Extended Abstract

Information Science: New Response to Old Challenges in the Scientific View of Reality

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Abstract. The challenges of complexity, of the lack of a comprehensive holistic methodology and of antithetic aspects of life and cognition are not new. They accompanied development of Western philosophy and science from the very beginning. Thus, it is not their presence in European intellectual tradition that is surprising, but their persistence. The first of these challenges, complexity is well known, but the focus of its study is more on the limits of the unconquerable, not on their elimination. Holism always fascinated European intellectuals, but was never fully admitted into standard scientific methodology. Only very recently under the name of integrative medicine acquires the status of institutionally recognized way of inquiry and practice. In the study of life and cognition challenges are multiple and commonly recognized, but there is lack of comprehensive, cross-disciplinary methodology to respond to them. Information science with sufficiently general and well defined concept of information can replace the crumbling foundations for science which until recently were given by physics. Concepts of modern physics lost intuitive character and are in increasing degree dependent on interpretation in terms of information, computation, or cognition. However, in order to serve as a firm new foundation they require a common comprehensive framework. The approach to information, its structure, integration and dynamics proposed by the author can serve as an example of a conceptual framework which can serve this purpose.

Challenge of Complexity

The challenges of complexity, of the lack of a comprehensive holistic methodology and of antithetic aspects of life and cognition are not new. They accompanied development of Western philosophy and science from the very beginning. Thus, it is not their presence in European intellectual tradition that is surprising, but their persistence.

Although the qualification for a system or process to be considered complex has changed, we still are facing limits for the exploration of systems which are and seem for ever to be too complex to explore, or for performing processes which due to their complexity require for their implementation too much of necessary resources (mainly time). The simplest example of the latter case is the impossibility of implementation of an algorithm which requires the number of steps that is an exponential function of the volume of data. Unplanned "gift" from the technological progress in the form of Moore's Law (Moore 1965) reporting the exponential temporal increase of the quantitative characteristics of electronic devices in the industrial innovation can push the limits, but cannot eliminate them. Algorithmic complexity theory has as its objective a clarification of the issue which of algorithms are feasible in the current forms of computation, and which are beyond practical applications. The actual challenge is in finding ways to implement algorithms of the latter type.

There are several other faces of complexity blocking intellectual and technological progress. Another example is in recently recognized need for the revision of statistical methodology. It is very often forgotten that traditional statistics is heavily dependent on the assumption of the independence of individual events which justifies the use of normal distributions in the analysis of collective phenomena and gives this form of analysis its predictive power. The recognition of the necessity to consider mutual dependence of events, and therefore of the necessity to replace normal distributions by power laws brought back the issue of unpredictability of "black swans" (Taleb 2007).

In order to confront the challenges of complexity, its studies have to go far beyond its traditional conceptual framework set by Warren Weaver (1948) in the 1940's, later complemented by the quantitative description in terms of algorithmic complexity.

Challenge of Holistic Methodology

Holism is a new name for the ancient view of reality which gives priority to a whole over its multiplicity of components. Jan Christiaan Smuts introduced this term in 1927 in his anticipation for a true holistic and integrative approach to science with the specific interest in the study of complex adaptive systems such as those exemplified in the biological evolution. It was an early attempt to give an academic status to the way of thinking that over centuries or even millennia remained on the fringes of science and philosophy. This inferior, non-academic status of the holistic thought did not come from the lack of interest in what integrative approach was offering. For instance, Hermeticism in which holistic view of reality played most fundamental role influenced Renaissance thinkers not less than Neoplatonic philosophers. Even the greatest minds of science and philosophy (e.g. Isaac Newton) were attracted to it by its alternative view of reality. The problem was in the lack of a consistent and comprehensive conceptual framework which could be used to formalize its vague esoteric claims (Schroeder 2012).

The situation did not change in the recent revival of the interest in holism which came with the works of Ludwig Von Bertalanffy (1950) on his General System Theory. Once again, the initial interest waned when the general description of the theory was not followed by a comprehensive scientific methodology with the increased power in solving problems unsolvable with the earlier methodological tools. This can be blamed on the excessive trust in the common sense comprehension.

Expressions of the type “a whole is more than sum of its parts” frequently used in the context of General System Theory can be easily understood by a lay audience, but is philosophically meaningless. The danger of this easy “understanding” for an unprepared audience was in the lack of clear distinction between an innovative view of the scientific methodology and pseudo-scientific creations such as George Van Tassel’s Ministry of Universal Wisdom. Van Tassel was using similar holistic terminology. His rejuvenating device built on instruction of Solganda from the planet Venus had name “integratron”. In absence of more profound philosophical foundations or mathematical formalism the distinction between General System Theory and Universal Wisdom was not easy for many who believed that they understood both. The latter gained undeserved recognition as a scientific invention, the former undeserved judgment of being just a toy for dilettantes.

