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Probabilistic Methods of a Complex Assessment of Quantitative Information

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Abstract: The probabilistic methods of a complex assessment of quantitative information on development of countries, regions and cities in the world are proposed and it is shown that the search for connections and regularities in databases of indicators can be established between the probabilities of joint events of observation of several main indicators. The universal technique of a complex assessment based on definition of statistical probabilities of such events is developed. On the basis of use of data of the research center new economics foundation the example of an assessment of well being of the countries is given. Such approach is alternative to expert approach of an assessment of wellbeing of the countries which is accepted at determining the world index of happiness.

Key words: Countries, regions and cities, complex assessment of a state, development, probabilistic methods of the analysis of data

INTRODUCTION

The main problem of modern science is the complex assessment of a condition of various natural and anthropogenic, social and economic and urbanized systems, establishment of regularities and tendencies of their development and also forecasting of processes of change of their state. Today, this direction of researches in the basic methodology leans mainly on expert methods which are used every where in the scientific and practical purposes. Any expert estimates are subjective, their reliability depends on experience of experts and their analytical opportunities at an assessment of development of situations. There is also another solution of this problem which differs in interdisciplinary basis of researches and is connected with use of natural-science methods in studying natural, social and economic processes. Modeling of such processes can be based on probabilistic methods of the analysis and description of the quantitative data obtained in the course of observation.

In practice, the purpose of a complex assessment consists in research of a condition of systems on set of indicators on the basis of establishment of their compliance to certain levels or norms, detection of significant natural, social and economic factors and determination of scales and intensity of their manifestation and influence.

The problem of a complex assessment is directly connected with improvement of techniques of rating estimates and rangings of systems on set of indicators and development of forecasts for a medium-term and long-term outlook at strategic planning. Today, we have an information on >30 indexes and over 20 ratings of development of the countries, regions and the cities in open access. The well known among them are: index of human development (human development index); indexes and ratings of democracy knit); index of business of the world bank (doing business); index and rating of wellbeing of the countries of the world (happy planet index) and etc. The assessment of these indexes is based on various expert techniques and often methodical principles of calculations are not revealed by the international organizations and agencies.

In this study, the probabilistic methods of the analysis of quantitative information are offered to use for definition of indexes and assessment of ratings of difficult systems for the purpose of development of a universal applied technique. Creation of techniques of a complex assessment which procedures will be based on application of objective methodology and which can be used by independent experts in the research is an actual problem of strategic forecasting.

MATERIALS AND METHODS

Hypotheses and data: We will present social and economic or natural and anthropogenic system in the form of set of objects of one class for example: citizens, collectives, cities, areas, regions, countries and, etc. All objects of the studied system have a certain number of the main indicators which are defined by observed parameters z_1, z_2, ..., z_n. Each object makes the natural development, in this connection, its parameters change in time $z_1(t)$, $z_2(t)$,

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..., $z_n(t)$. As a result the array of tabular and time data in which each table has structure "objects parameters" is formed and the set of tables is ordered in time with a certain step. The majority of data on development of the countries and the cities has similar structure. The offered ideas and hypotheses of a complex assessment are formulated in following statements: using of extensive statistical data on a state and development of systems in the most different aspects and also algorithmic definition of probabilities of the events W which are connected with observation of indicators will allow to determine the main system regularities.

Search of regularities in data array is carried out between probabilities of events of observation of these values, not between indicators. Statistical probabilities for characteristic simple and difficult events can be found empirically, using the various algorithms of an assessment of probabilities of events in the general selection of all observation. It is supposed that in space of states H_n (z_1, z_2, ..., z_n), it is possible to create some complex index $T = T(z_1, z_2, ..., z_n)$ in the form of analytical function on the basis of which the mathematical model for an assessment of objects and their multiple parameter ranging will be created.

Justice of a hypothesis of connection of statistical probability of characteristic events and a complex index in the form of dependence $dw = c_1 . dT$ where values c_1 are determined by statistical data, proceeding from change of values w and T at implementation of any development l of each object is supposed for the space of conditions of system H_n.

