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MODELING SYSTEMS

Аннотация

Целью данной статьи является использование систем моделирования и методов в проектировании систем. Рассматриваются аспекты применения систем моделирования, а также общие принципы и методы построения математических моделей; задачи и способы математического моделирования автоматизированных и управляемых технологических процессов и производств. Обозначены проблемы, возникающие в процессе использования имитационных методов моделирования.

Ключевые слова: системное моделирование, организация и управление, системы построения моделей.

Abstract

The aim of this article is how to use modeling systems and methods in the design of systems. The aspects of modeling systems application as well as general principles and methods for constructing mathematical models are considered. The tasks and methods of mathematical modeling of automated and controlled technological processes and productions are observed. The problems arising in the process of using imitation modeling methods are indicated.

Keywords: system modeling, organization and management, model building systems.

Modeling systems

The concept of the model and modeling

One of the characteristic features of modern natural science is its model nature, i.e., all objects, phenomena, and processes are described using models. In a certain sense, the extension of the boundaries of natural science can be imagined as the construction of more suitable and perfect models of nature. The model nature of natural science is also connected with the fact that the value of a concrete fact can be determined only on the basis of a certain model. A model is a simplified semblance of an object that reproduces the properties and characteristics of an object of interest to the source object or project object. The concept of the model began to be widely covered only in the twentieth century. At first the model began to be realized as something universal in the scientific disciplines of information, cybernetic, systemic directions, and then this idea spread to the whole of science. The concept of an abstract model is not reduced to mathematical models, but refers to any knowledge and ideas about the world. By model we mean a material or mental representation of an analogue of a certain original, similar to it, necessary for specific features of the study. In fact, this model is a kind of "substitute" for the original in cognition and practice. The main functions of the models are the establishment of knowledge and obtaining information.

They serve to store and expand knowledge or, as they say, information about the original, the design of the original, the transformation and management of it.

Imitation is understood as an imitation of the behavior of any really existing system, i.e., a simplified schematic or mathematical reproduction of the principles of its organization and functioning. Simulation is the study of any phenomena, processes or systems by constructing and studying their models, as well as using models to determine or refine characteristics and rationalize the ways to construct newly constructed objects. Modeling is one of the main categories of the theory of knowledge.

On the idea of modeling in essence, any method of scientific research is based. Modeling is an important stage of purposeful activity, since it is oriented towards realizing the image of the desired future, i.e., the state model. Any activity is performed in accordance with a certain plan (algorithm), which is the way of future activity, i.e., its model. In doing so, we must evaluate the current result of previous actions and choose the next step from many possible ones, so we need to compare the consequences of all possible steps without realizing them, in other words, to study them on the model. In addition, the model itself is the target mapping, and not in the original object itself, but by what interests us in this, that is, something that corresponds to the goal.

Since the model is the target mapping, we can talk about the multiplicity of models of the same object: for different purposes, as a rule, different models are required.

Classification of models

Depending on the direction of modeling (theoretical or practical), the models can be divided into cognitive and pragmatic. Cognitive models are a form of organization and representation of knowledge, a means of combining new knowledge with existing ones. Therefore, when there is a discrepancy between the model and reality, the task is to eliminate this discrepancy by changing the model, since cognitive activity is primarily focused on approximating the model to the reality that the model demonstrates. An example here are more and more complex models of space and time in natural science. Pragmatic models are a means of management and a means of organizing practical actions, a way of presenting exemplary actions or their results. When used in the event of a discrepancy between the model and reality, efforts are aimed at changing reality in order to bring reality closer to the model. Pragmatic models are normative in nature, fulfilling the function of the standard, a model in accordance with which the activity and its results are "adjusted". Pragmatic models are plans, algorithms, and programs of action (for example, on the transformation of the terrain of any territory), etc. Therefore, cognitive models, as a rule, reflect the existing and pragmatic desire.

Models can also be divided into static the model of the concrete state of the object we are interested in and dynamic, when it becomes necessary to display the process of state changes. For example, in some cases, models of a specific landscape are needed at a certain point in time, and in others, a model for seasonal changes in its states; you can describe the structure of a diamond crystal, but you can consider the process of its formation; can characterize the anatomy of the human body or build a model of its functioning or development.

The most common classification of models in abstract (mental, ideal) and material (real, material), depending on the way they are implemented or based on the use of one or another method of communication, since the person creating the model has the means of the consciousness itself and the means of the surrounding material of the world.

Abstract models are ideal constructions constructed with the help of thinking, consciousness. Non-linguistic forms of thinking play an important role for the human brain: emotions, unconsciousness, intuition, insight, imaginary thinking, subconsciousness, etc. Abstract models include linguistic constructs - a product of thinking, ready or almost ready for transmission to other speakers of the language. Natural languages are a universal tool for constructing abstract models, because they can be spoken about almost everything, and, in addition, language models are ambiguous. Ambiguity of words (for example, "little", "many", "several"), as well as the multivariate nature of their possible connections to phrases allows you to display any situation with sufficient accuracy for normal practical purposes. For situations where the approximation of a natural language becomes a defect, a specific language develops, the language models of various branches of the natural sciences are more accurate and contain more information than natural languages.

Models of conditional similarity are based on the fact that similarity with the original is established as a result of the agreement. They include various geographic maps and plans (relief models), working drawings (models of future products), various signals (message models), money (value model), identity cards (the official owner model), etc. These models are the real form in which abstract models can be transferred from one person to another is preserved until they are used on the basis of an agreement about which a particular state of the real object is put in correspondence with a particular abstract model. Usually these agreements are formulated in the form of a set of rules for constructing models of conditional similarity and rules for their use. (Note that we defined these models above as figurative-symbolic, which emphasize the conventionality of the classification in question, as well as the breadth of coverage and the multidimensionality of model representations.)

