SYNERGY BASED APPROACH TO SOCIAL SYSTEMS MODELING

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Summary

The global social problems cannot be solved without system approach, such as living systems analysis, autopoiesis, sociocybernetics, synergetics and complexity theory. Society of any level represents an open system interactive with the environment. The role of system sciences is more and more determined in the viewpoint of modeling and management of society, as the most complex chaotic system. This paper is consecrated to the new concept for a formal description of the society complexity with respect to the viewpoint of modeling social behavior, that is conditioned by the existence of a human being as of nonlinear and fuzzy factor, respectively with very high degree of freedom of behavior. The state of human society as a system is described by the different degree of dissatisfaction or satisfaction with the social, political and economical rules. Originality of this work is in the description of society in a form of multi-agent system, where every interaction between any social agents provokes redistribution of synergy-entropy, its balance and fitness in whole. Behavioral diversity of the society is conditioned by social homeostasis and heterostasis. In the given context, the criterion of society security is associated with stability, and in biological viewpoint with the idea of homeostasis or fitness-function.

Keywords: Social entropy. Synergy. Complexity. Stability. Homeostasis. Heterostasis.

1. Introduction

The modern world is like a machine with its wheels revolving at various speeds and to different directions. Hence such machine is unstable and does not develop. The analysis of the world history shows that the most complicated path, passed by the mankind, at each stage of its development until today, is full of with antagonism of interests and struggle. All kinds of the up-to-date existing antagonism and conflicts (particularly in recent years after system reconstruction of the world political geography), demographic disbalance or other problems are closely connected with inequality of economical levels and with sharp difference of being and consciousness that always create tensions. Each mentioned disbalance or desynchronization is the most important risk-factor of international destabilization. In spite of this, the development of international economical contacts does push the world going to modern, open, democratic society from confrontation to cooperation. All the same the problem cannot be solved without system approach, such as living systems analysis, sociocybernetics, synergetic and complexity theory [1]. The role of system sciences is more and more determined in the viewpoint of modeling and management of society, as the most complex chaotic system. Contemporary systems models are more likely to be nonequilibrium models emphasizing the concept of entropy.

2. System as such

Entropy, Order, Disorder. Let us briefly outline some touches to the development. All the system use relate to groups of related entities. Any change or evolution of the system can be described as a transition from one state to another one, which is closely related with the changing of entropy. In thermodynamics, entropy is often associated with the amount of order, disorder, and/or chaos in a thermodynamic system. A property frequently used to characterize development is an increase or decrease of order (disorder) which intuitive notion is to identify it with the entropy [2].

The "disorder" and hence the entropy associated with the number of system states as the degree of freedom. On the other hand, we can distinguish also two modes of the dynamics: epistemological i.e. on the same level (because of cluster entropy minimization) and hierarchic (through the evolutionary processing, when the overall system complexity, hence degree of freedom and entropy increase). Any action in characterized by changes (increasing or decreasing) of entropy. It has led to the development of a number of models using entropy, including Shannon information theory, synergetic, and complexity theory. As regards to synergy (also called synergic/synergistic science or synergetic), it means that wholes have properties (functional effects) different than those of the parts. Without synergy, there is no complexity, no adaptation, no self-organization and no life.

Complexity. Diversity. Development. Any system degree of development can be defined as a function of complexity including diversity. In general usage, complex systems tend to be high-dimensional, non-linear and hard to model. Structurally sustainable development represents the treelike structurogenesis of system fractals (or clusters) i.e. the hierarchy of epistemological levels, every level of which corresponds to the degree of system dimension. As the more complex the system is or has a multilevel structure the more developed it is. Therefore system development distinguish as ascending process in hierarchy when transition to the upper level occurs only after the formation of the lower level. And finally, developing of system can be considered by the sign of entropy differential. Consequently the evolution is determined as negative differential of entropy.

3. Self-organization based on synergy

Self-Organizing as optimization processes. If we consider any complex system as multiple interacting agents can be associated with its complexity, which one corresponds to the degree of system dimension and diversity of objects from viewpoint of modeling. Structurally multi-agent system represents the hierarchy of epistemological levels, every level of which corresponds to the degree of system dimension and complexity. So

sustainability of development as system complexity is the function of diversity (functionality) and dimensionality.

The algorithmic complexity consists in high heterogeneity of multi-agent systems. In this section we generalized present an algorithmic simulation of a natural multi-agent systems behavior. Our analysis shows, that the process of attraction and repulsion between agents can be described by nonlinear increasing or decreasing of synergy. Self-organization occurs in series: *leader kernel → matrix of clusters → chain reaction*, when for every synapses entropy converts into synergy and vice versa, when breaking up synergy converts into entropy. This process is comprising the two phases: before and after point of criticality when the self-organization begins.

Synergy-based modeling approach. Every system is characterized by a *structure, composition and state*. The state of a system is described by the different degree of incompatibility. Any scale the social processes are characterized by acute confrontational background, therefore often proceeding on sub-critical limit of disbalance. In this paper, on the basis of aforementioned preliminary studies and our current work with biological and social processes we formulate a new approach, which is based on an fuzzy entropy minimization of system.

