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PROCESSING EXPERIMENTAL RESULTS AND CREATING AN OPTIMAL MATHEMATICAL MODEL

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Annotation: The scientific research focuses on the systematic approach to analyzing experimental data and deriving an effective mathematical model that best represents the underlying phenomena. This process involves data collection, pre-processing, statistical analysis, and model selection. By using optimization techniques and mathematical tools, researchers aim to identify the most accurate and efficient model, ensuring that it not only fits the experimental data but also generalizes well to future experiments. The work typically includes model validation, error analysis, and refinement to ensure the model's robustness and predictive power. This process is crucial in various scientific and engineering fields where accurate modeling of complex systems is required for prediction and decision-making.

Keywords: experimental data, data processing, mathematical model, optimization, model selection, statistical analysis, prediction, regression analysis, machine learning, system identification

Introduction. In order to automate production and achieve scientifically sound results in a market economy, it is important to create adequate mathematical models of objects, processes, systems or phenomena and conduct scientific research based on them. Such adequate models directly depend on the accuracy and reliability of the experimental data. Today, experiments are not only a modern means of obtaining scientifically sound knowledge in the relevant fields of natural and technical sciences, but also a necessary component of the implementation of innovative technologies in economics, sociology, politics, the military sphere, as well as in production.

There are two methods for studying the objects, systems, processes, or phenomena mentioned above. The first is the transition from an object to a model, and the second is the transition from a model to an object. One of the main stages of the transition from an object to a model is the processing of experimental data. Such experimental data serve as the basis for analyzing the subject area, developing physical or econometric models, as well as studying the state of the object or predicting it, and determining alternative parameters. Therefore, in recent years, scientists have paid increased attention to the development of new statistical methods for processing experimental data, improving them and increasing their adequacy, and widely introducing them into various sectors of the economy. This, in turn, places demands on the quality of experimental work and the introduction of cost-effective methods and tools.

Such experiments are conducted in three parts: studying the object, analyzing the conditions, and exploring the possibilities of conducting the experiment.

Research shows that it is advisable to conduct experiments in the following stages:

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– studying the essence of the object or process being studied and expressing it mathematically based on the information collected, analyzing and determining the conditions and means of conducting the experiment;

– creating conditions that ensure the most efficient conduct of experiments and research of the object under study;

– collection of experimental results, their registration and mathematical processing and description of the processed results in a convenient form;

– experience the results detailed analysis and lighting ;

– experience the results application refers to the state of the object decisions acceptance q ilish , as well as from the model when making decisions , predicting , avoiding the object in the process or use in its optimization .

Experiments can be divided into several classes according to the type of research object. They are physical , engineering , medical , biological , social , sociological and other classes are included . Nowadays, it is scientifically proven by scientists and engineering their experiences of the transmission general The rules are scientifically based out That's it in the experiments , he gave an idea of processes natural and artificial physical objects (structures) are studied in detail . According to the rules of conducting experiments , researcher them start eating physical skills in situations measuring processes must be repeated several times .

Later, it will be possible to give the required values of the input variables, vary them over a large range, and remove or, conversely, include parameters whose dependence is not studied during this time interval. Such opportunities are limited in other class problems. Some methods used in conducting physics and engineering experiments, for example, methods of statistical data processing, can also be successfully applied to non-technical problems.

It is appropriate to divide research experiments into classes according to the following characteristics:

– by the degree of proximity of the experiment to the object being used directly, that is, the object from which new information needs to be obtained (natural, demonstration or polygonal, model, computational experiments);

– for the purposes of conducting the experiment (research, testing or control, management-optimization, guidance);

– according to the degree of influence on the conditions of conducting the experiment (passive and active experiments);

– according to the level of direct human participation in experiments (non-automated - automatic, automated tools that change and create the conditions for conducting experiments,

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collect and process experimental data).

It should be noted that a model created on the basis of collecting and processing experimental data is undoubtedly one of the necessary, but not sufficient, conditions for a positive impact on the development of the relevant field.

