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APPLICATION THE MATHEMATICAL METHODS IN THE PROBLEM OF DECISION MAKING UNDER INFORMATIONAL CONSTRAINTS

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Abstract:
The role of the mathematical methods in the research of decision making problems is noted. The importance of mathematical methods for predicting and evaluating solutions in the development of digital technologies is emphasized. Models are indicated in the form of a maximum (minimum) function and differential inclusions intended for applying mathematical methods to systems under informational constraints.

Key words:
Mathematical modeling, decision making, informational constraints, differential inclusions, forecast methods.

1.Introduction.

The development of the digital economy is one of the priority areas for most economically developed countries. All developed countries of the world community make strategic investments in the development of information and communication technologies (ICT), information infrastructure, in the study of economic and social features of the new economic system. Modern ICT, as the "core" of the digital economy, provides the basis for the development of new business models, digital platforms and services that allow for new types of economic activities. By now, it has become clear that qualitative economic growth is possible with the availability of technologies that make it possible to accurately assess the current state of markets and industries, as well as effectively forecast their development and respond quickly to changes in the national and world markets.

The synthesis of various areas of basic and applied scientific research is the main component of scientific and technological progress, which allows using modern technologies to create modern technical systems. By now it has become clear that the key and connecting link in the research of natural and technical sciences is the method of *mathematical and computer modeling* [1,2,5,10].

The methodological basis for the study of the problems of effective management of complex technical and economic systems is a *system analysis*. This method in all well-structured models of applied problems is implemented as *mathematical methods of decision making*. These methods allow you to make informed decisions of a particular problem depending on its formulation.

2. A problem decision making under informational constraints.

Currently, the most relevant *decision-making problems in the face of risk and uncertainty* (inaccurate data, incomplete information) [1,5]. By now, in connection with the development of information technologies, the possibility of applying such areas of mathematics as *mathematical programming, game* *theory, statistical decision theory, optimal control theory, fuzzy set theory, fuzzy logic and neural computing, etc., has expanded*.

Forecasting is a private form of modeling, as the basis of knowledge and control. Various forecasting methods have been developed. For forecasting econometric and economic-mathematical models can also be used, as well as special computer systems can be created that make it possible to jointly use all of the above methods.

The problems of forecasting are closely related to the issue of decision-making in planning. Planning is applied to important decisions that determine the further development of the economic structure (enterprises, firms). It is clear that the planning technologies actually used by firms are quite complex. At the same time, mathematical planning methods (mathematical programming, dynamic programming, game models) are useful.

Very useful are computational experiments based on mathematical models in the economy, including *standardization and product quality management. Econometric and statistical methods* allow the construction of simulation econometric models in order to study *forecasting and optimal control*.

The mobilization of reserves, the optimal allocation of resources are the main and prerequisites for production efficiency in a market economy. One of the models of conflict of great practical importance is the model of matrix games.

In modern *financial and banking operations*, for the analysis and calculation of the characteristics of payment flows, it is necessary to precisely specify all flow parameters - payment sizes, interest rates, etc. When solving many practical problems, as a rule, these parameters are not exactly known, but you can always set the intervals in which they lie with a sufficient degree of certainty. In this case, *interval analysis methods* can serve as an adequate mathematical apparatus for the quantitative analysis of payment flows.

3. A mathematical methods in the control problem under conditions of uncertainty.

Mathematical modeling of various problems of economics and technology, such as making the best decisions in economic planning and organization of production, in the design of technical devices and process control lead to special problems of mathematical programming with non-smooth objective functions.

Functions such as maximum and minimum make up a wide class of non-smooth functions. They can have a different structure and limitations on which their extreme properties depend. From this point of view, non-smooth functions of the maximum and minimum types of the following form are of interest:

$$f_1(x) = \max_{u\in U}\sum_{i=1}^{m_1}\varphi_i(u)g_i(x), \qquad f_2(x) = \min_{v\in V}\sum_{j=1}^{m_2}\psi_j(v)p_j(x),$$

where $x \in R^n, \varphi_i(u)$, $\psi_j(v)$ $i=\overline{1,m_1}$, $j=\overline{1,m_2}$ – limited on compact $U\subset R^s, V\subset R^k$ functions, R^n – Euclidean space of vectors $x=(x_1,\ldots,x_n)$.

For functions of the form of maximum or minimum, it is of particular interest to study the properties associated with the question of their extremum. Also of interest is their relationship with a wide class of so-called quasi-differentiable functions and questions of applying the studied properties to the optimization problem of this type of function. These questions for the functions maximum and minimum types were considered in [14]. Note that in order to develop numerical methods for optimizing the functions under consideration, it is necessary to learn how to construct the descent directions of such functions. Here you can use the methods of quasi-differentiable calculus [2,5,6].

With the increasing complexity of the structure of objects and their functions, it becomes increasingly difficult to use classical control methods. Control and optimization problems under conditions of uncertainty (informational constraints) [1,5], as well as differential games lead to models described by *differential inclusions with a control parameter* [3,4,7,8,12]

$$\dot{x} \in F(t,x,u), u \in U,$$

$$\dot{x} \in F(t, x(t), x(t-h_1(t)),\ldots, x(t-h_k(t)), u), \quad u \in U.$$

One of the important problems of the theory of controlled differential inclusions is the *controllability problem* of the ensemble of trajectories from the initial state to the terminal state. In this regard, the *time* *optimal control problem* for controlled differential inclusions is of particular interest, understood as the problem of optimizing the time that the ensemble reaches the trajectories of a given terminal set.

One of the important criteria for controlling a system under uncertainty is the *minimax problem for controlled differential inclusions*. This task is one of the non-smooth control problems, and characteristic of it is the construction of optimal control, which guarantees a certain quality of the process.

The task of controlling a dynamic system by feedback is the main task of control theory. This task covers a wide range of issues related to the choice of a mathematical model of a controlled process, the definition of a control goal, and the control synthesis method. Each of these questions falls into a number of theoretical and applied problems of independent significance. These include, in particular: *the task of stabilizing control systems in the face of incomplete data and lagging information; the observability problem of the ensemble of trajectories of differential inclusions; the task of minimax estimation of the projection (component) of a controlled process according to the results of observation*. Separate results these problems for differential inclusions with a control parameter were obtained in [3,4,9,10,11,13].

4. Conclusion.

The current stage of ICT development is characterized by the relevance of the introduction of information systems and digital technologies designed for forecasting problems. In conclusion, we note that in connection with the development of ICT and innovative technologies in education, an important problem remains the training of highly qualified specialists in artificial intelligence technologies and the organization of targeted comprehensive studies of forecasting and decision-making models in *conflict situations and in conditions of limited information*.

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