Self-organizing algorithm for pilot modeling the reaction of society to the phenomenon of the Black Swan

Michail Artemenko
Department of Biomedical Engineering
Southwest State University
Kursk, Russia
artem1962@mail.ru

Vladimir Budanov
Department of philosophy and sociology
Southwest state university
Kursk, Russia
budsyn@yandex.ru

Nicoly Korenevskiy
Department of Biomedical Engineering
Southwest State University
Kursk, Russia
kstu-bmi@yandex.ru

Abstract. **The work is devoted to pilot modeling of the reaction of society to technogenic and biological sudden environmental influences. For the description, the methodology of the socio-technical landscape is used, which reflects the development of certain social practices in the digital and technical environments. At the bifurcation points of the evolution of the socio-technical landscape, the phenomena of the "Black Swan" and "Boomerang Blow" arise - a powerful impulse effect on the landscape. There is an urgent problem of predicting reaction reactions. The aim of the work is the development and pilot study of a self-organizing algorithm of structural-parametric identification of transients. Impacts of a technical and biological nature are considered as objects of research: the development of the use of artificial intelligence and computer technology in medicine and the spread of COVID 19. Models for countries: UK, Russia and Uzbekistan are given. It is shown that the reaction of the sociotechnical landscape is acceptable described by homogeneous differential equations of the second degree with a complex exponentially harmonic function on the right side. The most adequate mathematical models are given. This work was supported by the Russian Science Foundation grant # 19-18-00504.**

Keywords: sociotechnical landscape; digital expansion; society reaction; COVID 19; Gartner curves; self-organizing modeling algorithm.

I. Introduction

How does the outside world affect human health, population, society? How does human behavior, which directly depends on his health, transform the world around him - umwelt and umgebung [1]? How do the boomerangs of anthropological impact on the world come back? What reaction can a society have from a "boomerang strike"? What kind of expansion occurs in the sociotechnical landscape (STL) at the same time, I adapt and stabilize its behavior in the environment?

These questions constantly concern Humanity and are reflected in philosophical treatises, beginning with Plato [2, 3, 4]. At certain stages of the development of STL on various hierarchical spatio-temporal strata, cardinal transformations of the world around him arise [5]. The indicated process according to the hypothesis of V. Arshinov and V. G. Budanov is characterized by rhythm cascade manifestations [6].

Consider the following hypothetical concept of co-evolution of society in a living environment. Currently, the evolution of Mankind and the world around it has come (or, as the events of 2019-2020 show, has already entered) to the next bifurcation point [7, 8] with its inherent "shell", in which various fluctuations of future alternative development paths occur [9]. Humanity seeks to conquer and control the planetary and universal Worlds. This is impossible without a measuring and cognitive process [10]. Any measurements, both active and passive observation, are impossible without prior exposure. The human impact on umwelt and umgebung initiates the emergence of two phenomena: "Black Swan" [11, 12] and "Boomerang Blow". The Black Swan phenomenon may or may not occur, and its occurrence is not predictable. A "boomerang strike" occurs in any case if the specific goal of the STL functioning in the conditions of digital and-or natural biological realities is not achieved ("the boomerang has returned"). However, the timing of this event is uncertain. Drawing analogies with the effects on the control system (or object) in terms of cybernetics, we can say that the "black swan" is the Heaviside unit, and "Boomerang Blow" is the Dirac delta function [13]. The phenomenon of "Boomerang Blow" can develop with different strength, power, momentum. At the points of bifurcations of the development of society, the epochs of the change of modes and industrial revolutions and crises [14], the phenomenon under consideration takes on the character of expansion. Since fluctuations, as a rule, are characteristic of strong stresses in the state of society (and / or environment) and are present in a certain small area of the bifurcation point, the expansion of the Man system leads to the "anti expansion" of the Environment system (and vice versa) . Selve G. characterized a similar effect as "stress-distress" [15]. As a protective measure, Man is trying to predict the appearance and development of risk factors for his existence as an element of society, by imitating the consequences of his relationships with the environment.

At present, due to the increase in anthropogenic pressure on the surrounding world, Nature responds with the following types of macro expansion: digital expansion [5, 7] - a response to anthropogenic impact and biological anti expansion that limits the biological pressure of Mankind at a certain stage of time on the planet (there are various "pestilences" - hungry, genetic, painful, "virus attacks", etc.).

Thus, such problems as relevance become: description of the evolution of society in digital reality, research on the development at the initial stage of development of the fourth signaling system [9], modeling the behavior of society in a digital environment and the reaction of society to biological anti-expansion. Scientists working in the field of convergence of the humanities and technical sciences suggest using the methodology of the socio-technical landscape (STL) as a tool [16, 17]. In order to predict the impact of digital reality on STL and the needs (demand) of various digital practices for digital technologies, Gartner was founded, which is engaged in the construction of so-called “Gartner curves” that graphically represent the stages of technological innovation in the course of its life cycle [18, 19, 20]. Analysts of the company found that each stage of the development of new technologies is determined by a certain level of informational "hype". Thus, by analyzing the number and quality of publications, one can predict the consequences of the phenomenon of “Boomerang Blow”.

