УДК 303.094:303.031.4

The use of natural science methods for phenomenological models development in the social and human sciences

Zviagintseva A.V., Averin G.V.
anna_zv@ukr.net, averin.gennadiy@gmail.com

Zviagintseva A.V., Averin G.V. "The use of natural science methods for phenomenological models development in the social and human sciences". This paper is an attempt to outline the ways of the solutions to some common problems in social and human sciences fields related with observation or experience data describing. Such data usually are represented by three-dimensional data arrays in the form "objects-figures-time". The main purpose of this paper is to study the possibility of phenomenological models development establishing on the such data basis having different multidimensional field representation of quantitative information about objects and systems status. The creation principles and phenomenological models theory construction in the social and human sciences are proposed. The relations and equations for applied problems solving are obtained. As an example of natural science methods applying in social and human knowledge areas there was made the country's development comprehensive assessment with use of the United Nations Development Program database, which is based on the joint monitoring events analysis of four basic human development indicators (HDI).

Keywords: Natural scientific methods, phenomenological model, socio-economic and environmental systems.

Introduction

Nowadays there is a clear division of human knowledge, which is characteristic for natural and social (humanitarian, social) sciences. The essence of differences affects the foundation of these sciences and determines the process of scientific paradigms formation in their knowledge fields.

Statement of any analytical problem is to translate its verbal description into a formal one. The creation of methodologies, methods and formal modeling languages is a natural process of development of any science, as this makes it possible to organize empirical knowledge and understand better the essence of the observed phenomena and processes. However, the modeling process should not be an end in itself, the construction of theoretical models should be based on experience and practice otherwise in theories (even at the front edge physics) there may be significant problems [1]. It is known that new fundamental discoveries are mostly established by experiment, experience and practice and are explained by the theory.

In many sciences in connection with the development of computer technology, various systems for collecting and processing information, experimental and statistical data accumulate very rapidly. In order to study this information, researchers are developing methods of analysis data that would be versatile in relation to systems of different nature. By this time in this field a whole research area has been already formed which focuses on use of scientific research methods in Humanities. Probably, this research area, which is closely associated with systems analysis and General systems theory, is the most promising path to a new modeling paradigm.

While in theory of the modeling systems a crisis is brewing the number of methods and tools for analysis and simulation is growing at a very fast rate, and experimental base for their approbation is far behind. It cannot be said that data are not enough, often these data are not structured and represent of diverse information, which requires significant labor processing and data assimilation. The academician P.L. Kapitsa pointed out to the existence of such problems in physics fifty years ago, and he saw a symptom of a serious disruption of normal development of science in the ties between theory and experiment [2]. It has long been known that the development of an empirical base of scientific disciplines is formed more slowly than the researchers' aspirations in the construction of theoretical models which are not always confirmed by experience and practice.

That's why, in order to obtain a significant result in the application of scientific methods of research in the Humanities, it is necessary to return to scientific methods, which provide a close connection between theory and experiment. Here we can talk, primarily, about proven by generations of scientists phenomenological research methods

ISSN 2411-720X (Print)
ISSN 2413-0834 (Online)

that are perfectly applicable to structured data sets characterizing the physical, biological, social and public processes.

Problem Statement

Today mathematization of biological, ecological, social Sciences and Humanities does not touch their initial positions, methodologies patterns, i.e. foundations of these sciences. If in economics mathematical and computer models are fairly widely used, but, for example, in philosophy and history the use of formalized models is rather rare. The possibility of the use of mathematical methods in philosophy very often provokes formal doubts and objections in many researchers' minds, even at the level of the discussion. The reason for this is that philosophy, like mathematics, largely determines the appearance of modern science and is a tool for the study of universal patterns in nature and society, therefore, the methodology of these Sciences cannot fundamentally have single research methods, except some general logical approaches.

However, recently certain preconditions have been already created for the quantitative approaches extension of the scope including simulation and mathematical models, in history, archaeology, anthropology, psychology, sociology and linguistics. This contributes to the accumulation of empirical data in these Sciences.

