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The notion of information and the notion of Ionian arché

ABSTRACT. The notion of information and the notion of Ionian arché
The article explores the possibility of interpreting the notion of arché as a metaphor of the notion of information. The notion of arché is presented from the perspective of Ionian school of philosophy and compared with the notion of information presented from the perspective of natural sciences. It is argued that there are three major similarities between the notions: both play important part in reflection on the nature of the world, describe the universe on a fundamental level and have its static and dynamic aspect.

KEY WORDS: arché, information, metaphor, natural sciences.

1. Introduction

The question “What is information?” is difficult to answer. Even Claude Shannon, the father the of contemporary information theory, did not define the notion [cf. Shannon, Weaver, 1948, pp. 279–423]. It seems that it is much easier to study manipulation, transfer, compression and storage of information than to formulate its general definition. The first to try and define information were cyberneticists such as Norbert Wiener and Gregory Bateson, who said, respectively: “Information is the recording of a choice between two equally probable simple alternatives” [Wiener, 1960, p. 9] and “Information is a difference that makes the difference” [Bateson, 1973, p. 448]. However, these definitions are rather unsatisfactory: they

seem too broad to be useful. Luciano Floridi realized how crucial for any widely used term is its clear definition. Although he did not give any general answer as to what information is, he formulated a set of eighteen questions that any such general theory should attempt to answer. [Floridi, 2004]

Regrettably, scholars rarely seek inspiration for such studies in classical philosophy. Even Floridi, who is deemed the father of philosophy of information, had little to say about how ancient philosophical concepts can help us to understand information better. That does not mean, of course, that such attempts are non-existent in literature. For example, an American philosopher Michael Heim compared virtual reality to platonic Eros: both, he claims, aim to immortalize human [Cf. Heim, 1993, pp. 83–109]. However, Heim's comparison is not directly connected to information and therefore not scope of the present paper. Another example can be found in the work of Polish philosopher Marek Hetmański, who stated that in contemporary culture the word information took place similar to that of *arché*. Both seem to be the basis and the principle of the universe [cf. Hetmański, 2013, p. 24]. Unfortunately, Hetmański's approach is merely a hint – a casual remark about the general state of research on the epistemology of information.

The goal of this paper is to expand Hetmański's idea: some similarities and differences between the notions will be presented, indicating that the notion of *arché* can be interpreted as a metaphor for information. Specifically, three major similarities will be highlighted: both notions play important part in any reflection on the nature of the world, both describe the universe on a fundamental level and both have its static and dynamic aspect. Due to the necessary limitations of the present paper, some restrictions will be applied: the notion of *arché* will be limited to its role in Ionian philosophy of nature and the notion of information will be limited to its use in natural sciences.

The article is structured as follows: firstly, the notion of *arché* will be presented and analyzed in the context of the Ionian philosophy of nature. Secondly, the notion of information will be presented, focusing on its role in physics and biology. Lastly, the similarities and differences of the two notions will be presented, claiming that *arché* can indeed be interpreted as modern metaphor of information.

2. About arché

The notion of arché is central for all Ionian philosophers of nature. Arché explains the original, most basic reality responsible for diversity of perceived phenomena (*physis*). It is worth noting that ancient Greeks' fascination with explanation of the world's origin reaches far earlier. The brightest example of this is the Theogony by Hesiod in which the world emerged from Chaos. Chaos, too, is the original reality that the world and the first Gods emerged. However, the mythical Chaos itself has an unexplained beginning: Hesiod successfully avoids giving a reason for the existence and purpose of Chaos. [Reale, 1993, pp. 70–72] Arché does not need such a beginning because it **is** the beginning. Thus, the difference between Chaos and arché is very much like the difference between myths and philosophy: the latter is trying to forge or find an explanation on how and why the world exists based on reason alone. Although there were many philosophers arguing about what arché actually is, this paper limits itself to Ionian school of philosophy: Thales, Anaximander, Anaximenes and Heraclitus.

Thales equated arché with the element of water. He did so most likely because of his observation of nature: water seemed to permeate all that is alive. Living things need water to survive, elder people lose water and get wrinkled, and life is born amid moisture. Food rots, bodies decay; these phenomena are for Thales a sign of water returning to its original state. Circulation of water in nature appears to be something universal, therefore water is the reason world exists, lasts and dies.

