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MINISTRY OF EDUCATION AND SCIENCE
OF UKRAINE
V. N. KARAZIN KHARKIV NATIONAL UNIVERSITY

**IT-SPACE OF TODAY:
TRENDS, INNOVATIONS
AND DEVELOPMENT PROSPECTS**

Collection of abstracts
of the II International Scientific and Practical
Student Conference

(October 21, 2026, Kharkiv, Ukraine)

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NEURAL NETWORK IMPLEMENTATION OF SOLVING DISCRETE OPTIMIZATION PROBLEMS

The purpose of the study is to solve the problem of minimum coverage on the graph. As a result of the work, a neural network model was developed to solve the problem of minimal coverage. During experimental modeling, the influence of choosing the initial states of the Hopfield neural network model on the quality of the results was investigated. It is concluded that the neural network method showed a greater time complexity of solving the problem than the method itself.

The use of models and algorithms of discrete optimization (DO) allows you to solve many problems, such as: optimization tasks on networks; traffic routing in communication networks; tasks of placement of economic objects; tasks of optimization of automated resource planning systems; logistics tasks (optimization of supply chains); tasks of artificial intelligence and robotics.

This is due to the fact that discrete optimization models adequately reflect nonlinear dependencies and take into account the constraints of logical and technological types, as well as have a qualitative character. A sufficient number of these problems are NP-difficult, their solution in the worst case may require the construction of a solution tree of exponential size. Many practical problems of DO contain a huge number of variables "and/or" constraints that create difficulties when trying to solve these problems using modern algorithms. Currently, among the most promising areas of research in the field of discrete optimization, the following approaches can be distinguished:

- development of effective computational algorithms (accurate and approximate) for solving DO problems;
- search for special classes of DO problems, on which certain algorithms work well;
- development and research of DO algorithms with effective parallelization of calculations;
- theoretical analysis of the complexity of algorithms for solving DO problems.

Let's list the most common applied problems of discrete optimization: the problem of packing a backpack, the problem of a traveling salesman, one-dimensional cutting of sheet materials of different sizes, the problem of covering a set with a system of its subsets, optimization of the structure of a computing cluster, transport problems, drawing up plans and schedules. Their mathematical formulations are well described in the relevant literature sources. Traditional methods of solving DO problems include algorithms that are built on the basis of the properties of the target function and constraints. The most famous are:

- Simplex – a method for solving integer optimization problems with linear constraints;
- A group of methods for sequential analysis and screening of variants, which is a development of the "branches and boundaries" method for a discrete optimization problem with non-decreasing target functions, and allows you to discard a larger number from the analysis of a certain number of options, successively reducing the set of options to sizes satisfactory for the use of direct enumeration.

These are the so-called precision methods. At the same time, approximate methods were developed – local optimization, heuristic procedures that take into account the specifics of the problems to be solved, the method of the recession vector, the method of guiding neighborhoods, methods of random search, and others. The solution of most applied problems related to the problems of selection, management and design consists in the construction of a mathematical model, which reflects the relationship of the most important and essential characteristics of the object of study for the problem to be solved. The object of research can be, for example, a technical

device, a physical or technological process, an economic system, etc. Solutions to discrete optimization problems are associated with difficulties of a fundamental nature – a complete enumeration of the points of an admissible set, as a rule, is impossible due to too much computational work. There are various heuristic techniques for reducing enumeration in discrete optimization problems. A discrete optimization problem is a problem of finding the extremum of a function given on a discrete set of points. If the domain of the function consists of a finite number of points, then the discrete optimization problem can be solved by enumerating the entire set. However, in practice, this set can be very large, so that brute force methods are not effective. One of the approaches to solving this type of problem is the use of artificial neural networks (SNM). Neural network theory is a promising area of mathematics and computer science and represents an interesting area for research. Many scientists have conducted theoretical and practical research on the creation of neural networks with different dynamics for solving problems of linear, quadratic, non-linear, combinatorial optimization. Methods based on the use of artificial neural networks can significantly increase the efficiency of solving this class of problems, ensuring sufficient accuracy of the result. Therefore, it is necessary to develop models and algorithms for solving the minimum coverage problem, which is a classic optimization problem based on the theory of neural networks.

The purpose of the work is to determine the effectiveness of using the neural network approach to solving discrete optimization problems, in particular the problem of minimum coverage. The object of the study is the solution of the problem of minimum coverage on the graph. The subject of the study is methods and algorithms for solving the problem of minimum coverage based on the SNM apparatus.

To achieve this goal, it is necessary to solve the following scientific tasks: to analyze the existing algorithms for solving discrete optimization problems (the traveling salesman problem, the minimum coverage problem); to analyze the effectiveness of using artificial neural networks to solve optimization problems; to build a neural network model for solving the problem of minimum coverage; to develop a methodology and algorithm for solving the problem based on the built neural network model; to develop a software product to solve the problem of minimal coverage using the Hopfield neural network; to investigate the influence of the choice of the initial states of the neural network model and modes of functioning of the Hopfield neural network on the quality of the results obtained; analyze the results obtained, compare them with the existing accurate method of solving the problem of minimum coverage.

An overview and analysis of approaches to solving discrete optimization problems based on the use of artificial neural network apparatus is carried out, as well as the effectiveness of using artificial neural networks to solve optimization problems is analyzed. The use of Hopfield's SNM and the energy function for solving the traveling salesman problem are investigated. The analysis of the energy function showed the efficiency of solving the traveling salesman's problem. An approach to solving the problem of minimum coverage based on Hopfield's SNM is proposed, namely, a neural network model for solving the problem of minimum coverage is

built, a methodology and algorithm for solving the problem based on the built neural network model are developed. A description of the energy function for solving the problem is given. The proposed algorithm for training the Hopfield network to solve the problem has proven its effectiveness by modeling experiments. The results of the simulation showed that the proposed algorithm works with an error (10% – 12%), which makes it suitable for solving practical problems under certain restrictions on the accuracy of the result and the dimensionality of the problem to be solved. A software product has been developed that will allow solving the problem of minimum coverage using the model and energy function of the Hopfield neural network. In the course of experimental modeling, the influence of the choice of initial states of the neural network model and modes of functioning of the Hopfield neural network on the quality of the results obtained was investigated. The analysis of the results obtained in comparison with the exact method is carried out and it is concluded that the neural network method showed a greater time complexity of solving the problem than the exact method.

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USING NEURAL NETWORK AND DATA VISUALIZATION ALGORITHMS FOR MEDICAL ANALYSIS

The purpose of the study is to conduct a medical analysis of disease symptoms using neural networks, as well as data visualization algorithms. The practical significance of the study is the possibility of using the created web application, which will allow you to analyze various data sets in accordance with the necessary

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Електронне наукове видання
комбінованого використання
Можна використовувати в локальному та мережному режимах

ІТ-ПРОСТІР СЬОГОДЕННЯ: ТЕНДЕНЦІЇ,
ІННОВАЦІЇ ТА ПЕРСПЕКТИВИ РОЗВИТКУ

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