The main areas of research are as follows: the construction of the Gartner curve and determine the place of computer technology on it at a certain time (usually the present). The main difficulty lies in the implementation of the first direction. Empirical methods for the synthesis of the Gartner curve [20, 21] are mainly used according to the results of monitoring in any “section of the curve” and without information on the temporal nature of the section. The solution of this problem would allow using simulation to carry out high-quality forecasting. This problem has been the subject of much research. For example, in [22] it is proposed to approximate the Gartner curve by a polynomial of the fourth degree, in [23, 24] - the ninth, 11, 12, and even 13 (the choice of degree is not explained in the works). In fact, the approaches proposed by the authors ultimately lead to the construction of the Newton interpolation polynomial, which does not have good prognostic characteristics outside the interpolation interval. In [24, 25], based on an analysis of more than 50 publications, the authors conclude that it is possible to obtain functions that describe the behavior of the Gartner curve by piecewise nonlinear approximation of the functions exp (k · x) and exp (k1 · exp (k1 · x)). Despite the acceptable adequacy of the resulting function within the interpolation interval, its prognostic capabilities (extrapolation) are not high. Errors of the first and second kind often arise at the “switching points” of piecewise nonlinear approximation, significantly complicating the study. In addition, the formulas given by the authors do not take into account the wave factor of the development of computer technologies (for example, Kitchin cycles (from 2 to 4 years) and Jungler (7-12 years) [9, 25, 26]).

In this regard, there is a hypothesis: the cybernetic model of society can be presented as a first approximation in the form of "a black box", the link of the independent managing director of a system characterizing by dynamics equation:

$$A\frac{dx(\mathrm{t})^2}{dt^2}+B\frac{dx(t)}{dt}+C\cdot x(t)=F(\mathrm{s},t)\ , \qquad (1)$$

where: t is time; A, B, C are the parameters that determine the transition process, $x(t)$ is the analyzed indicator of the functioning of the STL, $F(s, t)$ is the generating functional that determines the nature of the transition process depending on the time and state of the system s.

The fact of adequate behavior modeling by the social equation of dynamics of the second degree is noted in [27]. Note that in this case the STL reaction is characterized by three parameters of the dynamics equation, reflecting, possibly, the three-dimensionality of human life. In the theory of automatic control, various versions of the functional $F(s,t)$ are considered that do not take into account possible changes of s during the operation of the STL and, from the semantic point of view, have the following analogues in social psychology and philosophy, for example, as: “Black Swan” - the Heaviside function, “Boomerang strike”, “Lightning”, “Insight” - Dirac delta function, “Gray Swan” - the phenomenon of “Black Swan”, “Spiral Development”, “Rhythmological Cascades” - harmonic free or predicted as a result of the presence of feedback in the system amplitude-frequency modulated, decaying or power-law-enhancing effect (including meanders), “Comet” - “tail strike” - a decaying exponent, “Resonance” - an increasing exponent, etc.

Since STL and the umwelt acting on it possess, on the one hand, clearly expressed synergetic properties [28], and, on the other hand, the rapid formation of corrective and control decisions in the conditions of initial uncertainty and poorly structured information is required, it seems most appropriate to use self-organizing algorithms that allow obtaining adequate models in these conditions [29].

Thus, the aim of this study is to develop and study the results of applying a self-organizing algorithm for pilot modeling the response of a sociotechnical landscape to sudden technogenic and biological effects of umwelt.

Comparison of the reaction patterns of society allows us to predict the nature of expansion and co-evolution of the socio-technical landscape. That is, to dampen the negative consequences of the phenomena of “Boomerang Blow” and “Black Swan” and develop positive ones. For example, using the expansion of digital reality to strengthen the moral capabilities of society, use the expansion of a virus attack to optimally adapt and restructure the structure of society (interpersonal relationships in it, the use of digital technologies in various social practices). Improving the adequacy of the identification of Gartner curve models and the reaction of society to expansion from the environment will allow the design and operation of expert systems for predicting the assessment of the tension of sociotechnical landscapes.

II. Theory and Methodology

We will consider a certain ontology of the socio-technical landscape in the form of some “black box”. As a result of the phenomenon of “Boomerang Impact,” the effect is on STL, the reaction to which is required to be estimated and predicted. Generating functions (causes), it is proposed to classify as:

1. “News” is a purposeful formulated informational impact (characteristic of hybrid and informational wars [30]).

2. Unknown spontaneous effect (“Black Swan”) - expansion, the long-term effect of which leads to co-evolution of STL to the “bifurcation point”.

3. Unknown, synergistic reason.

As part of the implementation of the research objective, two types of the “Boomerang Impact” phenomenon are considered: digital and biological. According to Gartner [23], digital expansion can be represented by curves, representing the “expectations” in the STL of using social practices of certain digital technologies displayed by the media. In order to use evidence-based information as temporary trends of empirical data presented in Google Scholar [9]:

- the number of publications for the social practice of “Medicine” and digital technologies: “information technology”, “artificial intelligence”, “Big Data”, during the years 2000-2019 in Russia and in the World (annual monitoring since 2000) (SPmDTtype where type is the type of technology);

- the number of publications and the involvement of scientists and practitioners on the problem of the spread of COVID 19, according to weekly monitoring data, from December 1 to June 7, 2020 [31] (CovPub);

- daily spread of the incidence in Russia, Uzbekistan and the United Kingdom from early March to late May 2020 (CovRus, CovUzb, CovGB) [32].

