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The evolutionary and creative processes in biological systems

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Abstract: It is considered the computational models of biological systems with structured uncertainty which is determined by mean of number of the arbitrary coefficients. Any biological system interacts with its changing environment and its viability depends on its adaptability. The number of arbitrary coefficients in the structure of equivalent equations of biological system changes in the process of learning. In systems with more than six variables, the number of arbitrary coefficients increases first, and then, passing through the maximum, begins to decrease. This phenomenon makes it possible to explain the processes of system growth, complication and death in biological, economical and physical-engineering systems. The treatment processes are considered as the evolutionary processes, the genetic processes are considered as creative processes. We use the linguo-combinatorial method of investigation of complex systems, in taking key words for building equivalent equations. This approach permit to investigate the adaptability of different biological systems.

Keywords: Adaptability, Combinatorial Simulation, Uncertainty, Appearance, Essence, General Systems Theory, Evolution, Creation, Physics, Biology, Social-Economics

1. Introduction

The natural language is the main intellectual product of mankind. The structure of the natural intellect is reflected in natural language that is accessible for investigation. Some scientific experiments can be expensive and dangerous. The simulation techniques permit to decrease the cost for investigating these systems. The simulation must accurately reflect the characteristics of the real world. Combinatorial simulation allows studying the full set of system variants including uncertainty. Any system contains some types of uncertainty, which are determined by their existence in real world. Humans interact with both physical objects and their descriptions in terms of natural language, mathematics or tables. Descriptions often only partially represent the essence of real processes. The inaccuracy of description introduces uncertainty. More often the uncertainty of systems is, however, inherent to the real world. This study is aimed toward such types of uncertainty in mental processes. Physical laws, the balance of energy and matter, and information limit the systems behavior. Within these limits, biological systems interact and adapt to other systems and environment, and undergo destructive actions.

2. Linguo-Combinatorial Simulation

Frequently we use the natural language to describe systems. We propose to transfer this natural language description to mathematical equations.

For example, we have a sentence

$$\text{WORD1} + \text{WORD2} + \text{WORD3} \qquad (1)$$

where we assign words and only imply meaning of words, the meaning (sense) is ordinary implied but not designated. We propose to assign meaning in the following form

$$(\text{WORD1}).(\text{SENSE1}) (\text{WORD2}).(\text{SENSE2}) (\text{WORD3}).(\text{SENSE3}) \; 0 \qquad (2)$$

This equation (2) can be represented in the following form

$$A1.E1 + A2.E2 + A3.E3 = 0 \qquad (3)$$

where Ai, i = 1, 2, 3, will denote words from English Appearance and Ei will denote senses from English Essence. The equations (2) and (3) are the model of the sentence (1). This model is an algebraic ring and we can resolve this equation with respect to the appearances Ai or the essences Ei [4,5,6]:

$$\begin{aligned} A1 &= U1.E2 + U2.E3 \\ A2 &= -U1.E1 + U3.E3 \\ A3 &= -U2.E1 - U3.E2 \end{aligned} \quad (4)$$

or

$$\begin{aligned} E1 &= U1.A2 + U2.A3 \\ E2 &= -U1.A1 + U3.A3 \\ E3 &= -U2.A1 - U3.A2 \end{aligned} \quad (5)$$

where U1, U2, U3 are arbitrary coefficients, can be used for solution of different tasks on the initial manifold (2) or (3) and can to define the chaotic behavior. In general if we have n variables in our system and m manifolds, restrictions, then the number of arbitrary coefficients S will be defined as the number of combinations from n to m+1 [2], as shown in Table 1

$$S = C_n^{m+1}, \; n > m \quad (6)$$

Table 1. *The number of arbitrary coefficients depending on the number of variables n and the number of restriction m.*

n /m	1	2	3	4	5	6	7	8
2	1							
3	3	1						
4	6	4	1					
5	10	10	5	1				
6	15	20	15	6	1			
7	21	35	35	21	7	1		
8	28	56	70	56	28	8	1	
9	36	84	126	126	84	36	9	1

The formula (6) is the basic law of cybernetics, informatics and synergetics for complex systems. The number of arbitrary coefficients is the measure of uncertainty. Usually, when solving mathematical systems, the number of variables is equal to the number of equations. In practice we frequently do not know how many constraints there are on our variables. Combinatorial simulation makes it possible to simulate and study the systems with uncertainty on the base of incomplete information. The problem of simulation of condition, guaranteeing the existence of maximum adaptability is investigated.

