Semantic Intelligence

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INTRODUCTION

Semantic intelligence is an exclusive for the intelligent complex systems way of response to non-specified and non-predetermined ever-changing environment subject to the mild assumption of boundedness alone. Its major distinctive property is autonomous comprehension and creation of information. Another exclusive property of semantic intelligence is autonomous discrimination between true and false statements.

The semantic intelligence naturally arises in the setting of concept of boundedness where it commences from highly non-trivial interplay between structural and functional properties of a complex system. The major generic property of that interplay is that it renders the relation between structural and functional properties to be non-recursive. In result this renders the efficiency of semantic intelligence to be provided by efficiency of hierarchical self-organization of a complex system prior to the efficiency of software and to the speed of hardware.

Concept of boundedness is a new explanatory paradigm aimed towards explanation of the behavior of the complex systems behavior. A systematic study can be found in (Koleva, 2013; Koleva, 2016). In the setting of this paradigm the semantic intelligence is implemented by a specific for each intelligent complex system hierarchical self-organization of the physical processes. The major generic property of this hierarchy extensively discussed in the chapter, renders it bi-directional and non-extensive.

The concept of boundedness is the first systematic theory which considers the behavior of complex systems in non-specified non-predetermined ever-changing environment subject to the mild assumption of boundedness alone. The major assumption is that a non-predetermined bounded environment is the starting point for fundamentally novel properties of complex systems behavior, semantic intelligence included, which are not available for the traditional scientific approach where the environment is supposed set apriori. It is should be stressed that the traditional approach is grounded on the assumption that the environment is statistically or deterministically pre-determined and unbounded and hence all physical, chemical, biological and engineered systems are considered as set in specific pre-determined environment. The fundamental discrimination between both approaches consists of the fact that the behavior of corresponding systems, semantic intelligence included, is describable by non-recursive means while the behavior of the algorithmic intelligence is describable by recursive means only.

The goal of this chapter is to highlight the major properties of semantic intelligence that naturally arise under the concept of boundedness and to demonstrate their relation to the general characteristics of physical processes which implement it. This defines the strategic goal to be establishing the grounding principles of next generation approach for building a circuit able to exhibit semantic intelligence.

Since the semantic intelligence naturally arises in the frame of concept of boundedness, the most general assumptions of the concept of boundedness are presented. The necessary conditions for setting semantic intelligence are presented later. This is made because the intelligent complex systems are a sub-class of the family of complex systems. As such they share all properties of the wider class

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of complex systems along with specific for the semantic intelligence properties. A comparison between the exclusive properties of semantic and algorithmic intelligence is made.

BACKGROUND

Before presenting the basic principles of the concept of boundedness let us remind the notion of a complex system and the major characteristics of their behavior. Let us start with the notion of a complex system: it is how parts of a system are organized so that the system behaves as a single object and how it interacts with its environment. Thus the notion of a complex system encompasses an enormous variety of systems ranging from physical ones such as quasar pulsations, to biological such as DNA sequences, to social ones such as financial time series.

The intensive empirical examination that was going on in the last decades displays the remarkable enigma of complex systems behavior: the highly specific for each complex system properties persistently coexist with certain universal, shared by each of them ones. Thus on the one hand, they all share the same characteristics such as power law distribution and sensitivity to environmental variations, for example; one the other hand, each system has its unique "face", i.e. one can distinguish between an earthquake and heartbeat of a mammal. What makes the study of this coexistence so important is the enormous diversity of systems where it has been established. In order to get an idea about this vast ubiquity let us present a brief list of such phenomena: earthquakes, traffic noise, heartbeat of mammals, public opinion, currency exchange rate, electrical current, chemical reactions, weather, ant colonies, DNA sequences, telecommunications, etc.

But the greatest mystery enshrined in the behavior of complex systems is that both intelligent and non-intelligent systems belong to the same class: thus a Beethoven symphony, a product of a genius mind, and the traffic noise which, though being also a product of human activity, but un-intelligent in its behavior, share the same type of power spectrum. Another example is the semantics of human languages: in the year 1935 the linguist G. K. Zipf established that, given some corpus of natural languages, the frequency of any word is inversely proportional to its rank in the frequency table. Thus the most frequent word will occur approximately twice often as the second most frequent word, three times as often as the third most frequent word, etc. Thus, the Zipf law ignores any semantic meaning and thus it seems to sweep out the difference between mind activity and random sequences of letters. Thus we come to the following fundamental problem: what makes a complex system "intelligent" and why it should share such "indifferent" to the intelligence properties?

The affiliation of the apparently intelligent systems such as human languages and music to the same class as earthquakes and a variety of other natural phenomena, suggests in a straightforward way that the intelligent behavior is embedded in natural processes. Thus the opposition between intelligence as highly specific activity and the fact that it inherently belongs to a universal class of natural phenomena raises the major question whether it is likely to expect defining a criterion able to distinguish the specificity of a system from another one along with affiliating each of them to the same class of complex systems.

CONCEPT OF BOUNDEDNESS – GENERAL PRINCIPLES

Next the grounding assumptions of the concept of boundedness are introduced. They are:

- A complex system remains stable if and only if the rate and amplitude of variations that it exerts in response to an ever-changing environment are bounded to specific for the system margins.

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