Today, the rapid development of computer technologies has created opportunities for the automatic collection of experimental data and their processing, as well as the development of many technical and software packages for production automation and their successful implementation.

The main goal of our scientific research is to study one-factor processes and create a regression equation for such processes. An adequate mathematical model can be selected based on the data of experimental research processes using computer technologies. Instrumental software makes the work of scientific researchers much easier. It frees researchers from manually calculating the regression equation based on the data obtained from the experimental results. Also, the software allows to choose an alternative mathematical model in the management of technological processes. By entering the results of scientific research into the database of the program, it creates opportunities to choose a regression equation based on computer modeling, build appropriate graphs, and make alternative decisions.

Taking into account that creating an automated software system for selecting a regression equation for one-factor processes based on experimental research data is a complex process, we will develop them conditionally in several stages.

Phase 1. Include experimental data or observational results.

the influencing factors *X and the resulting factors Y* , as well as its physical meaning in the development of the process under study. One of the necessary factors for the effective use of statistical methods in the construction of empirical relationships is the preliminary statistical processing of experimental data or observation results.

The main content of initial data processing is to eliminate gross errors and suspicious values that may arise due to measurement of indicator values or some unexpected reasons.
During initial processing, specific issues are usually resolved: errors and outliers of the observed quantity and other indicators are eliminated, analyzed, omitted measurements are restored, measurement data are condensed (homogeneity is checked, univariate data is combined, data is grouped, parameters of the measured data are estimated), and distribution laws are studied.
Any model should allow you to simulate the observed phenomenon or process (in any language - mathematical, graphical, algorithmic, conversational, etc.). The specific goals set also determine the language in which the model will be written. Today, most technical and physical models are written in the language of mathematics.

Let $x_1, x_2, \ldots, x_N$ be the results of observing the input of an object, and $y_1, y_2, \ldots y_N$ be the observations of the output results 1,2,…N in discrete time units, respectively. Such observations

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associate the object with an unknown operator F_0:

$Y_i = F_0(x_i)$ $(i=1,2,...,N)$

is to synthesize such a model operator F, *where* F_0 is the estimation of x_i and y_i from observations . Naturally, any one model operator by criterion b ' F *is* the object operator F_0 ga ya q in b ' death demand will be done , that is $F \sim F_0$.

Stage 2. Calculation of statistical indicators.

To effectively use statistical methods in constructing empirical relationships, preliminary statistical processing of experimental data or observation results is required. This involves calculating the arithmetic mean, central moments, dispersion, root mean square difference, and coefficients of variation.

Stage 3. Calculation of the correlation coefficient.

The essence of this analysis is to determine the degree of probability of a relationship (usually linear) between two or more random variables. The set of such random variables includes the initial random variables (X) and the resulting random variable (Y). Correlation analysis allows you to select factors or regressors (in a regression model) that have a significant impact on the resulting factor and assess the degree of agreement with experimental data.

Correlation connections different densities level b can die . If (X) factor k ' indicator for the price close to each other , the resulting factor (U) of average price around dense located values suitable if it comes , such a part is dense is calculated . In a linear relationship, as the X indicator increases (decreases), *the* U indicator also increases (decreases), and the relationship is expressed by a straight-line equation. If the U *indicator decreases* (increases) as the X indicator increases (decreases), then the relationship is inverse and is expressed by some kind of curved line equation.

The closer the correlation coefficient value is to |1|, the stronger the linear relationship between X and Y, while the closer it is to 0, the stronger the linear relationship. If the correlation coefficient is 0, there is no linear relationship, but it can produce a nonlinear correlation.

Step 4. Determination of the optimal regression equation.

One of the problems in constructing a regression equation is to determine the type of analytical function that reflects the mechanism of the relationship between the outcome and factor indicators. In order to show a certain relationship with this or that equation, the researcher must put forward a working hypothesis that can be subsequently confirmed or refuted.