Pilot modeling was carried out based on the following provisions:

1) The synergetic control system for STL in real conditions operates with very limited information recorded in the process of explicit or latent monitoring;

2) Since STL is a living system, its evolution is based on the principle of decision making, taking into account the past, present) and the future (auto forecast). (For example, when listening to music, a person feels happiness if the melody coincides with his forecast and corresponds to the internal state [33]. Using the principle of analogies and the methodology of Markov processes, it is proposed to carry out structural-parametric identification of the functional:

$$S(t) = F(S(t-\tau_1), \mathrm{S(t+}\tau_2), \mathrm{t-}\tau_1, t, t+\tau_2), \qquad (2)$$

where: t is time, S(t), $S(t-\tau_1), \mathrm{S(t+}\tau_2)$ is the state of the system at time $t-\tau_1$, $\mathrm{t+}\tau_2$.,. Then, to carry out the forecast, a functional was allocated from (1), on the basis of which a prognostic function was identified: $S(t+\tau_3) = F(S(t-\tau_1), \mathrm{S(t)}, \mathrm{t-}\tau_1, t, t+\tau_3)$, we call this model SPR1 - symmetric retrospective and predictive a first order (SRP1). In the general case $\tau_1 \neq \tau_2 \neq \tau_3$, in the proposed study $\tau_1 = \tau_2 = \tau_3 = 1$.

Note that the values τ_1, τ_2, τ_3 are recommended to be selected on the basis of spectral or autocorrelation analyzes. However, when monitoring social systems, this is difficult to do. Therefore, the method of group accounting of arguments was chosen [29]. Algorithms of the method have synergistic properties and allow for structural and parametric identification on small volumes of data samples. The software tools used by us [35] allow us to build models that approximate the Kolmogorov-Gabor polynomials and terms with multiple harmonics. The proposed approach is fundamentally different from the classical one used in identifying predicative functions — linear or nonlinear filtering [33]:

$$S(t+\tau_2) = F(S(t-\tau_1), \mathrm{S(t)}, \mathrm{t-}\tau_1, t, t+\tau_2). \qquad (3)$$

Thus, the proposed methodology allows us to evaluate the response of the system to the impact, considering STL as a “living creature” that makes a decision about its action on the basis of the current state, past experience and the “happened” future (occurred on the basis of a decision made earlier and future circumstances)

3) During the monitoring process, the control system or the “decision maker”, with a high degree of probability, does not have accurate information on which part of the Gartner curve (or other transient process) values are recorded. The closer the monitoring is to the beginning and the shorter the registration time, the greater the uncertainty and the greater the risk of making the wrong, inadequate decision.

The following materials were used as factual material:

- To assess the response of STL to the expansion of digital reality, the results of the annual monitoring of the dynamics of publications in Google Scholar (2000 - 2019) were used;

- to assess the response of STL as a biological object, the results of daily monitoring of the distribution of COVID19 in Russia (Moscow), Uzbekistan and the UK were used. The choice of countries was determined by significant differences, namely: Great Britain - an island state, Moscow and Uzbekistan - representatives of continental countries; population densities differ significantly: Moscow - 9600 people/km^2, Uzbekistan - 73 people/km^2, Great Britain – 270 people/km^2 [36].

The following models were identified and analyzed (symbols in parentheses are indicated):
- polynominal dependence on time: parabola, the fourth and sixth degrees (Pol2, Pol4, Pol6); exponential (Exp); exponential and harmonious (ExpGarm):

$$x(t)=C_0+\Sigma(C_{1}\cdot exp(k_i\cdot t)\cdot sin(w_i\cdot t+\phi_i)) : \qquad (4)$$

- exponential and harmonious absolute (ExpGarmA):

$$x(t)=C_0+\Sigma(C_{1}\cdot exp(k_i\cdot t)\cdot /sin(w_i\cdot t+\phi_i)/) : (5);$$

- bell harmonic function (Exp2Garm):

$$x(t)=C_0+\Sigma(C_{1}\cdot exp(k_i\cdot t^2)\cdot sin(w_i\cdot t+\phi_i)) : \qquad (6)$$

- bell - absolutely harmonic function (Exp2GarmA):

$$x(t)=C_0+\Sigma(C_{1}\cdot exp(k_i\cdot t^2)\cdot /sin(w_i\cdot t+\phi_i)/) : \qquad (7);$$

- equations of dynamics (EqDim): in an operator form

$$T^2p+2sTp+1=0 : \quad (8),$$

- formula (2) (SRP1).

The monitoring results were divided into two subsamples - training and examination. At the first, structural and parametric identification of models was carried out; on the second, the quality of the constructed models was monitored by exceeding the value of the determination criterion R^2 of the threshold level corresponding to $p = 0.01$ [37].