The complex assessment and multiple parameter ranging of objects on set of indicators can be carried out by finding of functions of a state which define surfaces of level and coordinate lines in multidimensional space H_n for the field of probability of a condition of system.

It is supposed that universal techniques of a complex assessment which won't be connected with expert methods of the analysis of information can be developed for the urbanized and natural and anthropogenic systems on the basis of the offered probabilistic methods. As a statistical information data of the international organizations which undergo the procedure of assimilation and are submitted in the structured form of tabular and time data are used for creation of probabilistic models of systems.

RESULTS AND DISCUSSION

Main part: The new principles and theoretical bases of a complex assessment of difficult systems with use of probabilistic approaches of processing of quantitative information are the basis of these researchess (Averin, 2014; Averin *et al*., 2015a, b; Averin and Zviagintseva, 2012).

The technique of a complex assessment consists of the following stages. At the first stage the reasonable system of indicators of the natural and anthropogenic, social and economic or urbanized system is formed and the total and authentic characteristic of conditions of the studied system is possible using them. As the offered methods don't limit amount of the studied objects and their indicators initial information can include tens of indicators of systems. For the purpose of efficiency of the analysis of information data processing and search of regularities is carried out on groups of three four indicators at studying various aspects of development of systems.

Further the database of indicators in which the studied objects and information on them are represented in the lines of tables of the database and the indicators, defining conditions of objects of system, columns of tables is formed. Various tables correspond to various time points of collection of information on a condition of system.

At the following stage events which are peculiar to the studied system and which can characterize conditions of objects are chosen. Also joint events of simultaneous observation of several attributive indicators which unambiguously characterize in a certain aspect of a condition of the studied system are marked out. Probabilities of events are defined by an algorithmic way and connections between probabilities of these events are looked for using the methods of multiple regression. The corresponding algorithms have been offered in researchess (Averin, 2014; Averin *et al*., 2015a, b).

Further ways of a setting of an index $T = T(z_1, z_2, ..., z_n)$ on the basis of the chosen attributive indicators are offered. For the fullest assessment various indexes can be set and further their final choice is carried out proceeding from application of variable calculations and criteria of the best approach of skilled data. The scalar field of a complex index T forms the modeling environment for the studied system.

On the basis of theoretical methods which are given in researchess (Averin, 2014; Averin *et al*., 2015a, b) the mathematical model of probabilistic space is developed. It is considered that skilled points from the database are limited selection of observation of general selection of a set of conditions of objects which form the studied system.

At the following stage communications between probabilities and indicators of a condition of system are

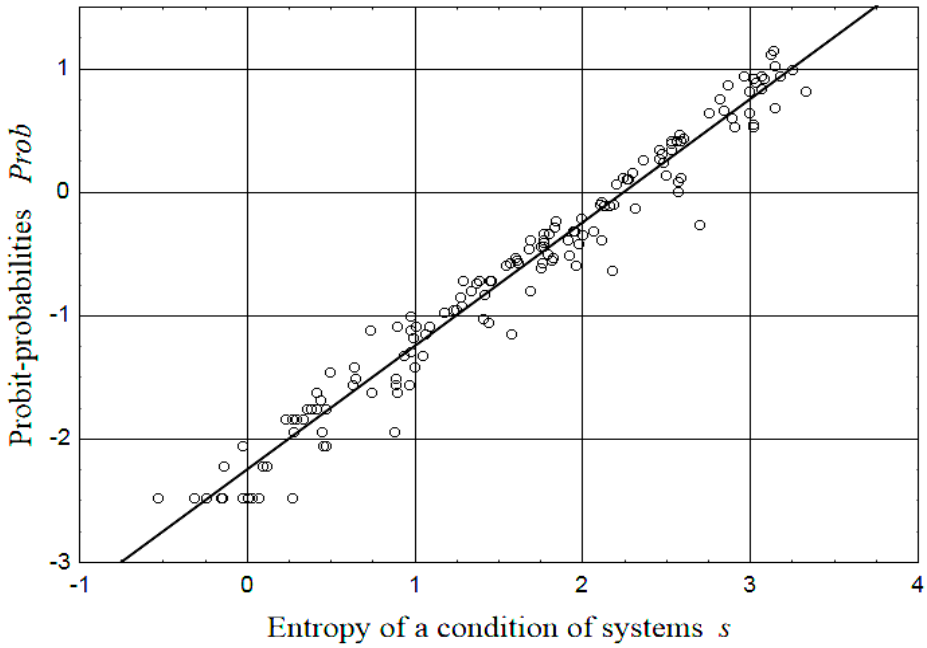

Fig. 1: Dependence of probability of a state w on entropy of a condition of system s for in common observed indicators z_1, z_{12}, z_3