Anaximander was unsatisfied with Thales' notion of water as arché. To him, something as primal and important as arché should not be compared with any observable phenomenon. Water is therefore a poor choice, even if it is a very important part of nature. Arché to Anaximander has neither beginning nor end, is undetermined, indefinite and infinite. Moreover, water already has its opposite – fire. Since arché is supposed to be the origin of all things, Anaximander suggested that *apeiron*, or indefinite vastness, is the best candidate for this title. Opposite qualities like heat and cold arise from that vastness, giving birth to all other things. All these

qualities are in advance sentenced to return to apeiron in proper time. To Anaximander, worlds emerged and collapsed into arché countless times and our own world is just one out of many. It is possible because of innate indefiniteness both in space and time. However, Anaximander did not explain how the opposite qualities emerge from arché or how they return to it in the first place. His student, Anaximenes tried to fill in this gap.

Anaximenes agreed with his master that arché is infinite, but he rejected the notion that it is indefinite as well. Anaximenes claimed that the element of air is best suited for arché because it is the most similar to the invisible, omnipresent and limitless vastness his mentor was arguing for. All things come into existence as a result of the process of condensation or rarefaction of the air. Condensation generates water and earth whereas rarefaction generates fire. All other things come into being as a combination of these four elements. Anaximenes' approach was therefore more dynamic than his predecessor.

For Heraclitus the nature of the world is too chaotic and dynamic for arché to be anything else than fire. Just like fire, arché is in constant motion, changing from one state into another without pause. Any existence is only a temporary aspect of the arché-fire. Transformations of nature are dictated by the unity of opposites: two seemingly exclusive phenomena are in fact impossible to exist with each other. Heat turns into cold, light becomes darkness, day becomes night. Apparent tensions and conflicts between the opposites is the basis of nature. Fire mirrors this well: by combustion of its fuel it is constantly extinguishing itself and igniting anew.

As exemplified by the aforementioned philosophers, arché appears to be described twofold: as a reason and a dynamic principle for all of existence. Thales and Anaximander focus on the former aspect of arché whereas Anaximenes and Heraclitus seem to be inclined more towards the latter. What is also important, reflection on arché is what differentiated mythical stories about the origin of the world from philosophical inquiry. This inquiry is what gave birth to modern scientific reasoning.

Considering what a modern notion of arché would look like, one ought to take into account the cultural and scientific differences between antiquity and present times. Ancient Greeks did not have institutional science as

we know it. Nevertheless, the notion of arché was an attempt to explain the reality in its totality; due to the diversification of sciences, its contemporary counterpart should be present in the overwhelming majority (if not all) of natural sciences. Contemporary arché should also reflect the static and dynamic aspects of arché: as being both a reason (cause, basis) and principle (explanation why things change or stay the same over time) of nature. The notion of information seems to fulfill these conditionp.

3. The scope of the notion of information

The notion of information in its contemporary understanding today can be traced back to an article “The Mathematical Theory of Communication” written by Claude Shannon and Warren Weaver. The article specifies minimum conditions for signal transmission to occur and presents a way of measuring the transmitted information. Information itself is regarded by the authors as a primitive notion and left undefined [c.f. Shannon, 1984, pp. 279–423].

Today, the notion of information has different in meanings in different fields of study. For example, it can be understood as a set of data, signals, a physical quantity, sensory input, DNA configuration, knowledge, conviction, message, transfer, etc. Regrettably, despite such diverse understanding of the word information, a unified theory of information is yet to be formulated. From the perspective of this article, the most important meanings of information are those present in natural sciences, especially physics and biology.