We can consider this phenomenon as clustering. Every synapse or interaction between any two (or more) clusters recursively form the new entity i.e. the new united cluster, which has mutually modified or provoked redistribution of synergy-entropy, its balance and fitness (homeostasis). Creation occurs when entropy converts into synergy and vice versa, when breaking up synergy converts into entropy. Clustering processes generally can be realized in the following sequence: *Confrontation → Cooperation → Consolidation.*

These are the destructive (antagonistic) and beneficial (cooperative) interaction forms. The very essence of any synergistic behavior is that the two parts both benefit, and in larger systems all participants should benefit. In each given case the realization of the following versions of optimization is possible by criterion of the stability maximization.

4. Society as a system

This section focuses on the new approach for a description of the social dynamics with respect to the viewpoint of modeling, that is conditioned by the existence of nonlinear environmental factors. Nature provides infinitely many examples of emergence and evolutional development.

One of the evident examples is biological organisms evolution, when perfect organism were formed from unicellular microorganisms. The first cells were antagonistic to each other due to the self survival instinct. But in the struggle for existence the weak homeostasis failed to save them. As a result unicellular colonies appeared in the evolution process. They created, so called, population having collective homeostasis in the case of interest coincidence on the bases of the social heterostasis. When the stability of the system can not be restored, then it applies for external help. Only those species survived which could adapt, overcome egoistic instincts and formed social heterostasis. In the given context, the criterion of the society security is associated with stability, and in biological viewpoint with the idea of homeostasis or fitness-function [3].

This example may appear too specific to support our argument. Nevertheless collective behavior of agents or clusters in different environmental conditions can be formalized for modeling of evolutional developing systems.

Structurally human civilization represents the treelike structurogenesis of social fractals (or clusters) i.e. the hierarchy of epistemological levels, every level of which corresponds to the degree of system dimension. At the same time, at any level society may be considered just in two aspects: horizontal (epistemological) and vertical (hierarchic). As the more complex the system is or has a multilevel structure the more developed it is. Society evolution (sociobuilding recursive process) in general represents ascending process in hierarchy when transition to the upper level occurs only after the formation of the lower level [4].

In historical viewpoint the development or building of society is realized in the following sequence:

Family → clan → commune → tribe → town-state → ethnos →nation→…→ state → empire or super-state → block of states → …→unified civilization→…

And we can see that, the fractal structure of the society becomes complex from lower beneath to the top, from human being to human civilization. At the end the evolution cycle, by global homeostasis of civilization, the formation into unified civilization is evident. Any level society can generally be represented in the form of the following scheme where macro-level society is considered as social environment which affects the society of the given micro-level.

Even in this case, antagonism existing between macro (super dominant) and micro-level (subdominant) subjects can be described in the form of axon-dendrite synapses or hierarchic interactive model. Double-level system stability can be represented in the following form: stability of macro-level and respectively, of the whole system, is conditioned by micro-level stability as well as by hierarchic interactive stability.

The analysis of historical processes shows that, with hierarchical antagonism there is either dictatorship or anarchy. If more power is concentrated in any group then the disbalance formed conditions the wrong development of society. But if there is democracy i.e. synergic balance, then antagonism ceases and necessity of

social heterostasis appears. Transition to a new stage will not occur without consolidation, because disbalance accumulation reaches crucial limit and the system demolishes. That is why all empires and all systems united by force sooner or later get destroyed. Where the social entropy accumulates to such an extent then a small perturbation provokes the social cataclysm. Any political system that permanently violates the social, political and economical rules of a country, contributes itself to increase its social entropy, it forces itself to its end [5].

Building a model of society based upon physical forces between atoms, or cellular physical and chemical interactions, would be quite difficult. Even constructing a model based upon social interactions is too difficult. If we consider society as an interactive, multi-agent, heterogeneous chaotic system of a multidimensional, complicated hierarchic structure, then its modeling is a very complicated problem. This is conditioned by the existence of a human being as nonlinear and fuzzy factor, respectively with very high degree of freedom of behavior. Human Social Entropy is equivalent to the degree of social disorder, of certain social, economic, or political system.

Society of any level represents an open system interactive with the environment.

5. Social Behavior

On the global scale the modern world political processes are characterized by acute confrontational background, therefore often proceeding on sub-critical limit of disbalance. The so called “strong” social cluster (state or block of states) try to widen by oppression of clusters with “weak homeostasis” and strive for world hegemony getting a new global but disbalanced cluster. On their part, the small clusters try to seek external assistance as social heterostasis, for strengthening own homeostasis, for survival of original culture. Three forms of society behavior are determined [6]:

Confrontation caused by antagonism of interests between subjects. *Cooperation* or collaboration (low degree of heterostasis) conditioned by coincidence of interests between subjects in case of internal antagonism. *Consolidation* or harmonious coexistence (high degree of heterostasis) which is conditioned by coincidence of interests between subjects without any internal antagonism. This is an ideal case of social state. These are the destructive (antagonistic) and beneficial (cooperative) interaction forms . The very essence of any synergistic behavior is that the two parts both benefit, and in larger systems all participants should benefit. In each given case the realization of the following versions of optimization is possible by criterion of the stability maximization. There are three modes of optimization:

Self-regulation: in case of the constant topological structure and composition, only the weight coefficients of terminals get varied;

self-tuning: in case of the constant composition, the structure and the weight coefficients terminals get varied;

self-organization: the topological structure, composition and weight coefficients of terminals get varied. The latter is in correspondence with the case of collective heterostasis.