In this situation, the following analytical method of determining the relationship is used: Let Y *be a function of* the variable X with parameters *"a"* and *"b"* . Then we choose the empirical relationship from the following set of functions:

1) $y = ax + b$ - linear function;

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2) $y = a \; x^b$ - level function;

3) $y = a \; b^y$ - k ' index function;

4) $y = \frac{a}{x} + b$ - hyperbolic function;

5) $y = \frac{1}{ax+b}$ - fraction rational function;

6) $y = \frac{x}{ax+b}$ - fraction rational function;

7) $y = a \lg x + b$ is a logarithmic function.

that represents an alternative representation $y = f(x, a, b)$ of the constructed graph, we perform the following steps:

x_1 and x_n) on the cross section where the experimental results are presented and find the following intermediate values:

a) $\bar{X}арифметик = \frac{x_1 + x_n}{2}$, $\bar{Y}арифметик = \frac{y_1 + y_n}{2}$,   b) $\bar{X}геометрик = \sqrt{x_1 \; x_n}$, $\bar{Y}геометрик = \sqrt{y_1 \; y_n}$,

c) $\bar{X}гармоник = \frac{2 \; x_1 \; x_n}{x_1 + x_n}$, $\bar{Y}гармоник = \frac{2 \; y_1 \; y_n}{y_1 + y_n}$,

2) We determine the values of the function $\bar{X}$ *"Y"* (*Y*)* corresponding to the calculated values of " " . If the calculated $\bar{X}$ value is equal to one of the given values of X, then the corresponding given value is *Y** . If the calculated $\bar{X}$ value does not correspond to the distribution values, then $\bar{X}$ the intermediate points (*i* and *i+1) at which these values lie* are determined: $X_i < \bar{X} < X_{i+1}$ and *Y** is found using the interpolation formula:

$$Y^* = Y_i + \frac{Y_i - Y_{i-1}}{X_i - X_{i-1}}(\bar{X} - X_i),$$

The arithmetic, *geometric* , and *harmonic values of Y * are determined* , respectively , and the following differences are calculated:

$P_1 = \left|Y^*_{\text{ар}} - \overline{Y}_{\text{ар}}\right|,$

$P_2 = \left|Y^*_{\text{гео}} - \overline{Y}_{\text{гео}}\right|,$

$P_3 = \left|Y^*_{\text{ар}} - \overline{Y}_{\text{гео}}\right|,$

$P_4 = \left|Y^*_{\text{гар}} - \overline{Y}_{\text{ар}}\right|,$

$P_5 = \left|Y^*_{\text{ар}} - \overline{Y}_{\text{гар}}\right|,$

$P_6 = \left|Y^*_{\text{гар}} - \overline{Y}_{\text{гар}}\right|,$

$P_7 = \left|Y^*_{\text{гео}} - \overline{Y}_{\text{ар}}\right|$

Each P_k *(k=1,2,…,7)* corresponds to a certain dependency function:

$P_1 \rightarrow y=ax+b,$

$P_2 \rightarrow y = ax^b,$

$P_3 \rightarrow y = ab^x,$

$P_4 \rightarrow y = \frac{a}{x} + b,$

$P_5 \rightarrow y = \frac{1}{ax+b},$

$P_6 \rightarrow y = \frac{x}{ax+b},$

$\boldsymbol{P_7 \rightarrow y = a\lg x + b,}$

the calculated P_k *is then* determined. The relationship to which the smallest value corresponds is considered a regression equation representing the distribution of the experimental results, and its unknown parameters a and b are determined using the least squares method.

$$a = \frac{n \quad xy - \quad x \quad y}{n \quad x_i - (\quad x)^2}, \qquad b = \frac{y \quad x^2 - \quad xy \quad x}{n \quad x^2 - (\quad x)^2}$$

Step 5. Graphical analysis.

At this stage, the correlation graph of the values obtained as a result of the research and the graphs of all seven calculated equations (functions) are built in one coordinate system.

Among them, if the graph of the corresponding equation is close to the correlation graph (main graph) of the values obtained based on the research results, then this equation is considered valid.

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