Information is one of the most important notions in quantum physics. It is best illustrated by the black hole information paradox. The principles of quantum determinism and reversibility (which due to the limited size of this article will not be explored in depth) entail that information contained in any physical system or particle must be preserved (cannot be destroyed) whereas the gravitational pull of the black hole does not allow even light to escape beyond certain threshold (event horizon). Thus, information about objects beyond event horizon appears to be irreversibly lost to any external

observer. Stephen Hawking proved that black holes, in fact, produce thermal radiation (named the Hawking radiation); what means that eventually black holes will disappear. The problem lies in that the information contained in Hawking radiation does not necessarily have any connection to the information that gets into the black hole. [Hawking, 1975] The holographic principle introduced by Leonard Susskind is a possible solution to this problem. According to the holographic principle, all information about the black hole is contained on the two-dimensional plane limiting it (event horizon in this case). Any object entering the black hole distorts the event horizon which in turn influences how the Hawking radiation is behaving. Susskind claims that the holographic principle is not exclusive to black holes but to the whole universe as well: the universe can be interpreted as information on a two-dimensional plane limiting it [Susskind, 1995]. Therefore, the most important element of the universe is, in fact, information.

Another interesting view on the cosmological role of information comes from Seth Lloyd, an engineer at MIT. Lloyd argues that the universe is a quantum computer. To support his claim Lloyd gives three reasons:

- a) The universe allows for quantum computing (quantum operations are indistinctive from physical quantum phenomena),
- b) A quantum computer efficiently simulates dynamics of the universe (since quantum computers use the same principles that govern quantum particles),
- c) The universe is a cellular automaton (a discrete system).

Seth Lloyd claims therefore that since operations of quantum computer are the same processes that occur naturally in quantum realm, there is no reason why the universe cannot be a quantum computer [Lloyd, 2007]. Since a computer requires some kind of information to operate (in form of data, algorithms etc.), information is therefore a crucial building block of the universe as a computer.

Information is also a very important notion in the field of biology. There are two kinds of information in biology: sensory and genetic. Genes are the carriers of genetic information: it is encoded in DNA via four nitrogenous bases: adenine, guanine, cytosine and thymine. Information

stored relates to the organism's environment; as information increases in quantity, so too does the chance of organism to survive and adapt to the environment. Moreover, genetic information is used as instructions used in the growth, functioning and reproduction of an organism. Sensory information is carried by sensory stimuli and organism's receptors. The more efficiently an organism can process sensory input the better is its adaptability and responsiveness. The efficiency is understood as speed of information processing and ability to synergize input from different senses [Adami, 2012]. Both kinds of information (sensory and genetic) appear to play fundamental role in evolution and adaptation to the environment. Genetic information is the cornerstone of any organism and sensory input is crucial in organism's communication with the environment.

4. Conclusions

The notions information and arché share at least three important similarities. Firstly, in the perspective of aforementioned sciences, both notions are used in reference to the nature or physical reality. The Ionian perspective is focused on explaining the observable physical phenomena (*physis*) based on reason. Similar task guides the natural sciences albeit with different methods: information, just as arché, is a fundamental notion for descriptions of nature; be it philosophical hypotheses or scientific theories. Secondly, the notions are universal: arché is the basis for all of nature and information plays fundamental role in physics of elementary particles and evolution of living organisms. Thirdly, both notions appear in two aspects: static and dynamic. It is well visible in the notion of arché where it is both a building block of nature and simultaneously a principle of nature's transformations. The notion of information might also be a building block (like two-dimensional information in the holographic principle or nitrogenous bases in DNA) and the reason behind the dynamicity of the world (like information transformations via Lloyd's Computer-Universe or processing of sensory information in living beings).

It is important to point out that despite its similarities the notions arché and information are also very distant. The most obvious difference is a temporal one. The notion arché was coined hundreds of years ago in ancient Greece, where there was no science in modern sense whereas information in its current understanding has a rather short history. The notions were also constructed for different purposes: arché was a metaphysical notion used in explanation of the world and information is a technical one, reinterpreted for a specific communication theory.

Despite the temporal and cultural differences, the notions still can be compared to each other. The search for arché was the first step in establishing critical studies of nature and as such may be considered a progenitor of scientific research. Moreover, the fact that the notion of information is used in theories which explain fundamental particles (quantum mechanics) bares similarity to the search of fundamental principle of the world: both attempts to explain world at a fundamental level. For these reasons it is possible, with certain restrictions, to interpret the notion of arché as a metaphor of information. The question of what condition does a notion has to meet in order to be considered a modern equivalent of arché and whether or not information meets these conditions, however, is the subject of separate studies.

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