



Extended Abstract

Selforganization of Information and Value – discussion of the relation to physics

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Introduction

There is general agreement that mathematicians like Shannon and Kolmogorov and physicists like Maxwell, Boltzmann, Szilard and Stratonovich contributed a lot to our modern understanding of information. Nevertheless there is no general agreement about the relation between physics and information. Is information a concept of physics, can it be reduced to physical terms like entropy. There are many interesting discussions on this problem (see e.g. the FIS-discussion [1]), but a general agreement is not yet to be seen. This author expressed together with Rainer Feistel the opinion that “information” and the related concept “values” are not physical terms [2,3], inspite of the fact that transfer of information and value is always related to transfer of a universal physical quantity, the entropy. In this way, information is subject to physics but it cannot be reduced to physics alone. In our opinion information-processing systems exist only in the context of life and its descendants: animal behaviour, human sociology, science, technology etc. The historically very first such system was the genetic expression machinery of early life, where DNA triplets were used as symbols for amino acid sequences of proteins to be mounted. However the process, how life appeared on earth, which way symbolic information developed out of non-symbolic, native one, was extremely complicated and is only in part known. We will not discuss this problem here but will leave it to the talk given by Rainer Feistel. Instead we will discuss here also the concept of values, which is also a typical emergent quantity related to physics inspite of the fact that it cannot be reduced to physics [4,5].

Selforganization of information and values

We know that the existence of all living beings is intimately connected with information processing and valuation. This we consider as the central aspect of life. We define *a living system as a natural, ordered and information-processing macroscopic system with an evolutionary history*. This may be

even used as a criterion for decisions of the staff on a space-ship which meet far from our home-planet earth unknown objects moving in space, sending signals and doing maneuvers, should they meet it with the respect for living objects? Information processing we consider as a special high form of self-organization. Information is an emergent property but we see several open problems here. How did information emerge by self-organization? Genuine information is symbolic information, needing a source that creates signals or symbols, a carrier to store or transport it, and finally a receiver that knows about the meaning of the message and transforms it into the structure or function the text is a blueprint for. This way symbolic information is always related to an ultimate purpose connected with valuation.

Information-processing systems exist only in the context of life and its descendants: animal behaviour, human sociology, science, technology etc. To our knowledge, the historically very first such system was the genetic expression machinery of early life, where DNA triplets were used as symbols for amino acid sequences of proteins to be mounted. However the details, how life appeared, which way symbolic information developed out of non-symbolic, native one, are hidden behind the veils of an ancient history. Other, later examples for the self-organization of information are much easier to study, and this was done first by Julian Huxley in the beginning of last century in behaviour biology. The evolutionary process of the transition from use activities of animals to signal activities he called "ritualisation". In our concept the transition to "ritualization" or "symbolization" is a central point. A more detailed view onto this transition process reveals rather general features which we consider as a universal way to information processing [2,3,4]. When a process or a structure becomes symbolized, its original full form of appearance is successively reduced to a representation by symbols, together with a building-up of its processing machinery, which still is capable to react on the symbol as if its complete original was still there. At the end of the transition the physical properties of the symbolic representation are no longer dependent on the physical properties of its origin, and this new symmetry (termed coding invariance) makes drift and diversification possible because of neutral stability. In all processes transferring and processing information, necessarily some amount of entropy is flowing. The argument that the quantity of entropy flow is small, is completely irrelevant. Who believes that the waves on an ocean or the structures on a planet are not of relevance?

What can be said about values, a central concept of biology and humanity, which appears also already in physics. In physics the concept of value was introduced by Wilhelm Ostwald who considered entropy as a measure of the value of energy. In the social sciences the concept of values was first introduced by Adam Smith in the 18th century in an economic context. The fundamental ideas of Adam Smith were worked out later by Ricardo, Marx, Schumpeter and many other economists. In another social context the idea of valuation was used at the turn of the 18th century by Malthus. Parallel to this development in the socio-economic sciences, a similar value concept was developed in the biological sciences by Darwin and Wallace. Sewall Wright developed the idea of a fitness landscape (value landscape) which was subsequently worked out by many authors; in the last years many new results on the structure of landscapes were obtained by Peter Schuster and his coworkers in Vienna. We will explain our concept that the value concept which is irreducible, has including its expressions as biological or ecological fitness or economic values, some background in physics and in particular in entropy.

The formation of information and values is a collective phenomenon and is due to selforganization. We are understanding self-organization as a "*process in which individual subunits*

achieve, through their co-operative interactions, states characterized by new, emergent properties transcending the properties of their constitutive parts." In this respect we would like to stress the role of values, which are indeed among the most relevant emergent properties. An example is the value of a species which means the fitness in the sense of Darwin. Competition is always based on some kind of valuation.

The concepts of values and fitness landscapes are rather abstract and qualitative. Our point of view is that values are an abstract non-physical property of subsystems (species) in certain dynamical context. Values express the essence of biological, ecological, economic or social properties and relations with respect to the dynamics of the system [3,4,5]. From the point of view of modelling and simulations, values are emergent properties. The valuation process is an essential element of the self-organization cycles of evolution.

Conclusions

Information and values are non-physical emergent properties. Both have some roots in physics which are important for understanding. Information and valuation were already absolutely central to the origin of life, in order to survive, living creatures needed information and a standard of basic values of food, shelter, protection etc.. Modern societies are based on information processes and an exchange value, money. Both concepts are intimately connected and have roots in physics.

References and Notes

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