The difference between paradigms of natural and humanitarian knowledge is largely related to the degree of formalization of the studied processes and phenomena and, as a consequence, with the presentation of the model descriptions in the respective Sciences. One of the most urgent problems of modern science is concerned with the search for the answer to the question: is it possible a high degree of formalization in the description of objects and phenomena in the Humanities? In this paper an attempt is made to outline the ways of solving some general problems in the field of systems theory. That's why, the aim of this article is to find a system-wide principles, which would open up the opportunities for the formalized models creation in the field of social Sciences and Humanities.

Some principles of creating theories in subject areas

The original principles of scientific knowledge (the determinism of phenomena; the truth of theories and models, which are proven with practice; the relativity of knowledge) are initially based on pervasive observation of events that underlie the receipt of any data, facts and laws of objective reality. Determinism is the doctrine about the universal and natural connections of phenomena and processes in the surrounding world. Indeterminism comes from the lack of any connection between phenomenas. Both principles give the opposite point of view about the nature of the relationship of events, processes and phenomena in time. Of course, in nature the universal connection between phenomena cannot be described only in simple cases and extremes, an organic unity of these opposing points of view should be observed.

During studying this problem in relation to the modeling process, we base on the principle of determinism in the model descriptions. It is an accepted fact that determinism is inherent in the modeling – any credible physical, mathematical or algorithmic model describes the logical connection of the studied phenomena and processes, which may be both deterministic and probabilistic features.

Depending on the nature of these features in the description of systems there are two types of the causal link existence related to dynamic (deterministic) and statistical (probabilistic) laws. Historically this problem lies in the relationship between formalism and reality.

As the basis for establishing of any regularity is always an event, the distinction between the laws is regarding. This is due to the fact that any event in the strict sense of the word is always accidental, and in this case many significant events (deterministic events required) will determine the dynamic pattern, which is characteristic of predetermination. In turn, many random events (events that may occur or may not occur) will determine the statistical regularity that is characteristic of randomness.

Assumption whether dynamic or statistical regularities prevail in the process or phenomenon, is set on the basis of practical experience. The decision on selection of a reliable model is produced for a long time with practice, by trying many different models, while the experience does not confirm the best option of choice. In this case, general ideas are being formulated which are accepted by the scientific community. Many famous scientists see a new paradigm in the development of science in the synthesis of dynamic and statistical regularities of the objective reality. Thus, if statistical and dynamic patterns can be reduced to more general stochastic regularities, it is necessary to determine the criteria that would reflect this similarity. Therefore, based on the objectives set in this paper, we will try to find common features in the formation of characteristic events, which primarily reflect evolutionary processes in different systems [3].

Let's make the following assumptions. Firstly, as the dynamic and statistical regularities are the essence of the more general stochastic

Звягинцева А.В., Аверин Г.В.
Донецкий национальный технический университет

regularities, the criterion of similarity should be determined on the basis of probabilistic beliefs about the feasibility of the event. That is, the criterion needs to take into account the relationship between events. Secondly, the basis of all models is the fundamental notion of mathematical analysis – the notion of a function. Thus, the studied problem is connected with use of probabilistic principles in the process of submitting functional dependencies.

In the simplest case, the notion of a function is given as: if the value x can take *arbitrary values*, and a certain rule is given, according to which specific values of the other quantities y are given in accordance with these values, in this case they say that y is a function of x and we write this relationship symbolically in the following way: $y = f(x)$. The modern definition of a function in terms of sets is: let for each *arbitrary number* x from a given set E there corresponds a certain number y denoted as $y = f(x)$, in this case they say, that the function $y = f(x)$ is determined on the set E.

If you imagine the target value x as an event, then, according to the highlighted phrases in the definitions: "*arbitrary values*", "*arbitrary number*", you can consider this event as equally possible. This indicates that the distribution of the variable x, as a probabilistic principle and premise for the model, will correspond to an uniform probability law. Consequently, an equally likely is the basic property of a dynamic pattern with its total original formulation in the frameworks of stochastic regularity. According to this fact, in a chosen space of variables different models (or other dependencies) developed by practice can be viewed as a simulation environment of a stochastic process that is observed in reality. The main features of this environment are an equally possible choice of values of the original independent variables and selection a set of the diverse functions for the simulation.