We are currently witnessing yet another instance of the revival of interest in the holistic way of thinking. Integrative medicine which emphasizes wellness and healing of the entire person in all bio-psycho-socio-spiritual dimensions came out of the fringes of medical sciences. The Consortium of Academic Health Centers for Integrative Medicine founded in 1999 has at present 60 members including medical institutions of the highest world recognition such as Mayo Clinique or Johns Hopkins University Hospital. The emphasis on the holistic aspect of human health is fundamental for this approach, as can be seen already in its name (Bell *et al.* 2002). It would be an ironic smile of history, if the triumphant reentry of holistic methodology happens through the interest in unorthodox methods of care for human health a millennium after pagan Aristotelean and other Classic Antiquity philosophy reentered European intellectual tradition through the interest in Arabic methods of such care.

Challenge of Life and Cognition

Studies of life and cognition (consciousness) are facing not one challenge, but a large variety of challenges, many of them old and some new. An example of an old challenge is the homunculus fallacy reappearing again and again in the attempts to explain consciousness (Schroeder 2011a, 2014). More fundamental challenge is in the consequences of the Cartesian mind-body dualism, which after each of its obituaries in philosophical works of the past was resurrected in more specific problems of the relationship between the subjective and objective forms of reality, problems of qualia, problem of quantum measurement, etc.

Consequences of Cartesian dualism can be found in many unexpected contexts. Even the title of this section of the abstract involves its reflection in the separation of the concepts of life and cognition. The need for the view in which life and cognition are only different facets of the same natural phenomenon, was already recognized in the works of Humberto Maturana and Francisco Varela (1980). But the concept of autopoiesis (self-creation) at the center of their philosophy of life is yet another example of a challenge to the traditional scientific methodology.

Even more revolutionary and challenging to the traditional science were ideas of Nicolas Rashevsky (1965, 1972) and Robert Rosen (1958, 1981, 1991) regarding a new order of scientific disciplines in which biology would have more fundamental place than physics in the development of united conceptual framework for the view of reality. This idea is definitely revolutionary, but the actual challenge in Rosen’s vision is in his insistence on the fundamental role of self-reference, which was banned from science as the main source of logical problems.

This brings us to the question about theoretical and philosophical tools necessary to confront these and other challenges to science.

Information Science

Even from the perspective of a singular discipline, the scientific view of reality is not as firm and clear, as it may seem. Physicists are referring to the concept of a physical system or its state, but what exactly is the meaning of these concepts is not clear, although we can identify elements of mathematical formalism associated with them. We still can find expressions such as “matter and energy”, clearly inherited from the 19th Century view of the world in which matter could be safely associated with the physical concept of mass. Today the use of such expression is questionable, as the former is a philosophical concept and the latter comes from a specific physical theory. The persistence of this hybrid can be viewed as a symptom of the lost conceptual framework that used to make physics a good foundation for other disciplines. Not only concepts of particles, waves, mass or energy have relative meaning, but the involvement of a conscious observer became a necessary element of the scientific view of reality.

The new conceptual foundation is sought in the concepts of information and computation. They can be characterized as more fundamental than those of traditional physics and can be found in the studies in the domains of physics, biology, cognition, etc. Problem is that not always, or even not frequently they are clearly defined. Information is simply associated with one of its postulated measures (most frequently with Shannon’s entropy) and computation with the work of a Turing machine. In order to serve as a new foundation for the scientific view of reality both concepts have to be well defined and equipped with a comprehensive theoretical formalism. In particular, information has to be described not only through its quantitative, but also qualitative or structural characteristics.

Concept of Information

There is no reason to claim that there is only one way to define information. No non-trivial philosophical or scientific concept was ever defined in a universal, absolute way. In the following one particular definition is considered as a potential candidate for the work with the challenges to science. Information was defined by the author in his earlier publications as identification of the multiplicity, i.e. anything that makes one out of, or of the many (Schroeder 2005). One out of the many is a selection of one element out of many, which can be called a selective manifestation of information. Making one of the many is giving the many a binding structure, which can be called a structural manifestation of information. It can be shown that these two manifestations are always coexistent, but for different multiplicities, or as they were called by the author for different information carriers. The degree of the determination of selection (for instance in terms of probability distribution and the value of entropy for this distribution) can be used as a quantitative characteristic of information when we focus on the selective manifestation. The degree in which the structure can be decomposed into a product of components describes the level of integration of information (Schroeder 2009). Both manifestations can be given one mathematical formalism, which due to the high level of abstraction of the concept of information is developed in terms of set theory and general algebra (general closure operators or closure spaces) (Schroeder 2011b).

