

MODELING SOCIAL SYSTEMS

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Summary

This paper is consecrated to the new concept for a formal description of the society complexity with respect to the viewpoint of modelling 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 the neural graph with synaptic connections between them, where every interaction between any two social clusters forms the new united cluster, provokes redistribution of synergy-entropy, its balance and fitness. 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, stability, homeostasis, heterostasis.

1. Society as a system

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. At the same time,

it should be mentioned that, all the same the problem cannot be solved without system approach, such as living systems analysis, autopoiesis, sociocybernetics, synergetics and complexity theory [1]. The role of system sciences is more and more determined in the viewpoint of modelling and management of society, as the most complex chaotic system. If we want to characterize society as a living system, we will first need to define the living organization as *autopoiesis* (Greek for “self-production”). An autopoietic system consists of a network of processes that recursively produces its own components, and thus separates itself from its environment. Contemporary systems models are more likely to be nonequilibrium models emphasizing the concept of entropy. Entropy has a number of advantages over equilibrium for social systems. It has led to the development of a number of models using entropy, including social entropy theory, synergetics, and complexity theory [8].

As regards to synergy (also called synergic/synergistic science or synergetics), it means that wholes have properties (functional effects) different than those of the parts. Without synergy, there is no complexity, no life and no humanity...[5]. We will see how these disciplines can enhance each other and merge in an evolutionary metascience.

One of the evident examples of civilization development 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.

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 [2].

Human Social Entropy is equivalent to the degree of social disorder, of certain social, economic, or political system. Society, as every system, is characterized by a *structure, composition and state*. The state of human society as a system is described by the different degree of dissatisfaction (for example, riots, political meetings, religious behavior, wars, etc.) or satisfaction with the social, political and economical rules of a country.

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.

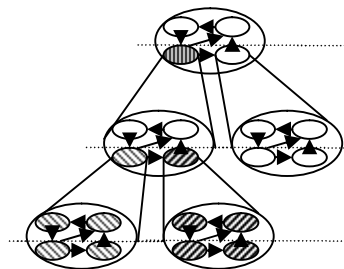


Figure 1. Structurogenesis of social fractals

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.

2. Formulation of the social system problem

Society of any level represents an open system interactive with the environment. Generally, society or its components can be considered as a neural model [6]. Model of the society is a multidimensional graph, where the degree of dimension is defined by the number of types of terminals. We can consider a cluster as a subgraph or projection of graph on any type of terminal. So, the graph is the set of clusters.

System behavior is determined in the area of external and internal freedom. Entropy is determined by the number of ways you could achieve a state. And entropy is calculated as the following function [4]:

$$H = - \sum_{r_{(ik)}=1}^F \mu_{r_{(ik)}} \log \mu_{r_{(ik)}} - \sum_{r_{(ik)}=1}^R P_{r_{(ik)}} (\mu_{r_{(ik)}} \log \mu_{r_{(ik)}} + (1 - \mu_{r_{(ik)}}) \log(1 - \mu_{r_{(ik)}})) \quad (1)$$

where: R – number of synapses: $R = \text{Card}\{C_{ij}\};$

F – number of free terminals: $F = Q - 2R;$

$\mu_{r_{(ik)}}$ – degree of incompatibility between the terminals of the neurons.

Compatibility of the synapses is the necessary condition of neuron graph unity. Synergy, on its part, is the function [3]:

$$S = \log \sum_{i=1}^n \mu_i - \sum_{i=1}^h p_i \log p_i$$

(2)

where: h – number of the orbits of isomorphic groups;

p – probability of the orbits of isomorphic groups.

System stability or social homeostasis in the given moment of time is determined as the difference of synergy and entropy.

$$M_h = S - H$$

(3)

As a result of synapses there takes place the merging of neurons, creation of a new ensemble that consists of synergic-entropic union. Every synapse or interaction between any two social clusters recursively form the new entity, the new united cluster, which has mutually modified or provoked redistribution of synergy-entropy, its balance and fitness. Creation occurs

when entropy converts into synergy and vice versa, when breaking up synergy converts into entropy.

3. 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 cultur. Three forms of society behavior are determined:

Confrontation caused by antagonism of interests between subjects.

$$\text{When Synergy} < \text{Entropy and } \sum_{i=1}^n \mu_i > 0.$$

Cooperation or collaboration (low degree of heterostasis) conditioned by coincidence of interests between subjects in case of internal antagonism.

$$\text{When Synergy} > \text{Entropy and } \sum_{i=1}^n \mu_i > 0.$$

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.

$$\text{When Synergy} > \text{Entropy and } \sum_{i=1}^n \mu_i = 0.$$

Social behavior can be represented as algorithm below.