Thus, for the systems of very different nature, we come to the idea of a probability space for many variables, where elementary equally likely outcomes of selecting values from the original set of some independent variables are associated with not equally likely complex events for many other dependent variables and the relationship between these values is specified by defining a function on the original set.

In this case, the probability space represents a certain set of (Z, A, W), which consists of the set Z (equally likely elementary events), of the class A of all subsets of Z (random complex events, observation or experience) and probability measure W, which is a real function and determines the relationship between the distributions on sets Z and A. This probability measure W can be defined in terms of statistical or dynamic patterns, since, based on the definition of the function, it does not matter how correspondence between quantities has been determined. It follows that in terms of the concepts of probability space and a function it is possible to formulate a general stochastic pattern, which as special cases includes both dynamic and statistical regularities.

From the above it follows that the criterion of dynamic similarity and statistical regularities can be the probability of events observed upon the occurrence of different phenomena and processes in nature and society, as well as their probabilistic distributions of various kinds. However, further we will show that this is not the only value that can be used for phenomenological data analysis.

The main idea of this work is connected with the new methods of phenomenological analysis development of the data which are presented in the measurements time series form or various quantities observations. For a number of diverse nature systems, the formation of tabular-time data is possible. Usually the data have the table structure in the form of matrices "objects – parameters", and multiple tables (t) is ordered according to time, such as years, months, hours, seconds, etc. As objects there are the same type of classes, for example, substances, organisms, species or individuals, products, devices, facilities, natural objects of one kind, technical systems, similar in production technology, specialized enterprises, cities, regions, countries, citizens of states or regions, etc. As parameters (indicators) that reflect the properties of certain types of systems can be various physical, chemical, biological, natural-resource, technological, socio-economic or identity values with quantitative measurement. For a specific object, each parameter in a table-temporary data array will be represented by a time series of experimental points of length t, which are specified with a certain time lag. In turn, each object at a specific point of observation is located in a certain state and is characterized by a set of parameters. Similar general approach allows to determine the state of an object as a set of its observed properties, the parameters of which are formed under the influence of environmental conditions at a particular point of time.

Suppose that for k of similar objects forming a certain nature system in a table-time data there is quantitative information about n of attribute parameters characterizing the various properties of this system. The list of attribute indices is determined by current views prevailing in the scientific community about the behavior of the studied system, correlation analysis or other methods of establishing the most significant

ISSN 2411-720X (Print)
ISSN 2413-0834 (Online)

variables. Any set of n variables for parameters of properties sets n-dimensional space $\{z_1, z_2, ... z_n\}$. The points of this space correspond to n-dimensional sets of values of all variables $z_1, z_2, ... z_n$. Thus, the state of any object in n-dimensional space at any moment of time will be displayed as multi-dimensional point $M = M(z_1, z_2, ... z_n)$, the process of changing the state of an object during the period of time – by multivariate curve that is described by a point $M = M(z_1, z_2, ... z_n)$ in this space. Let's consider a complex event A_j which represent simultaneous observation of several parameters and define that the state of a particular object at a given moment of time will be characterized not only by a set of parameters settings for this object, but by the observed event too. We assume that a probability of the event exists and can be determined. Let's call this the statistical probability as a probability of the state of the studied system. Statistical probabilities for a complex event A_j can be found using various algorithms of busting, grouping and counting frequencies of favourable events in the general sample of all observations [3]. The main condition for determining the statistical probability is due to the fact that the number of observations should be large enough, commensurate with the number $N = d \cdot f^p$, where f – the number of intervals of grouping data for one variable, which is usually taken equal to from 10 to 15; d – the number of experimental data on the same interval of grouping $(d = 5 - 7)$; p – the number of parameters that form the event A_j.