studied and various probabilistic distributions are established. It is one of the most laborious investigation phases because considerable number of alternative calculations for various sets of attributive indicators, different characteristic events and the chosen complex indexes is required. At this stage the values c_1 characterizing processes of change of a condition of system are calculated and various methods and criteria of the statistical analysis of data are applied for this purpose. Accuracy of the developed models is checked by comparison of the results received on the basis of settlement dependences with skilled data.

Further, ranging of objects is carried out on the basis of criteria which define multidimensional surfaces of level and coordinate lines in the transformed probabilistic space. Ranks are established proceeding from the provision of objects in relation to curvilinear coordinates.

Examples of a complex assessment of development of the countries: In researchess on the basis of the developed methods the technique which is alternative to a technique of an assessment of human development of the Program of development of the UN (UNDP) is offered. On the basis of this technique the analysis of development of the countries is made by the available data of UNDP for 2008-2013 (Averin, 2014; Averin *et al*., 2015a, b; Averin and Zviagintseva, 2012).

Now, we will illustrate possibilities of the offered methods on the example of development of a technique which is alternative to the known method of calculation of the world index of happiness. This index (happy planet index) is the assessment reflecting wellbeing of people and a state of environment in the different countries of the world. The index is offered by the research center New Economics Foundation (NEF) in 2006.

In NEF technique as attributive variables for calculation of an index the following indicators are used: average life expectancy (z_1), years; indicator of subjective satisfaction with life by people (z_2), ball; indicator of an ecological trace (z_3), gha/capita. We will use databases of the NEF center for solving this objective. Taking into account a probabilistic assessment of the joint events connected with observation of indicators the probabilistic models of wellbeing of the countries have been constructed and ranks of the countries of the world have been defined. The corresponding model is received as a probit-dependence of size of probability of joint events of observation of indicators on entropy of a condition of system:

$$w = \frac{1}{\sqrt{2\cdot\pi}}\int_{-\infty}^{Prob}\exp\left(-\frac{t^2}{2}\right)dt,\ Prob = -2.205 + s$$
$$s = 0.964\cdot\ln\left(\frac{z_1}{z_{10}}\right) + 2.032\cdot\ln\left(\frac{z_2}{z_{20}}\right) + 0.499\cdot\ln\left(\frac{z_3}{z_{30}}\right) \quad (1)$$

The coefficient of correlation of dependence (1) equals 0.983, results of data processing for 146 countries of the world are given in Fig. 1. Attributive indicators belonged to values z_{10}, z_{20}, z_{30} which correspond to the

chosen reference point, a condition of the country by Chad (2012). In 2012, the first five countries having the highest value in an assessment of wellbeing of the country were Belgium, USA, Trinidad and Tobago, Australia and Iceland. Sierra Leone, Angola, Burundi, Afghanistan and Congo (DRC) were five countries having the lowest value.

The obtained data differ from an assessment which is given by the NEF center and at which the World index of happiness differs in overestimate of weight of an indicator of satisfaction with life. In the method offered by researchers of study ranks of the countries are established proceeding from an assessment of probability of the joint events connected with observation of all three indicators of wellbeing of the countries.

CONCLUSION

Results of research allow to create new predictive and rating systems of assessment of the development of the countries, regions and cities of the world which on the basis of a universal technique of a complex assessment give the chance to determine ratings of the countries by set of indicators. Such system has to integrate data on development of the countries and the cities of the world from 25-30 international organizations and to determine 10-15 known indexes and ratings by various aspects of development. It will allow to offer new system of information and analytical support of decision-making in the field of global studies and urbanistics.

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