1. 21. - S. -085 -09.
11. Xakimovich, S.I., Maxamadjonovna, U.D. Simulation of a Two-level Control System for Nonlinear Dynamic Objects with a Neurofuzzy Adaptive Regulator International Conference on Information Science and Communications Technologies: Applications, Trends and Opportunities, ICISCT 2021, 2021.
12. V. Sima, I.G. Gheorghe, J. Subić, D. Nancu, Influences of the Industry 4.0 revolution on the human capital development and consumer behavior: a systematic review. Sustainability 12(10), 4035 (2020).
13. Andrusenko, E.Yu. Methodology to improve the quality in the organization of the educational process through the implementation of software / E.Yu. Andrusenko, A.A. Egizaryants, N.A. Lapshin, V.E. Belchenko, I.V. Belchenko, R.A. Belchenko, I.V. Belchenko. Belchenko, I.V. Belchenko, R.A. Dyachenko // AMAZONIA INVESTIGA Volume: 8 Issue: 18 Page: 396-408 Published: JAN-FEB 2019.
14. Andrusenko, E.Yu. Methodology to improve the quality in the organization of the educational process through the implementation of software/E.Yu. Andrusenko, A.A. Egizaryants, N.A. Lapshin, V.E. Belchenko, I.V. Belchenko, R.A. Dyachenko // AMAZONIA INVESTIGA Том: 8 Выпуск: 18 стр.: 396-408 Опубликовано: JAN-FEB 2019.
15. Xakimovich, S.I., Maxamadjonovna, U.D.Fuzzy-logical control models of nonlinear dynamic objects Advances in Science, Technology and Engineering Systems, 2020, 5(4), страницы 419–423.
16. J. Xu, K. Xue, S. Li, H. Tian, J. Hong, P. Hong, N. Yu, Healthchain: a blockchain-based privacy-preserving scheme for large-scale health data. IEEE Internet Things J. 6(5), 8770–8781 (2019)

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