The existence of statistical probabilities of events is the main probabilistic regularity of reality and connected with stability of relative frequencies of events. This property is true for systems of different nature and is a universal feature in the behavior of all systems. It should be noted that statistical probability of the most typical events that reflect the peculiarities in the change and development of specific systems, can act as some integrated characteristics of these systems. Therefore, for each n-dimensional point in space $\{z_1, z_2, ... z_n\}$ different probabilities of salient events can be assigned to. You can go farther and assume that there are a variety of complex characteristics that determine the state of the systems with the parameters of properties. Similarly, to each n-dimensional point can be assigned some empirical values, which comprehensively reflect the state of objects and are closely associated with the parameters of properties. In general case, let's call such values as the empirical measure of the system states. We assume that the empirical measure W can be determined in the experiment on the basis of some procedures of measurements, evaluations or calculations. The value W cannot be a parameter of one of the system properties $z_1, z_2, ... z_n$. Different complex values can be as the empirical measure, for example, the probability of different characteristic events, the amount of heat the empirical temperature, the value of the objects, various indices defined by experts, experienced quantities, which have a close relationship with many options, system properties, etc. Thus, on the basis of variables $z_1, z_2, ... z_n$ it is possible to form an n-dimensional coordinate space $\{z_1, z_2, ... z_n\}$, in which the possible states of the system form a certain area Q_n, covering all observable points in the experience. Each point M_i you can put into correspondence with some empirical measure of the state W_i.

The basic principle, which is accepted during construction data models consists of the continuity of the model environment.

Therefore, the first fundamental hypothesis is that we assume the continuity of the area Q_n. It means that in the area of states Q_n there are an infinite number of states for a general set of system objects of a certain nature and points of states $M = M(z_1, z_2, ... z_n)$ continuously fill this area. We also assume that an experienced points $M_i(z_1, z_2, ... z_n)$ are a limited sample of observations from a given general plurality. The second fundamental aspect lies in the acceptance of the hypothesis of the existence of some empirical measure for a comprehensive assessment of states of the studied system of a certain nature. For construction data models we also accept the hypothesis about the continuity of the empirical measure in the area Q_n in the form of a scalar field $W = W(M)$. All of the above allow us to formulate the following axioms.

1. Let in the state space of some system Q_n for each point M there is a corresponding number W, which will be called the empirical measure of the system state.

2. The value $W = W(M)$ is a function of the point and forms a scalar field, which is continuous in the area Q_n.

We suppose that in the area Q_n you can set continuous analytical function $\theta = \theta(z_1, z_2, ... z_n)$ on the basis which the mathematical model will be formed. For the known function $\theta = \theta(z_1, z_2, ... z_n)$ and the values of the variables $z_1, z_2, ... z_n$ in the area Q_n you can construct one more scalar field, which we will call the simulation environment. On

Звягинцева А.В., Аверин Г.В.
Донецкий национальный технический университет

this basis, in the general case to construct a phenomenological model of some system we formulate the axiom.

3. Let in the area of states Q_n of some system the scalar fields of values W and θ are definitely related. If in the neighborhood of any point M the object of the system implements some process l, then for line process l the ratio $dW = c_l \cdot d\theta$ is true, where c_l – empirical quantities which are the process functions.

In papers [3 – 5] it is shown that the axioms (1) – (3) are enough for phenomenological descriptions of the data, presented in tabular and temporal arrays of information. These descriptions are associated with multidimensional Pfaff's equations of the form:

$$dw = c_1 \cdot \frac{\partial\theta}{\partial z_1} dz_1 + c_2 \cdot \frac{\partial\theta}{\partial z_2} dz_2 + ... + c_n \cdot \frac{\partial\theta}{\partial z_n} dz_n, \quad (1)$$

