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Meaning in Action: a Qualitative Approach of Information

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Abstract. There are many approaches to the concept of information in terms of quantity, but there is a lack of consensus on what information is. We measure it in many ways, but we don't consistently state what information is. We will try in this text to offer a qualitative image for the concept of information. On this occasion, perhaps we will better understand the role of information at different levels in existence by defining information as a symbolic structure that acts through the meaning it has in a given context.

1. Introduction

We *know* about some things, we are *informed* about some events, we have all the *data* related to a certain reality. So there are three distinct ways in which we relate to those around us. *Knowledge – Information – Data* is a challenging and sometimes a confusing triad. The middle term seems to be the hardest to catch in a unanimously accepted definition. Dictionaries agree relatively easily on *knowledge* and *data*, but it is very difficult to identify the slightest attempt to provide an acceptable definition for the concept of information. Any attempt slips very quickly into quantitative assessments of an entity considered, by an unconfessed guilty consensus, as known. We do not ignore some successful attempts to provide qualitative interpretations of the concept of information, but we consider it necessary to deepen these encouraging beginnings to the level at which we can provide an effective qualitative and quantitative theory. Our approach is oriented in this direction.

In the next section we will briefly review the research through which a quantitative definition of information is pursued. The third section is dedicated to qualitative approaches and interpretations of the concept of information. In the next section we propose a qualitative definition of the concept of information. The paper ends with a concluding section.

2. Quantitative Theories of Information

Just as science flourished once Galileo removed the observer from nature, communication and storage of data exploded once Shannon removed meaning from information.
Giulio Tononi [19] p. 145.

It seems that the concept of *information* borrows from the concept of *time* an ungrateful destiny: it can be measured in a multitude of ways but it cannot be caught in a definition that answers, in a unanimously accepted way, the question: *What is information?* We all work with a vague mental representation that we accept by virtue of a pragmatically imposed use. An important role in this process of vague definition is due to the *language game*, in the Wittgenstein's sense [23], which we play in the various professional contexts in which the concept of information occurs. Two types of information are mainly considered: *statistical information* which describes the outcome of expected alternative behaviors of a certain system, or *algorithmic information*, defined as the minimum description of a given thing.

2.1. Claude Shannon: Information in the Theory of Communication

Claude Shannon's approach is of statistical information type. The start point of Shannon was the need to offer a theory for the communication process [16]. The information is associated with a *set of events* $E = \{e_1, \ldots, e_n\}$ each having its own probability to come into being $p_1, \ldots, p_n$, with $\sum_{i=1}^{n} p_i = 1$. The quantity of information has the value $I(E) = -\sum_{i=1}^{n} p_i log\ p_i$. This quantity of information is proportional with the uncertainty removed when an event e_i from E occurs. $I(E)$ is maximized when the probabilities p_i have the same value, because if the events are equally probable any event removes a big uncertainty. This definition does not say anything about the information contained in *each* event e_i. The measure of information is associated only with the set of events E, not with each distinct event. And, the question remains: what is *information*? Qualitative meanings are missing in Shannon's approach, so that:

> *"... communication engineers seldom concern themselves professionally with the meaning of messages."* [14]

2.2. Solomonov – Kolmogorov – Chaitin: Algorithmic Information

All big ideas have many starting points. It is the case of *algorithmic information theory* too. We can emphasize three origins of this theory [2]:

- Ray Solomonoff's researches on the inference processes [17]
- Andrey Nikolaevich Kolmogorov's works on the string complexity [13]
- Gregory Chaitin's work on the length of programs that generate binary strings [1].

2.2.1. Solomonoff's researches

Solomonoff's on prediction theory can be presented using a short story. A physicist makes the following experience: he observes at each second a binary manifested process and records the events as a string of 0's and of 1's, thus obtaining a n-bit string. For predicting the $(n+1)$-th events the physicist is driven to the necessity of a *theory*. He has two possibilities:

1. studying the string the physicist *finds* a pattern, thus he can predict rigorously the $(n+1)$-th event
2. studying the string the physicist doesn't find a pattern and can't predict the next event.

In the first situation, the physicist will write a scientific paper with a new theory: the "formula" just discovered is the pattern emphasized in the recorded binary string. Thus, the behavior of the studied reality can be *condensed* and a concise and elegant formalism comes into being. Therefore, there are two kinds of strings:

- patternless or *random* strings that are incompressible, having the same size as its shortest description
- compressible strings in which finite substrings, the patterns, are periodically repeated, allowing a shortest description.