A pilot simulation of the STL reaction to the influence of umwelt and-or umbergebung was carried out according to the following self-organizing algorithm.

P1. The analyzed indicator is determined, which reflects the reaction of STL, *IPR*.

P2. The IPR registration area (space, time, minimum volume of multiple values, IPR scale) is determined.

P3. A fashion designer - researcher (expert) carries out a visual analysis of the dynamics of the indicator under study for sufficient variability and the absence of artifacts and "gaps" for further analysis. Depending on the conclusions made, one of the decisions is made: "return to P1", "return to P2", "transition to P4" (structural-parametric identification of models), "termination of research".

P4. By results of a research and monitoring the set of values is forme $dIPR_N$, which is divided into two subsets – training $IPRu_{N1}$ and examination $IPRe_{N2}$ subsamples: $N1+N2 \leq N$, $IPRu_{N1} \cup IPRe_{N2} = IPR_N$. (According to recommendations [38] the principle of "golden ratio" is observed: N2/N1=N1/N is also assumed that $IPRu_{N1} \cap IPRe_{N2} \neq 0$). Separation is carried out by randomization with the provision of mutual representativeness of distribution laws. The set of IPR_N includes three vectors: $x(t)$, $dx(t)$ and $sx(t)$ –where, $x(t)$ is the fixed value of the *IPR* indicator, $dx(t)$ is the absolute change in the indicator $dx(t + 1) = x(t +1) - x(t)$, $sx(t)$ is the relative change $sx(t + 1) = dx(t + 1) / x(t)$.

P5. On the training subsample of $IPRu_{N1}$ models are identified: Pol2, Pol4, Pol6, Exp, ExpGarm, ExpGarmA, Exp2Garm, Exp2GarmA, EqDim, SRP1.

P6. On examination subsample of $IPRu_{N1}$ for each of the identified models the value of criterion of determination R^2 is estimated.

P7. The level of exceeding the value of the criterion for determining a certain threshold and-or attracting the opinions of experts assesses the acceptability of using models for analysis and forecasting. In the case of an unsatisfactory result, the transition to P3. In the case of a positive result, we go to P7, the model description.

P8. A tuple of the most acceptable models is formed (as the determination criterion obtained on the full set of IPR_N decreases).

P9. Based on the obtained models, a reaction analysis and a forecast are carried out.

P10. A hypothesis is being formed about the structure of a universal, convergent model, for which the identified models are a special case. (This stage is carried out with the aim of creating the methodological base of "universal modeling" and is carried out if necessary).

Self-organizing principles are as follows: different criteria are used for teaching and examination training under samples; during structural-parametric identification (P5 of the algorithm), software is used that supports the functioning of GMDH algorithms; as new information arrives, the forecast and the "new reality" are compared, based on which the parameters of the obtained models are adapted or the algorithm is re-applied.

III. Results of Research and Discussion

The following indicators of the STL reaction to the Boomerang Phenomenon were analyzed: "interest" in the "Medicine - digital technologists" cluster, publications on the subject of COVID 19, development of the COVID 19 pandemic in Russia (Moscow), Uzbekistan and the United Kingdom. Thus, according to P1 of modeling the dynamics of the STL reaction (generating Gartner curves) to digital and biological "boomerangs", IPR indicators are formed: SPmAIw (artificial intelligence in the World of Medicine), CovRus, CovGB, CovUz, CovPub - temporary trends in volumes: for Gartner curves - 20 values (annual monitoring of publications on Google Scholar from 2000 to 2019), for interests on the problems of COVID distribution 19 - 27 values of weekly monitoring of publications in the world, for the spread of morbidity in Russia (Moscow) - daily infections for 65 days, in Uzbekistan - in 58 days, and in the UK in 75 days. In order to determine the need and the possibility of further research according to P3 of the proposed algorithm, we carry out a visual analysis. For example, using the method of sociotechnical landscape modeling, a fragment of STL was obtained, which is shown in Fig. 1 [9].

Fig. 1 shows: a fragment of the temporal observability of STL on the social practice of "medicine" in the digital technologies "Artificial Intelligence", "Information Technologies" and "Big data" for 2019, the dynamics of publications on "digital medicine" (left) for 2000-2019 years, the dynamics of publications on digital technologies (above) and the dynamics of publications on joint publications "practice-technology" (a thin line shows the forecast for two years). The indicators *Ds* and *Sd* reflect the feasibility in social practice *i* of digital technology *j* ($Sd_{i.j}$) and the demand for digital technology *j* by social practice *i* ($Ds_{i,j}$), are calculated according to the methodology presented in [9].