where the phenomenological values c_l are determined according to observation data. Solutions of Pfaff's equations allow to obtain the general integrals, which in its form are close to the functions of the state and are widely used in thermodynamics – they are entropy and thermodynamic potentials. Entropy is a characteristic function of the state space of the system. Parametrically entropy is the length of the arc of some vector line of a field of directions which is generated by the system state W empirical measure's scalar field [3]. In the multidimensional area Q_n there is also a general integral (potential) of the form $U(z_1, z_2, ...z_n) = C$, which is a surface that is orthogonal to the vector lines of entropy. In general case, the modeling environment in the area Q_n can be represented in the form of various functional dependencies with respect to attribute parameters: multiplicative, power, additive, expert or other dependencies which belong to classes of homogeneous or multiplicative functions. In paper [3] it is shown that under these conditions the simulation environment θ in the area Q_n allows to use of multidimensional quasilinear PDEs of the first order, which are closely related to Pfaff's equations of the form (1). For example, for the case $\theta = z_1 \cdot z_2 \cdot ... \cdot z_n \big/ \left(z_{1_0} \cdot z_{2_0} \cdot ... \cdot z_{n_0}\right)$ entropy s and potential U for the equation (1), are defined as:

$$s - s_0 = c_1 \cdot \ln\left(\frac{z_1}{z_{1_0}}\right) + c_2 \cdot \ln\left(\frac{z_2}{z_{2_0}}\right) + ... + c_n \cdot \ln\left(\frac{z_n}{z_{n_0}}\right), \quad (2)$$

$$U - U_0 = \frac{\left(z_1 - z_{1_0}\right)^2}{c_1} + \frac{\left(z_2 - z_{2_0}\right)^2}{c_2} + ... + \frac{\left(z_n - z_{n_0}\right)^2}{c_n}, \quad (3)$$

where $z_{1_0}, z_{2_0}, ...z_{n_0}$ – some reference state's parameters. As a simulation environment different functional dependence can be used, for example, multidimensional geometric probability, multiplicative power function according to the parameters $z_1, z_2, ...z_n$, the index of the area $\theta = \sum_{k=1}^{n} \left(z_k - z_{k_0}\right)^2$, based on the geometric representations of the homogeneity of the area Q_n, etc.

Entropy s and potential U can be taken as generalized criteria for assessing the state of systems of different nature in a multidimensional space Q_n. Their most important feature is that they are functions of the system state under condition of the existence of a scalar field of empirical measure W. The change of these functions depends only on the initial and final states of the system and does not depend on the path of the transition of the system between these states. Q_n.

Thus, an axiomatic theory of phenomenological analysis of data for systems of different nature is based on the postulation of existence of a multidimensional scalar field of empirical measure W and the description of the processes of change and development of systems through connection of value W with the simulation environment θ of the form $dW = c_l \cdot d\theta$. The values c_l are determined with the help of table-temporary arrays of experimental data. It shows that the proposed method is closely related to the logic construction of the theory of thermodynamics, as originally phenomenologically determined values c_l are introduced, which characterize the processes of change and development facilities. The application of this theory is limited by systems for which there are empirical measures of a comprehensive assessment of conditions and descriptions, that have different field representation of state space, can be formulated. The feature of the proposed approach lies in the fact that the initial hypothesis can be accepted or rejected in the result of available data experience or observations processing that characterize the system behavior.

Phenomenological Data Model Example

The use of this approach is demonstrated on the elaboration of methods of assessment of human development which is alternative to the method of calculating the human development index of the UN development Programme (UNDP).

In 2010 the UNDP methodology for calculating of the human development index was changed [7]. Firstly, the basic calculated dependencies were changed that have been constructed by expert. Secondly, as the attribute variables to calculate the index the following indicators were used: the average period of study

(z_1), years; the expected duration of study (z_2), years; gross national income (GNI) per capita in terms of purchasing power parity (PPP) in USD (z_3); life expectancy (z_4), years. We also take these indicators as attribute variables. To solve the problem, we will use databases of Reports of human development [6, 7], which cover data of the world countries from 2008 to 2013. The algorithms for calculating frequencies of favorable events [3] provide an opportunity to find the probability value of the system state, based on the available array of experimental data. The statistical probability w is calculated in the whole group of objects (169 countries) for all experimental data.