It is supposed that the behavior of a system with n variables is given with an accuracy of m intersecting manifolds, n > m. If the system is considered as a multidimensional generator (Fig.1) where at least a part of the variables interact with environment variables, and if the objective of the system is to decrease the functional of discoordination between them (Δ 1… Δ k), the system control unit has two instruments of impact, a and b, upon the system. First, this is the tuning – the changing of uncertain coefficients in the structure of the differential equations of the system, taking account that the greater number of these coefficients implies more accurate system response to changing environment. Second, this is the learning – the imposing new restrictions on the system behavior. The number of arbitrary coefficients, in the structure of equivalent equations, changes in the process of learning, of consecutive imposing new and new restrictions on the system behavior. In the systems with more than six variables the number of arbitrary coefficients increases first, and then, passing through the maximum begins to decrease. This phenomenon makes it possible to explain the processes of system growth, complication and death. The existence of maximum adaptability phenomenon is observed in and proved by numerous biological, economical and physical-engineering systems.

Fig. 1 shows the interaction between system and environment. It is important that we describe a system with a full sum of combinations and have all the variants of decisions. The linguo-combinatorial simulation is a useful heuristic approach for investigation of complex, poorly formalized systems.

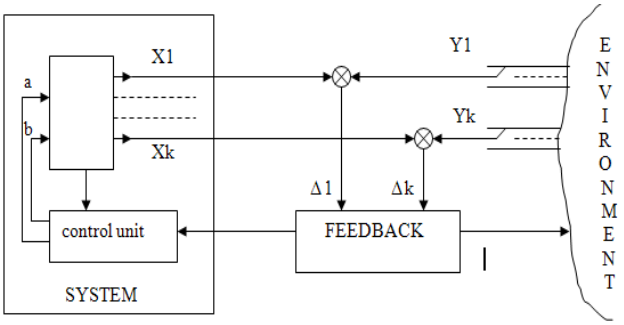

Fig. 1. *Model of "System - Environment".*

Natural language is the main intellectual product of mankind; the structure of natural language reflects the structure of natural intellect of mankind and its separate representatives on the level of consciousness and unconscious. Linguo-combinatorial simulation is the calculation, which permits to extract the senses from texts. Wittgenstein wanted to have the calculation of senses [2,3]. In our calculation we have the three groups of variables: the first group – the words of natural language Ai, the second group – the essences Ei, which can be the internal language of brain [1]; we can have the different natural languages, but we have only one internal language of brain; this hypothesis opens a new way for experimental investigation; the third group of variables – the arbitrary coefficients, uncertainty in our model, which we can use for adaptation in translation processes and etc

Each complex system interacts with environment, which are changing, and the life of complex system depends on the adaptational possibility of our system. The problem of simulation of condition of guarantee to the adaptational maximum are investigating. It is suggested that the behavior of system with n variables is given to an approximation of m intersecting manifolds, n > m. If the system is considered as a multidimentional generator where at least a part of variable interact with environment's variables, and if the objective of system is to decrease the functional of discoordination between them, the system control unit has two instruments of influence of the system. First, this is the tuning – the change of underdeterminated coefficients in the structure of the differential equations of system taking account that more is these coefficients the more accurate are the responses of the system to the change of environment. Second, this is the learning – the imposition of new restriction on the systems behavior. The amount of arbitrary coefficients in the structure, of equivalent equations is changing in the process of learning, of consecutive imposition of new and new restrictions on the system behavior. In the systems with the number of variables more than six the amount of arbitrary coefficients increase first and then going through the maximum begin to decrease. This phenomenon permits to explain the processes of growth, complication and death of a system. The existence of adaptational maximum phenomenon is proved by numerous biological, economical and physical-technical systems.

If we can not write the equation (2), we have the lingustical chaos situation. We can use the linguo-combinatorial method of investigation of the poorly formalized complex system, then we use the key words for creation of equivalent equations. The study of adaptational phenomenon in biological systems permit to increase the adaptational possibility in different systems and to resolve a lot of paradoxes[10].

3. Structure of General Model of Organism

Now the medical treatment is determination of illness symptom and generation of corresponding actions. This methodology is based on the physician education and support by means of telemedicine. Computer has big possibilities for complex system simulation, but physicians do not use these possibilities now.

The main idea of global computer model of organism has three parts:

1. It is necessary to create the integral model of generalized organism of man on the basis of biology and medical science;
2. Physician must have the possibility to tune the generalized model of organism on the concrete parameters of patient;
3. Physician must have the possibility to simulate the different variants of treatment and to select the best treatment way by means of model.

Since Aristoteles, there have been a lot of attempts in this direction, but now we have computer for investigations of complex systems and can use the combinatorial simulation method [4,7,8,9].

We have different levels of description of organism - organ level, cell level, molecular level, but for physician the organ level is useful and suitable. We can use the traditional system of organs :

1. The system of motion organs (bones, muscles, fasciae)
2. The digestive system
3. The respiratory system
4.. The urogenital system
5. The blood vascular and limphatic systems
6. The central nervous system
7. The peripheral nervous system -
8. The ductless glands
9. The skin and sensory organs.