With the tool of a general concept of information, we can proceed to the definition of computation in terms of dynamics of information (Schroeder 2013 b, 2013c).

Conclusion

The conceptual framework for information, its structure, integration and dynamics used by the author is definitely not the only possible one. The mathematical formalism developed for these concepts can also be considered as a matter of choice. However, we can see that the idea of using some form of information science as a response to the challenges to science is feasible. Now it will be a matter of comparison of the competing different approaches to information to find the best response.

References and Notes

Bell, I. R., Caspi, O., Schwartz, G. E., at al. (2002). Integrative medicine and systematic outcomes research issues in the emergence of a new model for primary health care. Arch. Intern. Med. 162 (2), 133-140.

Von Bertalanffy, L. (1950). An Outline of General System Theory. *British Journal for the Philosophy of Science*, 1, 134-165.

Maturana, H. R. & Varela, F. J. (1980). *Autopoiesis and Cognition: The Realization of the Living*. Boston Studies in the Philosophy of Science, vol. 42, Dordrecht: D. Reidel.

Moore, G. E. (1965). Cramming More Components onto Integrated Circuits. *Electronics*, April 19, pp.114-117; reprinted in Moore (1998), *Proc. IEEE*, 86 (1), pp. 82-85.

Rashevsky, N. (1965). The Representation of Organisms in Terms of (logical) Predicates. *Bull. of Math. Biophysics*, 27, 477-491.

Rashevsky, N. (1972) *Organismic Sets: Some Reflections on the Nature of Life and Society*. Holland, Michigan: Mathematical Biology, Inc.

Rosen, R. (1958). The Representation of Biological Systems from the Standpoint of the Theory of Categories. *Bull. of Math. Biophysics*, 20, 317-341.

Rosen, R. (1987). Some epistemological issues in physics and biology. In B. J. Hiley and F. D. Peat (Eds.) *Quantum Implications: Essays in honour of David Bohm. London:* Routledge & Kegan Paul.

Rosen, R. (1991). *Life Itself: A Comprehensive Inquiry into the Nature, Origin, and Fabrication of Life.* New York: Columbia University Press.

Schroeder, M.J., (2005). Philosophical Foundations for the Concept of Information: Selective and Structural Information. In: *Proceedings of the Third International Conference on the Foundations of Information Science, Paris 2005,* http://www.mdpi.org/fis2005

Schroeder, M.J., (2009). Quantum Coherence without Quantum Mechanics in Modeling the Unity of Consciousness, in: Bruza, P. et al. (Eds.) QI 2009, LNAI 5494, Berlin: Springer, pp. 97-112.

Schroeder, M. J., (2011a). Concept of Information as a Bridge between Mind and Brain. *Information*, 2 (3), 478-509.

Schroeder, M.J. (2011b). From Philosophy to Theory of Information. *Intl. J. Information Theor. and Appl.*, 18 (1), 56-68.

Schroeder, M. J. (2012). The Role of Information Integration in Demystification of Holistic Methodology. In P. L. Simeonov, L. S. Smith, A. C. Ehresmann (Eds.) *Integral Biomathics: Tracing the Road to Reality*. Berlin: Springer, pp. 283-296.

Schroeder, M. J. (2013a). The Complexity of Complexity: Structural vs. Quantitative Approach. In: Proceedings of the International Conference on Complexity, Cybernetics, and Informing Science CCISE 2013 in Porto, Portugal, http://www.iiis-summer13.org/ccise/Virtual_Session/viewpaper.asp?C2=CC195GT&vc=58/ Accessed 18 July 2014.

Schroeder, M. J., (2013b). Dualism of Selective and Structural Manifestations of Information in Modelling of Information Dynamics. In G. Dodig-Crnkovic and R. Giovagnoli (Eds.): *Computing Nature*, SAPERE 7, Berlin: Springer, pp. 125-137.

Schroeder, M. J. (2013c). From Proactive to Interactive Theory of Computation. In: M. Bishop and Y. J. Erden (Eds.) *The 6th AISB Symposium on Computing and Philosophy: The Scandal of Computation – What is Computation?* The Society for the Study of Artificial Intelligence and the Simulation of Behaviour (pp. 47-51).

Schroeder, M.J. (2014). Autonomy of Computation and Observer Dependence. In Preston J., Erden Y.J. (Eds.) Proceedings of the 7th Symposium on Computing and Philosophy: Is Computations Observer-Relative? 50th Anniversary Convention of AISB, London April 1-4, 2014, available at http://doc.gold.ac.uk/aisb50/

Smuts, J. C. (1927). *Holism and Evolution*. London: Macmillan.

Taleb, N. N. (2007). *The Black Swan: The Impact of the Highly Improbable*. New York: Random House.

Weaver, W. (1948). Science and Complexity. *American Scientist,* 36(4), 536-544.