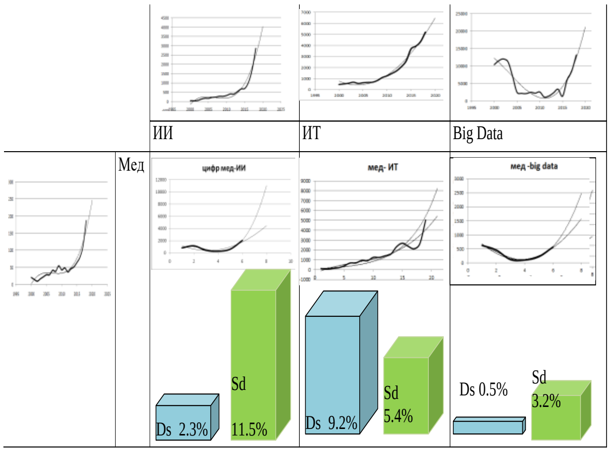
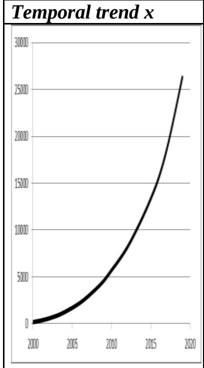
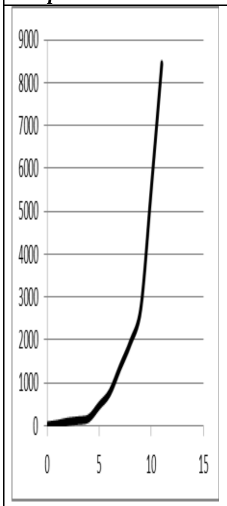


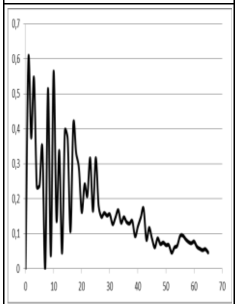
Fig. 1. STL response indicators to digital expansion in social medicine practice (fragment)

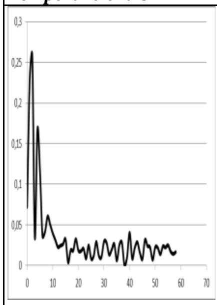
The behavior of the analyzed indicators is shown in the graphs in the first column of table 1. In the table: R^2_2, R^2_4, R^2_6 are the determination coefficients for approximating polynomials of the 2nd, 4th, and 6th degrees, respectively; k is the exponent *exp(kt)*; *P* is the period; w and φ — frequency and phase, model parameters (4) - (7); *T, s* are model parameters (8); SPR1 was represented as a first approximation of model (2) in the form $S(t+1) = F(S(t-1), S(t))$ (*F* is a linear function of two arguments). The threshold values of the determination coefficients were determined at the level of statistical significance *p <0.01* and amounted, respectively: for the Gartner curves R2por = 0.43, for publications on the problems of COVID 19 *R2por = 0.28*, for the spread of the disease - *R2por = 0.08*. Based on visual observation, sufficient time variability and the possible membership of future models in the set considered in the algorithm are ascertained. We decide on the transition to the P4 algorithm.

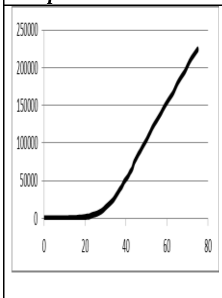
Table 1 The simulation results of the phenomenon of “Boomerang Impact” (fragment)

SPmAIw				
Temporal trend x	***Pol2,4,6***	***Exp***	***SRP1***	***expGarm***
	R^2_2=0,99 R^2_4=0,9998 R^2_6=0,9999	R^2=0,995 k=0,23	R^2=0,999	R^2= 0,99 k= 0,23 w=0,11 P=57 year φ=0.06
	ExpGarmA	***Exp2 Garm***	***Exp2 GarmA***	***EqDim***
	R^2=0.995 k= 0.23 w=0.11 φ=0.03 P=28 year	R^2= 0.01 k= 0.01 w=0.27 P=23year φ=4.6	R^2= 0.1 k=0.01 w= 0.27 φ= 0 P=28year	R^2= 0.9 T=3.53 s= -1.224 k=0.08 w=0

CovPub				
Temporal trend x	***Pol2,4,6***	***Exp***	***SRP1***	***expGarm***
	R^2_2=0,99 R^2_4=0,9998 R^2_6=0,9999	R^2=0,995 k=0,23	R^2=0,98	*R^2= 0,15 k= 0,38 w=0,52 P=12 weeks φ=0.48*
	ExpGarmA	***Exp2 Garm***	***Exp2 GarmA***	***EqDim***
	R^2=0.18 k= 0.38 w=0.52 φ=0.48 P=6 weeks	There is no model	There is no model	R^2= 0.69 T=0,403 s= -0,112 k=0.27 w=2,46 P=14 weeks φ=0,11
	R^2=0.98 k= -0.05 w=1,1 φ=6,1 P=3 weeks	R There is no model	There is no model	*R^2= 0.1 T=0.049 s= 5,32 k= -109 w=0*

CovRus (Moscov)				
Temporal trend sx	***Pol2,4,6***	***Exp***	***SRP1***	***expGarm***
	R^2_2=0,51 R^2_4=0,52 R^2_6=0,57	R^2=0,21 k=-0.03	R^2=0,96	*R^2= 0,02 k= -0.03 w=1.12 P=6 days φ=3.7*
	ExpGarmA	Exp2 Garm	Exp2 GarmA	EqDim
	R^2=0.21 k= -0.03 w=1.12 φ=3.7 P=3 days	R^2= 0.01 k= -0.0004 w=0.89 P=7 days φ=1.15	R^2=0.08 k=-.0004 w=0.89 φ=1.15 P=3 days	R^2= 0.13 T=1.74 s= 1.73 k= -0.995 w=0