To search nonlinear relationships between variables we use the method of probit analysis. Taking into account (2) we correlate the obtained probability w with distributions of attribute variables in the array of experimental data and as the result of which we will have the following regression dependence of the probability from entropy of the system state:

$$\Pr ob = -3{,}6717 + s\,; \quad w = \frac{1}{\sqrt{2\cdot\pi}} \int_{-\infty}^{\Pr ob} \exp\left(-\frac{t^2}{2}\right) dt\,;$$

$$s = 0{,}6525\cdot\ln\left(\frac{z_1}{z_{1_0}}\right) + 0{,}9291\cdot\ln\left(\frac{z_2}{z_{2_0}}\right) +$$

$$+0{,}0245\cdot\ln\left(\frac{z_3}{z_{3_0}}\right) + 2{,}2575\cdot\ln\left(\frac{z_4}{z_{4_0}}\right) \qquad (4)$$

The correlation coefficient of the association (4) was 0,90 (fig. 1).

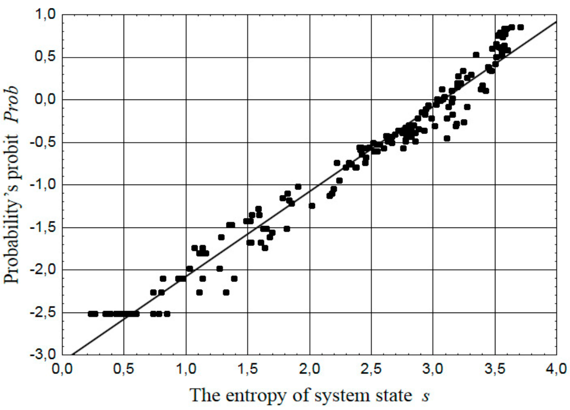

Figure 1. – The dependence of the statistical probability of the state w from entropy s for the shared values of the observed attribute variables p_1, p_2, p_3, p_4

Attribute variables were related to values $z_{1_0}, z_{2_0}, z_{3_0}, z_{4_0}$, which correspond to a selected reference state. As a reference state the indicators of the country Niger development in 2008 were taken, as one of the most underdeveloped countries, which, in particular, are equal to: $\rho_{1_0} = 1{,}4$ years; $\rho_{2_0} = 4{,}3$ years; $\rho_{3_0} = 675$ \$; $\rho_{4_0} = 52{,}5$ years.

Taking into account the probabilistic evaluation of complex joint events associated with the joint monitoring indicators z_1, z_2, z_3, z_4, based on the definition of potential values U, development for every world country was ranked, based on the level of human development of the countries during the period 2008 – 2013. The results of ranking of the countries are given in table 1.

The first ten countries with the highest level of development in 2013 are Qatar, Liechtenstein, Kuwait, Singapore, Brunei, Norway, Luxembourg, the UAE, Switzerland and Hong Kong. It is seen that among twenty countries (G20) in this list there is no any country from G20, and from the EU – there is only Luxembourg. According to the pace of development for the period 2008 – 2013 the top ten of the fastest growing countries include Qatar, Kuwait, Singapore, Brunei, Saudi Arabia, Switzerland, Liechtenstein, Luxembourg, Hong Kong and Iceland.

The ten countries with the lowest level of development are Ethiopia, Togo, Guinea, Guinea-Bissau, Mozambique, Niger, Liberia, Malawi, Burundi and the Central African Republic. All these countries are in Africa.

According to the pace of development in 2008 – 2013, the most lagging countries were: Uganda, Niger, Central African Republic, Malawi, Solomon Islands, England, Equatorial Guinea, Greece, Bahamas and Barbados. This list contains two European countries (England and Greece), which during the studied period there was a decrease in the specific GNI.

Russia took place number 44 in the ranking of the level of development in 2013, in its turn, Kazakhstan – 53, Belarus – 62, Ukraine – 97. According to the pace of development during 2008 – 2013 Russia occupied the 24th place, Kazakhstan – the 25th , Belarus – the 52nd, and Ukraine – the 95th . During the same period, Russia was ahead of Italy, France, Japan, England, Canada, Estonia in the pace of human development, however, lagged behind the US, Germany, Sweden, Lithuania, Latvia.

