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Structural Realism, Structural Information, and the General Concept of Structure †

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Abstract: The main goal for this paper is to revisit and rehabilitate structuralist methodology based on the idea of invariance and symmetry for the purpose of the discussion of structural realism and its consequences for ontology of information. This paper continues the earlier work of the author carried out in this spirit. In the present paper the focus is on the general concept of a structure, not necessarily in terms of information, but with important consequences for the study of structural information. The conceptual study of the general concept of a structure is followed by an outline of the mathematical formalism suitable for the development of its theory.

Keywords: concept of information; structural information; concept of structure; structural realism; meta-symmetry

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1. Introduction

There are many obstacles in attempts to clarify ontology of information when information is understood in a very general way. On the other hand, the concept of information requires such general understanding as it currently is utilized as one of most fundamental, directly or indirectly in virtually all disciplines of inquiry and in a very wide range of contexts. One of main obstacles is in that which made the concept of information so popular and so widely utilized. Information entered the stage of science and technology directly in the quantitative form defined by Shannon [1]. To be more precise and fair Shannon mentioned information in only few places in his paper and only casually, writing for instance “the quantities of the form of entropy that play a central role in information theory as measures of information, choice and uncertainty” [1]. Entropy and its application to communication was the actual subject of his work, not its relation to the concept of information. Thus the use of entropy explicitly as a measure of the general concept of information came only later with interpretations of Shannon’s work. No matter who initiated this common belief, entropy started to be used in multiple contexts, in particular in communication studies or in relation to the communication psychological inquiries as a measure of information and this use preceded the attempts to establish a definition of the concept of information.

The difficulties and failures of the attempts to provide a properly formulated definition, i.e., such that it would meet even modest expectations regarding the logical rules of defining concepts, did not discourage the use Shannon’s entropy or its multiple variations in a large variety of applications. Majority of practitioners who used entropy in their work believed and still believe that Shannon’s famous 1948 paper republished in the book format in 1949 provides a theory of information and therefore it contained the definition of the concept and its properties. Some believe that Shannon defined there information as a resolution or reduction of uncertainty. This common misconception is an interesting case for the study of sociology of science, but is not of special interest for ontology of information. More important for us is that the common use of entropy as a measure of information without much attention to the meaning of this concept or to its properties makes the experience of the decades of technological and scientific practice of very limited help in the questions regarding ontological matters.

Another, very different obstacle in establishing the ontological status of information is its role within epistemology. Traditional separation of epistemology and ontology in philosophical analysis of concepts is here difficult as information, whatever of its multiple understandings is considered, is definitely involved in the way how we know, as well as what we know. Even more, we cannot expect that knowing and knowledge can be considered independently from the concept of information.

It would be easier to relegate information to the type of epistemological concepts (following some conservative calls that information has to inform someone about something), but then we face objections that the concept of information becomes too narrow to be useful in the contexts of physical and life sciences where information acquires the status of independently existing entity, or even the distinctive status of the only entity of primary ontological status as expressed in Wheelers famous call "it from bit" [2].

Thus we have to reconcile these two ways the concept of information enters philosophical discourse. This seems like increase of difficulty, but it can be considered as an unexpected blessing for the progress in overcoming fundamental philosophical problems in philosophy of science [3].

Modern science, in particular physics shows that the separation of epistemology from ontology becomes increasingly difficult. Special relativity started from the recognition of the necessity to relate the concept of simultaneity of events (necessary for co-existence) to the observer. Soon later quantum mechanics smashed many other bricks in the wall separating ontology and epistemology. Already the recognition of the unavoidable influence of observation on the state of observed entity threatened the meaning of this separation, but the most fundamental ontological concept of individuation of entities lost its meaning for quantum objects entering entanglement.

The blessing coming from the fall of the epistemology-ontology wall is at this moment purely speculative and is based on the recognition of internal problems of physics, in particular of the estimated 96% unaccounted mass and energy of the universe in cosmological analysis which is founded on the present physical theories. Whether these "dark mass" and "dark energy" will be finally found or the need for reformulation of physics is confirmed, we should consider potential problems arising as a consequence of the separation between epistemology and ontology. After all "dark mass" and "dark energy" are only created by vacancies in our knowledge, but they are recognized as entities at present.

Alternatively, we can think about the benefits of the integration of epistemology and ontology as the underlying it reasoning is very plausible. Thus far we recognized inseparability of what we know and how we know because the knower is constrained by the same spatio-temporal restrictions as the known (in Galilean and in special relativity). Situation started to change with the development of quantum mechanics. The knower is an object governed by classical physical rules and its interactions with the world at the micro-scale necessarily induce quantum decoherence of superimposed states of the known. Knowing (associated with observation or experiment) turns out to be inseparable from being, or in the other words the state describing existence becomes dependent on knowing.

Now we should consider another form of interdependence between knower, knowing, and known which resembles Kant's postulated necessity of the involvement of an interface of a priori categories, but is slightly different. Particular categories such as time, space, etc. may be a posteriori, very likely with strong cultural, i.e., acquired from social interactions imprints, but the very bottom of category formation there is the ability to overcome the opposition of one and many, which is a necessary pre-condition for learning about reality. Thus, the issue is not in the limitations in learning about "things as they are" because we project on the things our a priori intellectual tools—categories, but our (knower's) intervention starts in the very idea of a "thing" which requires integration of many (for instance parts, properties, instants, ...) into one, which we call "thing".