CovUz				
Temporal trend sx	***Pol2,4,6***	***Exp***	***SRP1***	***expGarm***
	R^2_2=0,99 R^2_4=0,999 R^2_6=0,9995	R^2=0,94 k=-0.0258	R^2=0,47	*R^2= 0,02 k= -0.0258 w=1.01 P=6 days φ=3.7*
	ExpGarmA	*Exp2 Garm*	*Exp2 GarmA*	EqDim
	R^2=0.21 k= -0.0258 w=1.01 w=1,04 P=3 days φ=3.7	*R^2=0.04 k= -0.003 w=1.76 φ=4,247*	*R^2=0.06 k= -0.003 w=1.76 P=2 days φ=4,247*	R^2= 0.999 T=1.5 s= 1.2 k= -0.785 w=0

CovGb				
Temporal trend x	***Pol2,4,6***	***Exp***	***SRP1***	***expGarm***
	R^2_2=0,991 R^2_4=0,998 R^2_6=0,9998	R^2=0,88 k=0,124	R^2=0,999	*R^2= 0,07 k= 0,124 w=0,25 P=26 days φ=1.4*
	ExpGarmA	Exp2 Garm	Exp2 GarmA	EqDim
	R^2= 0,19 k= 0,124 w=0,25 φ=1.4 P=13 days	R^2= 0,1 k= 0,0014 w=0,19 P=3 days φ=0.08	R^2= 0,16 k=0,001 w=0,19 P=2 days φ=0.62	R^2= 0,81 T=18.2 s= -1.54 k=0,085 w=0

In italics in table 1, statistically insignificant models are highlighted (p>0.01).

Let's carry out the analysis of results of a pilot research.

1) The required level of adequacy ($p \leq 0.01$) corresponds to 115 out of 150 models (77%): for SPmAIw models - 98%, CovPub, CovUz - 67%, CovRus - 80%, CovGb - 74%. Thus, the presented algorithm makes it possible to obtain, by various methods, a multitude of adequate models, which make it possible to obtain a result acceptable enough for further research.

2) The polynomial models Pol2, Pol4, Pol6, SPR1 for “Tempotal trend x” for all considered indicators had the greatest adequacy in the test samples. An exception was observed for SPR1 for indicators CovRus and CovUz. In the UK, there is a decrease in the adequacy of the model of this indicator within the threshold level. This may be due to the following. In this case, two biological entities “collide”, each of which has its own autoregulation mechanism - a population of people and a new coronovirus, whose behavior is very poorly predicted by people.

3) Exponential models of the "bell" type (*exp* ($k \cdot t^2$) showed less adequacy in all cases considered and are not recommended for use as prognostic at the early stages of analysis.

4) When analyzing Gartner curves (CovPub and SPmAIw processes), it is preferable to use models of the EqDim type. Note that they correspond to the transfer functions of the vibrational links. This is confirmed by the revealed cycles in STL [9, 39]. When analyzing the response of STL to a viral attack, such models were less adequate than the rest. The exception was models: daily absolute and relative growth rates of Covid19 cases in Uzbekistan and the total number of cases in the UK. Perhaps this is due to a lower population density than in Russia (Moscow).

5) The obtained models suggest the cyclic components in the process under consideration: the demand for artificial intelligence systems in medicine SPmIw 9-12-28 years; for scientific and practical publications on the problems of a new coronovirus infection - 3-6-12-14 weeks (in the first half of 2020); for the spread of diseases in countries: CoVRus - 7-16-16 days, CovUz - 6-15-30 days and CovCb 3-6 - 18 days (this does not contradict the findings of the virologist [40]). Therefore, the cyclical distribution can be estimated as (6-7) - (12-15) - (27-30) days.

In general, for the processes under consideration, the most appropriate should be considered not so much the parabolic functions that are characteristic of the early stage of registration, but how to solve the differential equations:

- for Gartner's curves:

$$3{,}5\frac{d^2x(\mathrm{t})}{dt^2} - 8{,}6\frac{dx(t)}{dt} + x(t) = e^{0{,}23 \cdot t} \cdot \sin(0{,}11 \cdot t + 0{,}03);$$

- for dynamics of "interest" (publications) on subject of COVID 19:

$$0{,}4\frac{d^2x(\mathrm{t})}{dt^2} - 0{,}09\frac{dx(t)}{dt} + x(t) = e^{0{,}38 \cdot t} \cdot \sin(0{,}52 \cdot t + 0.48);$$

- on distribution of COVID 19: In Russia (Moscow):

$$1{,}74\frac{d^2(sx(\mathrm{t})}{dt^2} + 6\frac{d(sx(t)}{dt} + sx(t) = e^{-0{,}03 \cdot t} \cdot \left|\sin(1{,}12 \cdot t + 3{,}7)\right|;$$