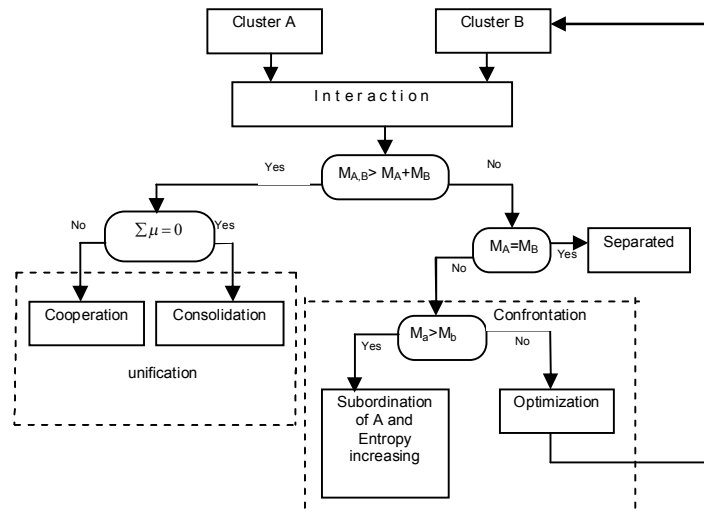


Figure 2

These are the destructive (antagonistic) and beneficial (cooperative) interaction forms . The very essence of any synergistic behaviour 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. With the viewpoint of optimization it may be convenient to use artificial intelligence methods, particularly those of genetic programming [7].

4. Hierarchic model

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 (superdominant) 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.

$$M_V = \log \sum_{i=1}^n \mu_i - H \quad (4)$$

$$M_S = M_H \cdot M_V \cdot M_L \quad (5)$$

where: M_H - the stability of the high level society;

M_V - the stability of the vertical interactions;

M_L - the stability of the low level society;

M_S - the stability of the whole system.

If: $M_H > M_L$ then case corresponds to the board of administration as dictatorship.

$M_H < M_L$ then case corresponds to the board of administration as anarchy.

$M_H = M_L$, $M_S = \max$ or $\sum_{i=1}^n \mu_i = 0$, then case corresponds to democracy.

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 cataclism. 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. Civilization Complexity

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 dimention, 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. Homogeneity 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 dimentions 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 [9]:

“rigid” hierarchy → hierarchy with lateral interactions → hybrid → network.

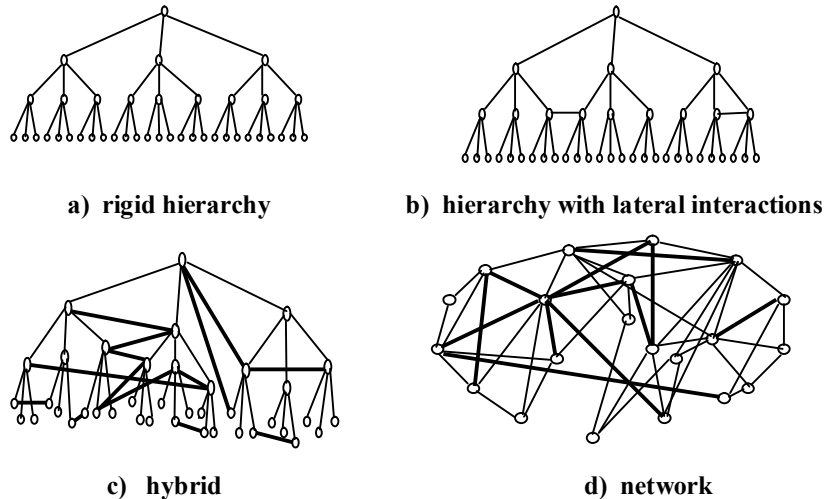


Figure 3

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.

6. Conclusions

1. This paper has explicated social entropy analysis applying the new type of synaptic graph based on the neural model. Our analysis shows, that every synapse or 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.

2. 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. But if there is democracy i.e.

synergic balance, then antagonism ceases and necessity of social heterostasis appears.

3. The formation of synergetic connections gradually changed the structure of human organization from “rigid” hierarchy through the hybrid structure into eventually the balanced network.

4. It is clear that cultural diversity will be a necessary condition for creation of a 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.

Every society must evaluate fitness from the viewpoint of the *whole* and not of the *parts*. It is undoubted, that the future of civilization should not be sacrificed for particularistic interests. This may seem an impossible dream, especially for the societies of third world, but sooner or later it will become evident for everybody, that we, each of us, are parts of the greater whole and salvation is only in the unity!

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სოციალური სისტემების მოდელირება

ბადრი მეფარიშვილი, გულნარა ჯანელიძე და თამარ მეფარიშვილი

საქართველოს ტექნიკური უნივერსიტეტი

რეზიუმე

მოცემულ სტატიაში შემოთავაზებულია სოციალური სისტემების მოდელირებისადმი ორიგინალური მიდგომა, რაც განპირობებულია არაწრფივი და არამკაფიო ფაქტორების, აგრეთვე თავისუფლების მაღალი ხარისხის არსებობით. ნაშრომის ორიგინალურობა მდგომარეობს რთული სოციალური სისტემის ნეირონული გრაფის ე.ი. სინერგული მოდელის სახით აღწერაში. სოციალური სისტემის განვითარების მოდელის აგება და ოპტიმიზაცია შესაძლებელია სისტემის ენტროპიის მინიმიზაციის ანუ მდგრადობის მაქსიმიზაციის კრიტერიუმის მიხედვით.

МОДЕЛИРОВАНИЕ СОЦИАЛЬНЫХ СИСТЕМ

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Резюме

В данной статье предлагается оригинальный подход к моделированию социальных систем, что обусловлено наличием нелинейных и нечетких факторов, а также степени свободы. Оригинальность работы заключается в описании сложной социальной системы в виде нейронного графа т.е. синергетической модели. Построение модели и оптимизация развития социальной системы происходит на основе критерия минимизации энтропии или максимизации стабильности системы.