We can increase the number of organ systems, but for illustration of our approach we will use nine systems, which interact among themselves. The organism equation will consist nine variables:

$$A1*E1 + A2*E2 + \ldots + A9*E9 = 0 \quad (7)$$

where:

A1 - characteristic of motion organs, E1 - variation of this characteristic,
A2 - characteristic of digestive system, E2 - variation of this characteristic,
A3 - characteristic of respiratory system, E3 - variation of this characteristic,
A4 - characteristic of urogenital system, E4 - variation of this characteristic,
A5 - characteristic of blood vascular and limphatic systems, E5 - variation of this characteristic,
A6 - characteristic of central nervous system, E6-variation of this characteristic,
A7 - characteristic of peripheral nervous system, E7-variation of this characteristic,
A8 - characteristic of dustless glands, E8 - variation of this characteristic,
A9 - characteristic of skin and sensory organs, E9 - variation of this characteristic.

The structure of equivalent equations of organism model will be (8)

$$E1 = U1*A2 + U2*A3 + U3*A4 + U4*A5 + U5*A6 + U6*A7 + U7*A8 + U8*A9$$

$$E2 = -U1*A1+U9*A3+U10*A4+U11*A5+ +U12*A6+U13*A7+U14*A8+U15*A9$$

$$E3 = - U2*A1-U9*A2+U16*A4+U17*A5+ +U18*A6 +U19*A7+U20*A8+U21*A9$$

$$E4 = - U3*A1-U10*A2-U16*A3+ +U22*A5+U23*A6+U24*A7+U25*A8+U26*A9$$

$$E5 = - U4*A1-U11*A2-U17*A3-U22*A4 +U27*A6+U28*A7+U29*A8+U30*A9$$

$$E6 = - U5*A1-U12*A2-U18*A3-U23*A4-U27*A5+U31*A7+U32*A8+U33*A9$$

$$E7 = - U6*A1-U13*A2-U19*A3-U24*A4-U28*A5-U31*A6+U34*A8+U35*A9$$

$$E8 = - U7*A1-U14*A2-U20*A3-U25*A4-U29*A5-U32*A6-U34*A7+U36*A9$$

$$E9 = - U8*A1-U15*A2-U21*A3-U26*A4-U30*A5-U33*A6-U35*A7-U36*A8$$

where U1, U2, . . . ,U36 - the arbitrary coefficients, which can be used for tuning of the model. System of equations (8) is full, this system covers all combination of interaction between different organs of organism.

In general we have the representative point of organism in parameters space, each organism has the zone of health, where the parameters correspond the health of concrete man. During illness the representative point of organism is found in another zone of parameters - in illness zone. The process of treatment is the movement of the representative point from illness zone to health zone.

In our example the equation of treatment organism will be

$$(X1 - X10)^2 + (X2 - X11)^2 + (X3 - X12)^2 +$$
$$+ (X4-X13)^2 + (X5 –X14)^2 +$$
$$(X6-X15)^2 + (X7 - X16)^2 + (X8 - X17) +$$
$$+(X9 - X18)^2 = (X19)^2 \qquad (9)$$

where X1,X2, . . ,X9 - characteristics of health organism, X10, X11, . . , X18 - characteristics of illness organism, X19 - the distance between health zone and illness zone. For system (9) we can create the equivalent equations system according to type (2) and can use the arbitrary coefficients for simulation of physician actions. The physician actions must decrease the variable X19 and return the representative point from illness zone to health zone.

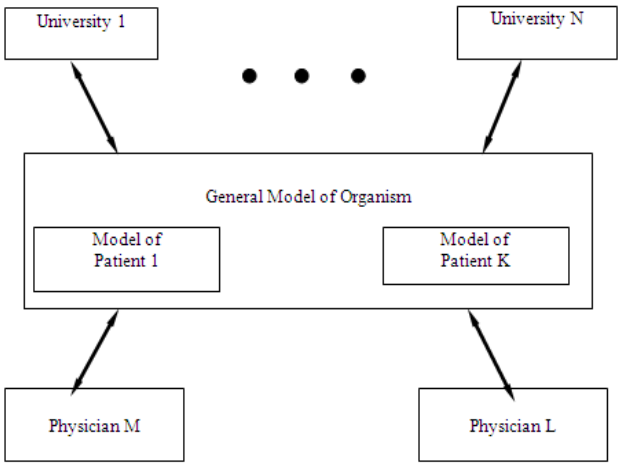

***Fig. 2**. Interaction between scientific organization (University 1,... University N) and General Model of Organism. Interaction between models of particular patients and physicians.*

There is a good experience in creation of the international classification of diseases by means of WHO It is necessary to organize the next step of scientific cooperation to create of general model of organism and to provide the possibilities of each physician to access the general model of organism by means of telecommunications. It is very difficult problem, but successful implementation of it can be based on recent simulation technology advances.