In Great Britain:

$$18{,}2\frac{d^2x(\mathrm{t})}{dt^2} - 56\frac{dx(t)}{dt} + x(t) = e^{0{,}124 \cdot t} \cdot \sin(0{,}25 \cdot t + 1{,}4);$$

In Uzbekistan:

$$1{,}5\frac{d^2(sx(\mathrm{t})}{dt^2} + 3{,}6\frac{d(sx(t)}{dt} + sx(t) = e^{-0{,}03 \cdot t}\left|\sin(1{,}04 \cdot t + 3{,}7)\right|.$$

This suggests the following universal model, the considered models of which are a special case:

$$a\frac{d^2z(\mathrm{t})}{dt^2} - b\frac{dz(t)}{dt} + z(t) = e^{k \cdot t \cdot |\sin(\omega_1 \cdot t + \varphi_1)|} \cdot (c \cdot \sin(\omega_2 \cdot t) + d \cdot \cos(\omega_2 \cdot t)) + l \cdot t, \quad (9)$$

where: *z(t)* is the analyzed indicator; $a, b, c, d, k, l, \omega 1, \omega 2, \varphi 1, \varphi 2$ - model parameters (coefficients, frequencies, phases).

Note that formula (13) reflects the development of the process along a “pyramidal” or “whirlpool” type spiral in three times: *t* is “world time”, *T1= w1*t* is the amplitude time of the exponential harmonization of the “spiral rise” and *T2 = w2·t* is the time of the spiral cycle (in the general case, the ratio of the parameters c and d of the model (13) determine the form of the ellipse - the “base” of the spiral).

IV. Conclusions

The proposed self-organizing algorithm makes it possible to obtain adequate mathematical models for small amounts of empirical information monitoring the reaction of the socio-technical landscape to the “Boomerang Phenomenon”, which consists in a sudden but predictable response of the immediate environment, expressed in technical and biological expansion. In the process of functioning by the algorithm, synthesis and ranking of linear, power, exponential and harmonic prognostic models is carried out, considering the behavior of STL from cybernetic positions. For the first time, models were obtained that reflect the trend of world interest in the development of artificial intelligence in medical social practice, scientific and practical work in the field of combating the COVID 19 pandemic, the spread of the disease caused by a new coronovirus infection in Russia, Uzbekistan and the UK. It is shown that the algorithm allows obtaining acceptable results by performing structural-parametric identification of solutions of a homogeneous second-order differential equation with generating functions on the right side of the equation in the form of a complex exponentially harmonic function (the parameters of the function are determined by small amounts of recorded data by the methods of group accounting of arguments).

V. ACKNOWLEDGEMENT

The research is financed by the Russian Science Foundation, project #19-18-00504 “Sociotechnical environment of digital reality: ontological matrices, ethical and axiological regulative structures, roadmaps, and information support for management decision-making”.

[1] O. V. Letov, “Some Philosophical Problems of Biology and Medicine,”.Social and human sciences.Domestic and foreign literature.Ser.3, Philosophy: Review Journal, #4, pp. 60-68 . 2019.

[2] J. Radkau,”Nature and power. World Environment History. Litres,” 2019.

[3] P. State, “Plato. Collected works in,” 2019

[4] Anthony Sulez,"Wittgenstein face au platonisme de la signification: le tournant anthropologique vers une philosophie de la praxis."Philosophical Journal, vol 12(4), pp. 13-52, 2019.

[5] M.V. Artemenko, A.V. Mayakova, , “Management of social problems of the expansion of modern digital reality: philosophical, methodological and technical aspects, ”News of Southwestern State University Series: Economics. Sociology. Management, 9(4), pp. 216-223. 2019

[6] V.G. Budanov, “Rhythmocascades of history and the forecast of the development of socio-psychological archetypes of Russia until 2050,”Synergetic paradigm. Social synergetics. M.: Progress-Tradition, pp. 234-263. 2009

[7] V. G. Budanov, E.G. Kamensky, V.I. Arshinov, I.A. Aseeva, “Sociotechnical landscape in the context of digitalization: the problem of the concept and research methodology,“ News of Southwestern State University. Series: Economics. Sociology. Management, vol. 9(3), pp. 213-225. 2019

[8] G.G. Malinetskiy, "Digital reality at the bifurcation point and the strategic tasks of the Union State in the context of the humanitarian and technological revolution. "Designing the future. Digital reality problems (February 7–8, 2019, Moscow) .– M.: IPM im. MV Keldysh, pp. 12-28.2019

[9] 9.V.I. Arshinov, M.V. Artemenko, I.A. Aseeva I.A. et al., ”Sociotechnical landscape of digital reality: philosophical and methodological concept, ontological matrices, expert empirical verification”, Kursk, 232 p. 2019

[10] S.V. Prokopchina, “The modern theory of measurements: classification of types of measurements,” Soft Measurements and Computations, (1), pp. 4-16. 2017

[11] G.G. Malinetskii, “The risks of digital reality. Designing the future. Problems of Digital Reality, (1), pp. 228-249.2019

[12] Nassim Nicholas Taleb, “Skin in the Game. Hidden Asymmetries in Daily Life,” Penguin Group. 2019