Features and properties of models

In order for the model to meet its goal, it is necessary to have the conditions that ensure its functioning. Thus, the geographic map can be understood only by knowing the meanings of those symbols that are applied to it; Ancient Egyptian cuneiforms could not be read until a stone had been found on which the text was depicted both in the forgotten ancient Egyptian language and in the ancient Greek. Therefore, in order to realize its model functions, the model must be coordinated with the environment in which it should function.

The main differences of the model from reality are the finiteness, simplicity, and approximation of the model. So, the real world is infinite in its manifestations and connections. However, an endless world must be known for finite means accessible to man. This is possible as a result of building models. Thus, A. Rosenbluth and N. Wiener noted that private models are the only means developed by science to understand the world. Finiteness of mental models is expressed in the fact that they are endowed with a strictly fixed number of properties. In real models, from the set of properties of the object model, only certain properties that are similar to the properties of the original object are selected and used.

Finiteness of models makes their simplicity and approximation unavoidable. As a rule, to achieve the goal of a fairly incomplete, simplistic representation of reality. The degree of simplification depends on the purposes of modeling. Simplification is an important tool for determining the main effects in the phenomenon under study. This can be seen on the example of such models as ideal gas, non-absorbing mirror, absolutely black body, mathematical pendulum, etc. The level of simplification is also determined by the ability to work with models. So, it's one thing to do a simulation using a logarithmic ruler, and another - using a computer. Moreover, it has long been noted that of the two models that describe the phenomenon with equal accuracy, the simpler one will be more successful. For example, the geocentric model of Ptolemy allowed with sufficient accuracy calculating the motions of the planets, predicting the eclipses of the Sun, but required calculations on very cumbersome formulas with alternation of numerous "cycles". Instead of a geocentric system, the simpler and more elegant Heliocentric Copernican system appeared.

Approximation of models in the display of reality is also an inherent property of the model. Thus, an absolutely accurate map of the country will be only this country itself, and the atom itself can be an absolutely exact model of the atom. The allowable difference is determined for the purpose of modeling. Thus, the accuracy of wrist watches is usually sufficient for everyday purposes and is insufficient for many other purposes, including scientific ones.

The main purposes of modeling

The forecast is an assessment of the behavior of the system with some combination of its controlled and uncontrolled parameters. The forecast is the main goal of modeling.

Help and better understanding of objects. Here are the most common problems of optimization and sensitivity analysis. Optimization - the precise definition of such a combination of factors and their magnitudes, provides a better indicator of the quality of the system, best by any criterion, achieving the goal with a simulated system. Sensitivity analysis is the identification of a large number of factors that most affect the functioning of the simulated system. The initial data in this case are the results of experiments with the model.

Often a model is created for use as an educational tool: model simulators, stands, exercises, business games and the like.

Simulation as a method of cognition was always used by people - consciously or intuitively. On the walls of the ancient temples of the ancestors of the South American Indians, graphic patterns of the universe were discovered. The doctrine of modeling arose in the Middle Ages. An outstanding role in this belongs to Leonardo da Vinci (1452-1519).

True commander A.V. Suvorov before the attack of the fortress Izmail coached a soldier on the model of the fortress of Ishmael, built especially in the rear.

Our well-known self-taught mechanic Kulibin (1735-1818) created a model of one hand-built wooden bridge across the river Neva, as well as a number of models of metal bridges. They were fully technically justified and highly appreciated by the Russian academicians L. Euler and D. Bernoulli. Unfortunately, none of these bridges were built.

A huge contribution to strengthening the defense potential of our country was carried out by modeling the explosion - General-Engineer N.L. Kirpichev, modeling in aircraft construction - M.V. Keldysh, S.V. Ilyushin, A.N. Tupolev and co-authors, simulation of a nuclear explosion - I.V. Kurchatov, A.D. Sakharov, Yu.B. Khariton, etc.

In particular, to test a new method of mathematical modeling, a mathematical model of the Battle of Sinop, the last battle of the era of the sailing fleet, was created. In 1833 Admiral P.S. Nakhimov defeated the main forces of the Turkish fleet. Simulation on the computer showed that Nakhimov acted almost unmistakably. He so correctly arranged his ships and hit the first blow, the only salvation of the Turks was a retreat. There was another way out. They did not retreat and were defeated.

The complexity and volume of technical objects that can be studied by modeling methods are practically unlimited. In recent years, all the main structures - models, dams, canals, Bratskaya and Krasnoyarsk hydroelectric power stations, long-distance communication systems, models of military systems and other objects have been studied.

A striking example of the underestimation of modeling is the death of the English captain-battleship in 1870. In order to further increase military strength and strengthen imperialist aspirations in England, the Super Battleship Captain was developed. In it, everything that was necessary for "supreme power" in the sea was invested: heavy artillery of revolving towers, powerful side armor, backed up by sailboats and very low sides - for less vulnerability to enemy shells. Engineer-consulting Reed built a mathematical model for the stability of the "Captain" and showed that even with a small wind and excitement, he was threatened with overturning. But the lords of the Admiralty insisted on building a ship. On the first training session after the launch, the battleship of the squall turned the battleship. 523 sailors were killed. In London, on the wall of one of the cathedrals, is a bronze plate, recalls this event, and, adding about the dullness of the self-confident lords of the British Admiralty, who neglected the results of the simulation.

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