The process of the integration which is necessary for the knower, but only possible, not necessary for the known, can be identified with consciousness, and therefore it has epistemological character. We can see that knowing is not independent from being, but it transcends being.

Integration presupposes the concept of structure. Formation of sets, if unconstrained by any conditions is the lowest form of integration and is not sufficient for knowing. Typically the first level of integration considered as epistemologically significant is the formation of mutually exclusive sets that cover entire multiplicity, i.e., in the language of mathematics determination of an equivalence relation. In reality there is an intermediate step where the integration consists in formation of sets that does not require exclusiveness and the resulting binary relation is called tolerance. Its common sense interpretation is similarity. The set of objects similar in being of given color (e.g., red) can overlap with the set of objects with same shape (spherical). There can be a red sphere in the collection, but we can have spheres of different color or red cubes.

These first steps are the beginnings of an infinite hierarchy of structures with diverse properties, some of which acquired mathematical formal description.

Out of this large variety of possible structures some are involved in our exploration of the world and have distinctive roles in the process of knowing. For instance, geometric structures, in particular the structures of Euclidean geometry have very distinctive role. Is it because they are congruent (or maybe even identical) with some independently existing structures (structured entities) which we discover while we explore reality, or they are invented by us as most useful or aesthetically pleasing, or else...? Here we approach the fork of the roads in our inquiry which defines structural realism (postulating that it is a discovery). At the fork we can see representatives of different views presenting a wide range of pro and contra arguments [4].

The most surprising is that the current discussion of scientific realism apparently carried out by philosophers who either subscribe to structuralism or try to oppose it do not refer to the methodology of structuralism. Moreover, the rare references to symmetry (or invariance with respect to a group of transformations), the fundamental concept of structuralism, which served as the fundamental evidence for the objective existence of a structure is called in some discussions "invariantism", as if it was a position separate from structuralism, not one of its most important tenets [5].

If philosophical arguments are not sufficient, we should remember that symmetry is the most important tool of scientific inquiry and physics is not much more than study of symmetry. This view is not new. It is sufficient to recall the frequently quoted sentence of the Nobel Prize laureate in Physics Philip Warren Anderson "It is only slightly overstating the case to say that physics is the study of symmetry" [6]. Even those who are more cautious about not going too far in generalizations agree that symmetry is involved in physics in so many ways that they are inseparable. Anderson shows in his article that the increase of complexity of systems studied in physical sciences not only does not eliminate the fundamental role of symmetry, but makes this concept even more important for understanding transitions between different levels of complexity.

2. Back to Structural Methodology Based on Symmetry

Our main goal in this paper is to revisit and rehabilitate structuralist methodology based on the idea of the invariance and symmetry for the purpose of the discussion of structural realism and its consequences for ontology of information. This paper continues the earlier work of the author carried out in this spirit [7]. In the present paper the focus is on the general concept of a structure, not necessarily in terms of information, but with important consequences for the study of structural information. Symmetry in mathematics, physics and physical sciences is studied following Felix Klein's Erlangen Program formulated 1872 in terms of groups of transformations and corresponding invariants of transformations, where transformations are defined on the coordinates. First step made in the earlier work of the author was to generalize symmetry to eliminate the need for coordinates [8]. The formalism of this generalization has a surprising feature. It allows application of the same theory of symmetry to itself. We get what can be called "meta-symmetry", i.e., symmetries of symmetries which can be used for the purpose of the study of the structure of structures.

Conflicts of Interest: The author declares no conflict of interest.

References

1. Shannon, E.C. A mathematical theory of communication. In *The Mathematical Theory of Communication*; University of Illinois Press: Urbana, IL, USA, 1949.
2. Wheeler, J.A. Information, Physics, Quantum: The Search for Links. In *Complexity, Entropy, and the Physics of Information*; Zurek, W.H., Ed.; Addison-Wesley: Redwood City, CA, USA, 1990; pp. 3–28.
3. Schroeder, M.J. Crisis in Science: In Search for New Theoretical Foundations. *Prog. Biophys. Mol. Biol.* **2013**, *113*, 25–32.
4. Bokulich, A.; Bokulich, P.; (Eds.) *Scientific Structuralism*; Boston Studies in the Philosophy of Science; Springer: New York, NY, USA, 2011; Volume 281.
5. Weyl, H. *Symmetry*; Princeton University Press: Princeton, NJ, USA, 1952; 132p.
6. Anderson, P.W. More is Different. *Science* **1972**, *177*, 393–396.
7. Schroeder, M.J. Invariance as a Tool for Ontology of Information. *Information* **2016**, *7*, 11. Available online: http://www.mdpi.com/2078-2489/7/1/11/htm (accessed on 15 May, 2017).
8. Schroeder, M.J. Concept of Symmetry in Closure Spaces as a Tool for Naturalization of Information. In *Algebraic System, Logic, Language and Computer Science*; Horiuchi, K., Ed.; Research Institute for Mathematical Sciences, RIMS Kokyuroku, Kyoto University: Kyoto, Japan: 2016; pp. 29–36. Available online: http://www.kurims.kyoto-u.ac.jp/~kyodo/kokyuroku/contents/pdf/2008-04.pdf (accessed on 15 May 2017).