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The emergence and evolution of living systems compensating for entropy processes

Ratushnyak A.S.*, Zapara T.A., Proskura A.L., Sklyarov A.N.

Federal Research Center for Information and Computing Technologies, Novosibirsk, Russia
** ratushniak.alex@gmail.com*

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Understanding the principles and mechanisms of the functioning of biological systems and the brain, in particular, is necessary both for developing methods and approaches to the prevention, diagnosis and correction of neuropathologies, and for advancing in the field of creating cognitive systems. However, progress in the field of understanding the principles and mechanisms of the functioning of biological systems has not yet had fundamental success. To achieve significant results, it is necessary to search for conceptually new approaches. The construction of new concepts can be based on an understanding of the basic principles underlying the emergence and evolution of biological functional systems. It is important to define the very concept of living systems. There is uncertainty in understanding the term itself. Now there are several hundred definitions of such systems, essentially reducing to the concept of "self-reproduction with variations". NASA, for example, defines life as "a self-sustaining chemical system capable of undergoing Darwinian evolution". At the same time, not self-reproducing, but of course, living organisms are known – neurons, erythrocytes, etc. Naturally, scientific analysis does not allow us to reasonably assert that even the simplest systems capable of self-reproduction could spontaneously form in the foreseeable time interval. Another assumption about the basic function of any biosystem is the concept that their emergence and existence are based on the processes of counteracting entropy. Self-reproduction, at the same time, is a derivative that arose in the process of evolution, but not at all their main property. On the basis of such a concept, one can try to create a model of the primary prebiont and consider possible logical schemes for its functioning and evolution. One can proceed from the idea of living systems as molecular, digital, logical (with non-binary logic) machines, the main function of which is to create and maintain a certain order (homeostasis, complex information and energy) based on forecasting using previously obtained (recorded) information. In this case, the mechanism of emergence, spontaneous formation of extremely simple molecular machines without an auto-replication complex, but having the features of living systems that maintain their stability in an entropic environment, becomes more understandable. The elements of such machines can be rather simple organic molecules that perform the functions of receptors of external influences, logical elements that process, fix information and act as effectors. In this case, logical operations are reduced to fixing the relationship between receptable events in the environment and the reactions of effector molecules, which make it possible to avoid events that increase the entropy of such a molecular system. Environmental factors interact with molecular structures that act as P1 and P2 receptors. The influences transformed by these structures are transmitted to the molecular logical structures that perform the selection of time-related signals and the reaction to them by turning on the effector, which allows optimizing the loss/gain of

energy and information by the system. At the initial moment, the effector turns on only under the action of a factor that changes the information-energy state. In this case, the previous factor (factors) are remembered as signal ones. At the first stage, the basis of the interconnection of signals is not of fundamental importance – association, correlation or cause-and-effect relationships. The connection of two (or more) signals is remembered. When the next pair of interconnected signals occurs in the environment, the effector turns on already under the action of the first factor – the signal. At the same time, the system avoids losses or optimizes acquisitions. Spontaneous emergence of such molecular constructs consisting of several simple biomolecules seems quite probable. And the stability they receive in an entropic environment can lead to their accumulation. The fusion of such complexes differing in the set of receptors and effectors contributed to the expansion of the possibilities of avoiding damage and the acquisition of additional information and energy. At the same time, natural selection can be based not on the basis of reproducing organisms, but when primary agents appear after fusion and fragmentation with the selection of the most relevant molecular structures. For example, sets of receptors for associative factors, times and directions for the implementation of logical processes, the volume and depth of "memory" about a changing environment. On the basis of such natural scientific ideas about biological functional systems and their primary prebiotic prototypes, a model of a logical agent has been developed. A model of the medium has been developed in which there are signals of various modalities and agents can be spontaneously formed from the elements (molecules) present. In the process of modeling in the environment, the number of elements (having logical functions) that determine the probability of the emergence and persistence of the agent is optimized. A set of conditions, coefficients of their values and rules for the interaction of agents and the environment, stabilizing the system as a whole, is determined.

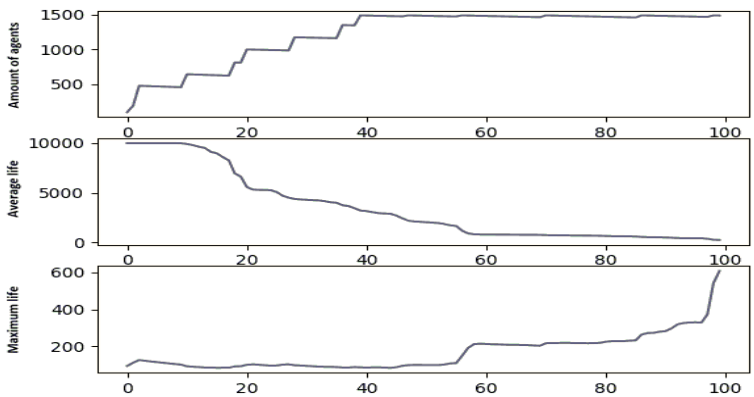

Figure 1 shows an example of the dynamics of adaptation of negentropic agents for given parameters of the environment and the agent. When a pool of agents is formed, their interaction with the environment leads to the selection of the most stable ones, their number stabilizes and then remains constant until the end of the analysis cycle. It is possible to increase the complexity of the model of biologically inspired cognitive systems by combining them with a network or matrix approach up to the limits of the capabilities of the tools.