It is necessary to decrease the number of mistakes made by physicians.

4. Maximum Adaptability Phenomenon

The equivalent equations of any system contain arbitrary coefficients, which can be used for controlling it. The control may be internal or external. The behavior of any system with an environment contact will be determined by means of formula (6), which is the main law of cybernetics.

Each organism has a maximum adaptability zone. Table 2 shows the mortality depending on the age as a result of the census in Russia in different times. The minimum of mortality is observed within 10-14 ages in different historical periods. The minimum of mortality is identified with the maximum adaptability. Having passed through the maximum adaptability zone, the organism has got the possibility of reproduction.

***Table 2.** The mortality depending on the age as a result of the census in Russia in different times.*

Years/ages	1896-1897	1958-1959	1969-1970	1978-1980	1982-1983	1984-1985
0 – 4	133,0	11,9	6,9	8,1	7,9	7,7
5 – 9	12,9	1,1	0,7	0,7	0,6	0,6
10 – 14	5,4	0,8	0,6	0,5	0,5	0,5
15 – 19	5,8	1,3	1,0	1,0	1,0	0,9
20 – 24	7,6	1,8	1,6	1,7	1,6	1,5
25 – 29	8,2	2,2	2,2	2,3	2,2	2,0
30 – 34	8,7	2,6	2,8	2,9	2,9	2,8
35 – 39	10,3	3,1	3,7	4,3	3,8	3,6
40 – 44	11,8	4,0	4,7	5,4	5,6	5,7
45 – 49	15,7	5,4	6,0	7,8	7,4	7,3
50 – 54	18,5	7,9	8,7	10,3	10,9	11,3

Fig.3 shows the evolution of system, the cycle of development begins in point 1, passes the maximum of the

arbitrary coefficients number, and finishes in point 2, where the system must have the transformation, forgetting old restrictions, after new cycle begin in point 3 and etc. Maximum adaptability phenomenon makes it possible to explain different cycles in biological and socio-economical systems, for example, Kondratiev cycles and evolutionary cycles. Each enterprise must be within maximum adaptability zone if we would like to retain this enterprise in changes flow. The sustainable development of systems can be only within maximum adaptability zone.

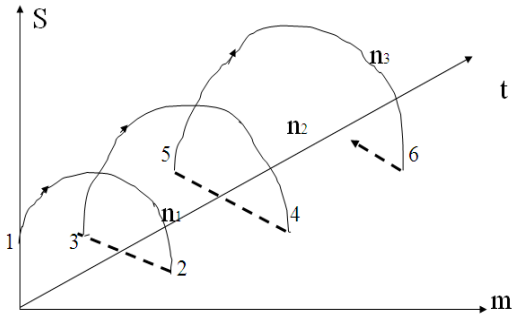

Fig. 3. *Transformation of developing system, n1 < n2 < n3, trajectory of system: 1-2-3-4-5-6-..., dotted lines – creative processes, compact lines – evolutionary processes.*

For retaining the system within maximum adaptability zone, we have the different instruments – increasing the variables number, imposing new restrictions or removing the old ones etc. For example, we can joint different systems in an integral system to increase or decrease the adaptability of systems. So, from the two following systems.

$$\mathrm{S1} = C_{n1}^{m1+1} \text{ and } \mathrm{S2} = C_{n2}^{m2+1} \tag{14}$$

we can joint them in imposing new restrictions, mcol, in view of obtaining the new collective system

$$\mathrm{Scol} = C_{n1+n2}^{m1+m2+mcol} \tag{15}$$

where the adaptability of this new system can be either Scol > S1 + S2 or Scol < S1+ S2 depending upon concrete parameters. We can only see the collective, total effect. By means of these models it is possible to resolve the paradoxes of approaching complexity and global collaboration.

5. Conclusion

From Darwin times a lot of scientists had developed the theory of evolution in connection with the different aspects of animals and plants [1]. In this article the new is the extension of evolution approach to the illness processes of the human organism. These processes are more fast than the evolution processes in tradition theory of evolution [11]. But computers permit to simulate with high speed for the medical decisions making support.

The combinatorial simulation is a universal method for simulation and modeling. With it, it is possible to create a new model in different areas – in physics, chemistry, biology, psychology, etc. It is possible to create the new medical substances [7]. The linguistic basement of the simulation determines the universality of this method: the natural language is the universal sign system and the linguo-combinatorial simulation is thus the simulation method, perhaps, of everything. We have tried to show different levels of models. For reliability, each system must be then within maximum adaptability zone. It is necessary to carry out the verification of these models, but their structure is interesting for understanding complex biological systems.

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