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INTEGRATION OF HYBRID SYSTEM ANALYSIS METHODS TO IMPROVE DECISION-MAKING EFFICIENCY

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Abstract. The article discusses the integration of hybrid methods of system analysis to improve the efficiency of decision-making under uncertainty and multiparameter constraints. Modern approaches to solving complex control and optimization problems are analyzed. The use of hybrid algorithms that combine classical and modern analysis methods, such as genetic algorithms, the Monte Carlo method, and neural networks is proposed. The use of these models allows improving the accuracy and stability of decisions, as well as reducing time and computational costs. The article discusses modern approaches to the integration of hybrid methods of system analysis and optimization algorithms to improve the efficiency of decision-making in complex systems. The main concepts of system analysis combined with optimization algorithms, including methods of evolutionary modeling, multicriteria optimization and machine learning, are considered. The purpose of the work is to demonstrate the advantages of a hybrid approach in solving problems in such areas as management, energy, logistics and information systems.

Keywords: systems analysis, hybrid methods, decision making, optimization, control, algorithms, uncertainty, multivariable systems

Introduction. Modern society is increasingly dependent on complex systems. To effectively manage them, a systems approach is needed. It combines knowledge from various fields and allows finding optimal solutions to complex problems. Systems analysis has become an interdisciplinary science that combines methods of mathematics, control theory, modeling and other disciplines. It is used in all areas of human activity, from industry to science [1].

In modern conditions, complex systems that specialists in various industries face require highly effective tools for decision making. Increasing data complexity and multivariable constraints create new challenges for systems analysis and optimization [2]. The use of classical methods is often insufficient in the face of uncertainty and variability of external factors. In this regard, interest in hybrid methods that combine classical algorithms with modern approaches such as machine learning and stochastic modeling continues to grow. This paper discusses the integration of hybrid methods of systems analysis to improve decision making efficiency. We propose the use of hybrid approaches to improve decision accuracy and reduce computational costs, making them particularly useful for systems with high uncertainty [3,4].

The effectiveness of decision-making in modern complex systems often depends on the ability to integrate various methods of analysis and optimization. Systems analysis, as a discipline aimed at studying and solving complex problems, needs the support of modern optimization algorithms that are able to find the best solutions taking into account many factors and constraints.

Classical methods of systems analysis often face the problem of computational complexity and data uncertainty. In such conditions, there is a need to create hybrid approaches that combine various methods for

solving multi-criteria problems and minimizing risks in the decision-making process [5].

Research methods. Hybrid methods of system analysis are a powerful tool for solving complex problems arising in various spheres of human activity. They combine the advantages of various approaches, such as mathematical modeling, expert assessments, neural networks and others, in order to increase the accuracy and reliability of the analysis results.

The methods of analysis and research of control systems are based on the principle of idealization as a thought process of creating ideal objects by changing the properties of real objects. Idealized properties of control systems are formalized in the form of a set of system-analytical technologies, including philosophical, mathematical, physical, chemical and other technologies, adequate models and methods of system analysis and decision-making [6].

The features of hybrid methods include several criteria [7,8]:

• *Complexity of real systems*: Modern systems are characterized by a high degree of complexity, nonlinearity and uncertainty. Hybrid methods allow taking into account the diversity of factors and relationships in the system.

• *Inadequacy of traditional methods*: Often, to solve a specific problem, a combination of different methods is required to obtain a more adequate model.

• *Increased forecast accuracy*: Combining different methods reduces the impact of errors inherent in each of them individually.

• *Improved decision quality*: More accurate and reliable analysis results allow you to make informed and effective decisions.

Basic concepts of system analysis and optimization

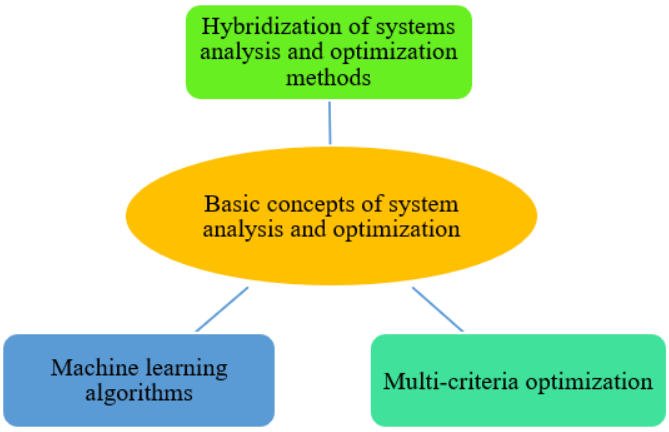

Figure.1. Basic concepts of system analysis and optimization

1. Hybridization of system analysis and optimization methods

Hybrid methods are based on the combination of system analysis with various optimization algorithms, such as genetic algorithms, particle swarm methods, gradient methods and others. For example, multi-criteria optimization plays a key role in decision-making in conditions where it is necessary to take into account several goals at once, often contradicting each other. This is typical for resource management problems, energy systems and logistics processes.