Ratings of countries in terms of development, identified by the method of calculation of human development index of UNDP, differ significantly from the rating, calculated on the basis of this approach (table 1). For most developed countries the UNDP methodology provides inflated ratings of level of development and many developing countries have low ratings.

All of this suggests that the human development index gives a more favorable integrated assessment for the countries of “Golden billion” (USA, Canada, Australia, Japan, EU countries) and less favorable for all other countries.

Table 1. – The values of the potential (U), its changes (ΔU) and the ratings of countries in the development processes of the countries in the world in 2008 and 2013

The World Countries	The potential of the country U (2013)	The potential change ΔU (2008 – 2013)	Ranks countries according to the proposed method		Countries' ranks according to the HDI of the UNDP methodology (2013)
			the level of development (2013)	the rate of growth (2008 – 2013)	
Norway	365995	56065	6	11	1
Switzerland	259015	116708	9	6	3
The USA	245219	46445	11	13	5
Germany	166119	54351	14	12	6
Canada	157264	23242	18	26	8
Singapore	469250	255069	4	3	9
Sweden	167274	44982	13	15	12
England	109843	-485,4	26	165	14
Japan	121041	13151	23	41	17
France	120260	14557	24	38	20
Italy	95662	17025	28	33	26
Greece	54522	-13679	39	167	29
Qatar	1269241	704098	1	1	31
Poland	41441	12999	49	43	35
Hungary	40482	13057	51	42	43
Latvia	44168	29103	45	20	48
Belarus	24179	9174	62	52	53
Romania	27282	12446	57	45	54
Russia	45899	25014	44	24	57
Turkey	30315	14329	55	39	69
Kazakhstan	33911	24475	53	25	70
Brazil	18266	8178	70	56	79
Georgia	4334	2101	103	99	79
Ukraine	6115	2220	97	95	83
China	11812	7084	80	62	91
India	2356	1380	116	106	135
Nigeria	2551	2153	114	98	152
Ethiopia	118,0	67,0	160	151	173
Niger	28,6	28,2	165	161	187

Conclusion

A phenomenological approach for the analysis and description of observations or experiences can be used in various subject areas where sufficient amounts of structured quantitative data are accumulated. Phenomenological models are characterized by a high level of formalization and versatility of the submission, they can be focused on the description of various problem-oriented arrays of quantitative information and allow you to create original principles and patterns for building theories. This approach has an importance for the development of the modeling theory, as it allows to offer objective research methods of objects and the systems of multivariate dimension, which include all the natural, biological and social systems.

References

1. Смолин Ли. Неприятности с физикой: взлет теории струн, упадок науки и что за этим следует / Перевод с англ. Penguin Book, London, 2007. – 226 с.
2. Капица П.Л. Эксперимент, теория, практика. – М: Наука, 1981. – 495 с.
3. Аверин Г.В. Системодинамика. – Донецк: Донбасс, 2014. – 405 с.
4. Аверин Г.В., Звягинцева А.В. Взаимосвязь термодинамической и информационной энтропии при описании состояний идеального газа // Системный анализ и информационные технологии в науках о природе и обществе. Донецк: Друк-инфо, 2013. – №1 (4) – 2 (5). – С. 46 – 55.

5. Аверин Г.В., Звягинцева А.В. Применение методов интеллектуального анализа данных при оценке развития Украины // Геотехническая механика. 2013. Выпуск 112. – С. 257 – 270. – Электр. ресурс URL: http://geotm.dp.ua/index.php/ru/2013-god/vypusk-112 (12.06.15).
6. Human Development Reports (1990 – 2014 years). – Available at: http://hdr.undp.org/en/reports/ (03.07.15).
7. Human Development Report 2010 "The real wealth of Nations: pathways to human development". – 228 p.

