Simulation Modeling Using Modern Computer Programs

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ABSTRACT

This article discusses the stages of simulation modeling and computer programs for creating simulation models.

Keywords: simulation modeling, universal programming languages, standard mathematical software systems.

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Today, as a result of the rapid development of information and communication technologies in our country, modeling, complex decision-making and evaluation of results in logistics, healthcare, education, production and various fields are urgent issues.

Modeling provides assumed information about a certain part of reality, after certain checks it can be true or false and requires the construction of new models. Along with observation, measurement, experiment and comparison in science, this procedure serves as one of the general scientific methods.

Imitation modeling is a method of studying objects based on the fact that the object being studied is replaced by an imitating object. At the same time, experiments are carried out using a simulating object without referring to experiments on a real object, and as a result, information about the object under study is obtained.

After the model is created, many simulation experiments are conducted with it using a computer. In the experiments conducted, the process of reducing or completely rejecting the hypotheses to describe the system is carried out. Such an approach allows to find analogs of experience in the areas of optimization, planning and economy, sociology, ecology in solving the problems that arise in doing business.

Simulation modeling consists of four main steps:

1. Discrete event modeling is a form of simulation modeling (derived from the English word discrete-event simulation, DES) in which system activity is shown as a chronological sequence of events. In this case, an event occurs at a certain time and represents a change in the state of the system. Most business processes are described as a sequence of discrete events. For example, a truck comes to the warehouse and stands in front of the unloading gate, unloads and leaves the goods. The discrete event method can be used to model such processes. In discrete event modeling, the movement of a train from point A to point B is represented as two events: the first is the departure from point A and the second is the arrival at point B. The train itself is a temporal moving object between events. This process and the movement between them can

be modeled and animated using computer programs. Using the discrete event method, the system is modeled at a moderately abstract level. Also, specific physical details such as the direction of traffic or the acceleration of trains are usually not taken into account. Today, discrete event modeling is widely used in manufacturing, logistics, and healthcare.

2. System dynamics is a field of study of complex systems, which studies their behavior over time and depending on the structure of system elements and their interaction. Including: causal relationships, feedback loops, reaction delays, environmental effects, etc. Particular attention is paid to the modeling of such systems using computer programs. System dynamics allows to simulate complex systems at a high level of abstraction, without taking into account the individual characteristics of small systems: individual products, events or people. Such models provide an overview of the system and are ideal for strategic planning. For example, when a mobile operator creates its marketing company, it can simulate the behavior of each customer without modeling it and analyze the effectiveness of new methods of communication with customers;

3. Agent-based modeling is used to simulate intelligent, centralized and distributed systems in order to obtain information about the operation of elements and their effect on the interaction system. Agent-based modeling is different from system dynamics, in which the analyst determines the behavior of agents at the individual level, and the global behavior is the result of the activities of many agents (bottom-up modeling). Agent-based modeling uses cellular automata, elements of game theory, complex systems, multi-agent systems, evolutionary programming, Monte Carlo methods, and random numbers.

Computer simulation modeling is a method of constructing conceptual, mathematical and software models, conducting targeted simulation experiments , and processing and interpreting the results of experiments using a wide range of complex computer systems.

The process of creating imitation models consists of the following stages:

• formulation of the research objective;

• collect information;

• conceptual model development;

• checking the suitability of the conceptual model;

• translating the conceptual model into computer-understandable language using software;

• conducting analyzes and verifying the result of the simulation model. Return to the first, second or third stage, depending on the identified errors;

• conducting and analyzing experiments;

• form conclusions.

Modern software for creating simulation models provides an opportunity to automate the process of creating a model on a computer using various graphical components of models and to conduct experiments on it.

Programs that provide the above-mentioned opportunities can be divided into four groups:

1. Creating a model using universal programming languages (C ++, Delphi, Pascal). The dynamics of the system is described by equations, the program code is written, the equations are calculated, and the correlation between the output of the results and the input of the variables is established.

2. Modeling using computer programs specialized for modeling (for example, GPSS, AnyLogic). System dynamics is manifested as a result of interaction of model elements in time and space.

3. Creating simulation models and conducting experiments on them using specialized computer programs (for example, Arena, AnyLogic, GPSS World, VisSim). Such programs do not require programming as a sequence of program commands during the creation of simulation models. Instead of writing program codes, users build sample graphic modules from the program's library or fill out special forms. Such an opportunity provides a visual representation of the simulation process and enables the analysis of models and the search for optimal solutions.

4. Introduction of simulation models to standard mathematical software systems (for example, Matlab, Mathcad, Mathematica,

Simulink package). These are programs designed to perform various mathematical and technical calculations, and the user uses a graphical interface with formulas, numbers, texts to control variables, input and output data in the process of creating a model.

Among the programs mentioned above, AnyLogic is a program that has a number of advantages in creating simulation models and conducting experiments on them. The specificity, flexibility, and level of detail of simulation modeling provided by AnyLogic allows you to consider any aspect of the simulated system. In addition, the program's graphical interface, tools and libraries have the ability to create rapid models for a wide range of tasks, from production modeling, logistics, business processes and strategic models for developing markets. Regardless of the chosen approach, the correct formulation of the problem, the accuracy of the initial data and the adequacy of the model are the most important factors in the development of the simulation model. During the development process, special attention should be paid to the documentation and visualization of the results, which will increase the reliability of the model and facilitate the reuse of the model in the future.

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