2. Machine learning algorithms

In modern conditions, machine learning is becoming an important part of system analysis. Machine learning methods can be used to predict and improve the behavior of systems. An important feature of machine learning is the ability to adapt to changing data, which makes it useful in conditions of uncertainty.

3. Multi-criteria optimization

Multi-criteria problems require the use of methods that allow you to simultaneously take into account several criteria. One of the popular approaches is the Pareto optimality method, which allows you to find solutions where improving one criterion is impossible without worsening another. This is especially useful for tasks in managing large systems and optimizing resource allocation [9, 10].

Results. For the task of integrating hybrid methods of system analysis and optimization

algorithms to improve the efficiency of decision making, we have compiled an algorithm in the form of the following steps (fig.2):

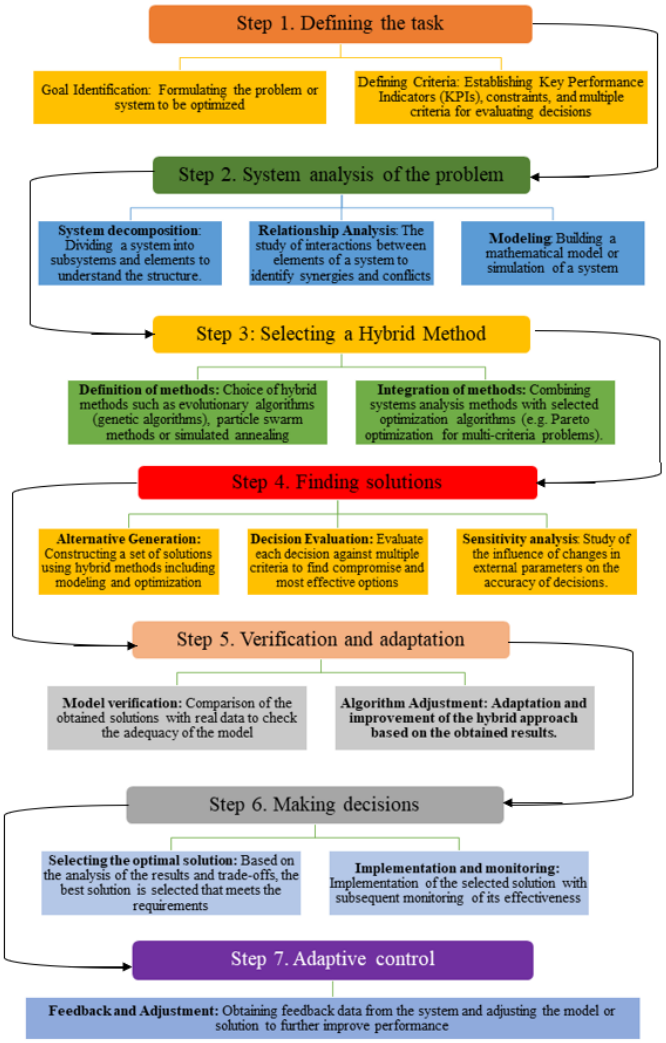

Figure.2. Algorithm for integrating hybrid methods of system analysis and optimization algorithms to improve decision making efficiency

This algorithm can be adapted for different industries and tasks where it is necessary to improve the efficiency of decision-making using systems analysis and optimization methods.

The main stages of applying hybrid methods are:

1. Formulating the problem: Clearly defining the objective of the study, identifying the main variables and constraints.

2. Selecting methods: Determining the most appropriate modeling and optimization methods depending on the specifics of the problem.

3. Developing a hybrid model: Creating an integrated model that combines various methods and data.

4. Checking and validating the model: Assessing the adequacy of the model to the real system.

5. Making decisions: Using the model to predict and optimize various indicators.

Conclusion. Hybrid methods of system analysis open up new possibilities for solving complex problems arising in various spheres of human activity. Their application allows to increase the accuracy of forecasts, optimize processes and make more informed decisions. However, for the effective use of hybrid methods it is necessary to have deep knowledge in the field of mathematics, computer science and the corresponding subject area. The integration of hybrid methods of system analysis provides new possibilities for solving complex problems of management and decision-making. The combination of classical optimization methods with modern approaches, such as neural networks and genetic algorithms, allows to achieve significant improvements in the efficiency and accuracy of decisions. The research results show that hybrid approaches significantly reduce the computation time and increase resistance to changing external conditions. Thus, the use of these methods can become an important tool in modern management and decision-making systems.

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