References (transliteration)

1. Smolin Li. Neprijatnosti s fizikoj: vzlet teorii strun, upadok nauki i chto za jetim sleduet [The trouble with physics: the rise of string theory, the decline of science and what follows]. Perevod s angl. Penguin Book, London, 2007. – 226 p.
2. Kapica P.L. Jeksperiment, teorija, praktika [Experiment, theory, practice]. – M: Nauka, 1981. – 495 p.
3. Averin G.V. Sistemodinamika [Systemdynamik]. – Doneck: Donbass, 2014. – 405 p.
4. Averin G.V., Zvjaginceva A.V. Vzaimosvjaz' termodinamicheskoj i informacionnoj jentropii pri opisanii sostojanij ideal'nogo gaza [The relationship of the thermodynamic and information entropy in the description of the ideal gas states] // Sistemnyj analiz i informacionnye tehnologii v naukah o prirode i obshhestve. Doneck: Druk-info, 2013. – no 1 (4) – 2 (5). – pp. 46 – 55.
5. Averin G.V., Zvjaginceva A.V. Primenenie metodov intellektual'nogo analiza dannyh pri ocenke razvitija Ukrainy [Application of data mining techniques for the assessment of Ukrain developmen] // Geotehnicheskaja mehanika. – 2013. – Issue 112. – pp. 257 – 270. – Elektr. resurs. URL: http://geotm.dp.ua/index.php/ru/2013-god/vypusk-112 (12.06.15).
6. Human Development Reports (1990 – 2014 years) – Available at: http://hdr.undp.org/en/reports/ (03.07.2015).
7. Human Development Report 2010 "The real wealth of Nations: pathways to human development". – 228 p.

Звягинцева А.В., Аверин Г.В. «Применение естественнонаучных методов при разработке феноменологических моделей в общественно-гуманитарных науках». *В данной работе делается попытка наметить пути решения некоторых общих задач в области общественных и гуманитарных наук, связанных с описанием данных наблюдения или опыта. Такие данные представляются чаще всего трехмерными массивами информации вида «объекты-показатели-время». Основная идея работы направлена на изучение возможности создания на основе таких данных феноменологических моделей процессов и явлений, отличающихся многомерным полевым представлением количественной информации о состоянии объектов и систем. Предложены принципы создания и теория построения феноменологических моделей в общественных и гуманитарных науках. Получены соотношения и уравнения для решения прикладных задач. В качестве примера применения естественнонаучных методов в социально-гуманитарных областях знаний выполнена комплексная оценка развития стран мира с использованием баз данных Программы развития ООН, которая основана на анализе событий совместного наблюдения основных четырех показателей человеческого развития.*

Ключевые слова: естественнонаучные методы, феноменологические модели, социально-экономические и экологические системы.

Звягінцева Г.В., Аверін Г.В. «Застосування природничо-наукових методів при розробці феноменологічних моделей в суспільно-гуманітарних науках». *У роботі робиться спроба намітити шляхи вирішення деяких загальних задач в галузі суспільних і гуманітарних наук, пов'язаних з описом даних спостереження або експерименту. Такі дані подаються найчастіше тривимірними масивами інформації виду «об'єкти-показники-час». Основна ідея роботи спрямована на дослідження можливості створення на основі таких даних феноменологічних моделей процесів і явищ, які відрізняються багатовимірним польовим поданням кількісної інформації про стан об'єктів і систем. Запропоновано принципи створення та теорія побудови феноменологічних моделей в суспільних і гуманітарних науках. Отримано співвідношення та рівняння для вирішення прикладних задач. Як приклад застосування природничо-наукових методів в соціально-гуманітарних галузях знань виконана комплексна оцінка розвитку країн світу з використанням баз даних Програми розвитку ООН, яка заснована на аналізі подій спільного спостереження основних чотирьох показників людського розвитку.*

Ключові слова: природничо-наукові методи, феноменологічні моделі, соціально-економічні та екологічні системи.

Статья поступила в редакцию 20.05.2015
Рекомендована к публикации канд. техн. наук В.Н. Беловодским