With the viewpoint of optimization it may be convenient to use artificial intelligence methods, particularly those of genetic programming.

6. Society Development Modeling

Since time immemorial humans have considered that the structure of the society is becoming more and more complex. The use of the term "complexity" reflects the degree of evolution, structure dimension, functional diversity. Social synergy exists as much as the interests coincide, necessity of heterostasis exists, and entropy is conditioned by incompatibility. The more is the synergy, complexity or diversity the more developed is the society. Homogenity is unstable because when diversity decrease the system comes to the lower hierarchic level i.e. it gets primitive. The necessity of original culture diversity is conditioned just by it. Hierarchy does not mean only a treelike structure, but it is a system of diverse dimensions degree level and multiple contacts. Society development is connected with its structural complexity, most likely the more intercontacts, functional symbiosis the more holism. The history of civilization can be characterized through the progressive (though non-monotonic) appearance of collective behaviors of larger groups of human beings of greater complexity. Historic changes in the structure of human organizations are self-consistently related to an increasing complexity of their social and economic contexts. So there are the controls structures [7]: *“rigid” hierarchy → hierarchy with lateral interactions →hybrid → network.*

The society with the “rigid” hierarchy (early civilization) was disbalanced and characterized by high entropy. Further the formation of synergetic connections changed the structure of human organization. Because of the functional complexity increase and for disbalance (or entropy) minimization, the hybrid structure gradually converts into eventually the balanced network.

7. Conclusions

Our analysis shows, that every interaction between any two social clusters recursively form the new entity, which has mutually modified or provoked redistribution of synergy-entropy, its balance and fitness. The formation of synergetic connections gradually changed the structure of human organization from “rigid” hierarchy through the hybrid structure into eventually the balanced network. It is clear that cultural diversity will

be a necessary condition for creation balanced global civilization, because society development rates is determined by diversity, otherwise the quantity increases not the quality. Globalization should take place preserving diversity. Globalization also provides the technical and systematic foundations for this new thinking. As a result, a self-regulated mechanism is formed, which effectively prevents conflicts, and safeguards the world's long-term peace.

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რეზიუმე

სტატია ეძღვნება სოციუმის სირთულის ფორმალური აღწერის ახალ კონცეფციას, სოციუმის ქცევის მოდელირების თვალსაზრისით, რომელიც განპირობებულია ადამიანის არსებობით, როგორც არაწრფივი და არამკაფიო ფაქტორების მქონე, ქცევის თავისუფლების მაღალი ხარისხით. ადამიანთა სოციუმის მდგომარეობა შეიძლება აღიწეროს სოციალური, პოლიტიკური და ეკონომიკური წესებით, დაკმაყოფილებათა თუ დაუკმაყოფილებათა განსხვავებული ხარისხებით. სამუშაოს ორიგინალურობა მდგომარეობს სოციუმის მულტიაგენტური ფორმით აღწერაში, სადაც აგენტებს შორის ყოველი ურთიერთქმედება იწვევს სინერგია-ენტროპიის, მათი ბალანსისა და მთლიანობაში ფიტნესის გადანაწილებას. სოციუმის ქცევითი სხვადასხვაობა განპირობებულია სოციალური ჰომეოსტაზით და ჰეტეროსტაზით. მოცემულ კონტექსტში, სოციუმის მგდრადობის კრიტერიუმი ასოცირდება სტაბილურობასთან, ხოლო ბიოლოგიური თვალსაზრისით, ჰომეოსტაზის ან ფიტნეს-ფუნქციის იდეასთან.

ОСНОВАННЫЙ НА СИНЕРГИИ ПОДХОД ДЛЯ МОДЕЛИРОВАНИЯ СОЦИАЛЬНЫХ СИСТЕМ

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Резюме

Статья посвящена новой концепции формального описания сложности социума, его поведения с точки зрения моделирования, что обусловлено существованием человека с нелинейными и нечеткими факторами, высокой степенью свободы поведения. Состояние социума людей может быть описано с помощью социальных, политических и экономических правил с различными степенями удовлетворенности или не удовлетворенности. Оригинальность работы заключается в описании социума посредством мультиагентной формы, где каждое взаимодействие между агентами приводит к перераспределению синергии - энтропии, их баланса и общего фитнеса. Поведенческое различие социума обусловлено социальными гомеостазом и гетеростазом. В этом контексте критерий устойчивости социума ассоциируется со стабильностью, а с биологической точки зрения - с идеей гомеостаза или фитнес-функции.