[13] D. P. Kim, “Theory of automatic control. Multidimensional, nonlinear, optimal and adaptive systems,” 2017

[14] I. Wallerstein, “ World-Systems Analysis: An Introduction,” Duraham and London: Duke University Press, 110 p. 2004

[15] G. Selye, “Stress without distress,’Journal of Neurology iм. BM Man'kovsky, vol. 1, pp. 78-89. 2016

[16] A.A. Kostyaeva,A.A. Sushkova, I.P. Dashkevich, “ Stress in the daily life of the modern society,”In All-Russian Conference of Young Researchers "Social and Humanitarian Problems of Education and Professional Self-Realization" Social Engineer-2018".pp. 177-180.2018

[17] V.I. Arshinov, V.G. Budanov, “Ontologies and risks of digital technology: on the issue of representing the sociotechnical landscape. Complexity. Mind. Postclassics,“ 2019

[18] .N.A. Korenevsky, M.V. Artemenko, S.N. Rodionova, “Socio-technical landscape: soft mapping on the base coordinates of ontological matrices of social practices and digital technologies,”Complexity.Mind. Postclassics , (3). 2019

[19] V.N. Kononov, E.S. Zambrzycka, M.V. Kharchenko, “The life cycle of industrial technology as an object of modeling and management, ”Journal of new economy, vol. 19(3). 2018

[20] A.I. Pozmogov, “Digital transformation of the industrial complex of Russia, ”Management Issues, vol. 3 (39), pp. 149-154. 2019

[21] 21. Information portal Gartner. URL: http://www.gartner.com/technology/research/methodologies/hypecycle.jsp

[22] X. Chen, T. Han, “Disruptive Technology Forecasting Based on Gartner Hype Cycle,” In 2019 IEEE Technology & Engineering Management Conference (TEMSCON) pp. 1-6. IEEE. 2019

[23] F. Gartner, U.S. Patent Application # 14/840,535. 2015

[24] H. Sasaki, “Simulating hype cycle curves with mathematical functions: some examples of high-tech trends in Japan, ”International Journal of Managing Information Technology, vol. 2(7), pp. 1-12. 2015

[25] .L.E. Grinin, A.V. Korotaev, “Cycles, crises, traps of the modern World-System: A study of the Kondratieff, Juglar and secular cycles, global crises, Malthusian and post-Malthusian traps,” 2019.

[26] E.V. Balatsky, “General theory of social development and coercion cycles. Social sciences and modernity,” (5), pp. 156-174. 2019.

[27] G.G. Malinetskiy, "The mathematical foundations of synergetics." 2005

[28] H. Haken, “Synergetics: Introduction and advanced topics,” Springer Science & Business Media, 2013

[29] GMDH [Online], [Retrieved October 15, 2019], http://gmdh.net/.

[30] D. Schweitzer, S. Fulton, “A hybrid approach to teaching information warfare,” In International Conference on Cyber Warfare and Security (p. 299). Academic Conferences International Limited. April, 2010l

[31] Alexa. An Amazon company // URL:https://www.alexa.com/siteinfo/wildberries.ru#trafficstats

[32] Coronavirus: statistics on the countries.URL: https://index.minfin.com.ua/reference/coronavirus/geography/

[33] P.N. Juslin, “Emotional reactions to music,” The Oxford Handbookd of Music Psychology, pp. 197-213. 2016

[34] V. Labunets, E. Osthaimer, “Systematic approach to nonlinear filtering associated with aggregation operators. Part 1. SISO-filters,” Procedia engineering, vol. 201, pp. 372-384. 2017

[35] M.V. Artemenko, A.A. Krasnopivtsev, “Decomposition of a signal on not multiple harmonics: the certificate about ofitsa. registration of computer program,” # 2006610038 of Russia of Federation it is registered in the register of the computer programs on February 28, 2006.

[36] “Countries of the world: indicators,” URL: https://ru.countries.world/

[37] P.A.A. Resende, C.C.Y Dorea, “Model identification using the efficient determination criterion,” Journal of Multivariate Analysis, vol.150, pp. 229-244. 2016

[38] M.V. Artemenko, T.A. Dronova, N.M. Kalugina, A.A. Boytsov, A.A. “The use of system organization indicators in the automation of the diagnostic and therapeutic process,” News of the Southwest state university. Management series. Computer facilities. Informatics. Medical instrument making, vol. 7, #2(23), pp.123-136. 2017

[39] M. Artemenko, N. Korenevsky, “Pilot Study of Representation and Simulation of Differential Ontologies and Basic Principles of Temporal Observability of Evolution of Digital Reality of Social-Technical Landscapes,” Vision 2025: Education Excellence and Management of Innovations hrough Sustainable Economic Competitive Advantage. Proceedings of the 34th International Business Information Management Association Conference IBIMA). 13-14 November. Madrid, Spain, 2019

[40] A.B. Gussow, N. Auslander, Y.I. Wolf, E.V. Koonin, ‘Prediction of the virus incubation period for COVID-19 and future outbreaks,” bioRxiv. 2020.