2.2.2. Kolmogorov's work

Kolmogorov starts from the next question: *Is there a qualitative difference between the next two equally probable 16 bits words*:

0101010101010101

0011101101000101

or there does not exist any qualitative difference? Yes, there is. The first string has a well-defined generation rule and the second seems to be randomly generated. We need, according to Kolmogorov, additional concepts to distinguish the two equally probable strings. If we use a fair coin for generating the previous strings, then we can say that in the second experience all is well, but in the first - the *perfect* alternating of 0 and of 1 - something happens! A strange *mechanism*, maybe an *algorithm*, controls the process. Kolmogorov defines the *relative complexity* (now named *Kolmogorov complexity*) in order to solve this problem.

Definition 1. *The complexity of the string x related to the string y is*

$$K_f(x|y) = min\{|p| \mid p \in \{0,1\}^*, f(p,y) = x\}$$

where p is a string that describes a procedure, y is the initial string and f is a function; $|p|$ is the length of the string p. $\diamond$

The function f can be a Universal Turing Machine (says Gregory Chaitin in another context) and the relative complexity of x related to y is the length of the shortest description p that computes x starting with y on the tape. Returning to the two previous binary strings, the description for the first binary string can be shorter than the description for the second, because the first is built using a very simple rule and the second has no such a rule.

Kolmogorov proved that always there exists a function that generates the *shortest* description for obtaining the string x starting from the string y.

2.2.3. Chaitin's approach

The teeneager Chaitin used a *Universal Turing Machine*, M, instead of the function f. He was preoccupied to study the minimum length of the programs that generate binary strings.

Definition 2. *Chaitin's complexity of the string x as follows:*

$$C_M(x) = min\{|p| \mid p \in \{0,1\}^*, M(p) = x\}$$

where p is the shortest program *of length $|p|$ that generate on the machine M the string x starting with an* empty string *on its tape.* $\diamond$

Chaitin defines the basic concepts of algorithmic information theory, as follows [3].

Definition 3. Algorithmic probability, P(s), *is the probability that the machine M eventually halts with the string* s *on the output tape, if each bit of the program p results by a separate toss of an unbiased coin.* $\diamond$

Definition 4. *The* algorithmic entropy *of the binary string* s *is $H(s) = -log_2 P(s)$.* $\diamond$

Definition 5. *The* algorithmic information *of the string* s *is* $I(s) = min(H(s))$*, i.e. the shortest program written for the best machine M.* $\diamond$

In this approach the machine complexity or the machine language complexity does not matter, only the length of the program measured in number of bits is considered.

Theorem 1. *The minimal algorithmic entropy for a certain n-bit string is in* $O(log\, n)$. $\diamond$

Therefore, according to the algorithmic information theory the amount of information contained in an *n*-bit binary string has not the same value for all the strings. The value of the information is correlated with the *complexity* of the string, i. e., with the degree of his internal "organization". The complexity is minimal in a high *organized* string.

Theorem 2. *For most of n-bit strings s the algorithmic complexity (information) is:* $H(s) = n + H(n)$*; or most of the n bits strings are random.* $\diamond$

This is a tremendous result because it tells us that almost all of the real processes cannot be condensed in short representations and, consequently, they can not be manipulated with formal instruments or in formal theories. To widen the scope of the formal approach, we need to "filter out". in the direct representations of reality, insignificant nuances. It increases so that the domain of the real in which formalisms can be applied.

Another very important result of algorithmic information theory refers to the complexity of a theorem deduced in a formal system. The axioms of a formal system can be represented as a finite string, as well as the rules of inference. Therefore, the complexity of a theory is the complexity of the string that contains its formal description.

Theorem 3. *A theorem deduced in an axiomatic theory cannot be proven to be of complexity (entropy) more than* $O(1)$ *greater than the complexity (entropy) of the axioms of the theory. Conversely, "there are formal theories whose axioms have entropy* $n + O(1)$ *in which it is possible to establish all true propositions of the form* "$H(specific\ string) \geq n$"." $\diamond$

2.2.4. Consequences

Many aspects of the reality can be encoded in finite binary strings with more or less accuracy. As most of these strings are random, our capacity to provide *strict rigorously* forms for all the processes in reality is practically null. Indeed, formalization is a process of condensation in short expressions, i.e., in programs associated with machines. Some programs can be considered a *formula* for large strings and some not. Only for a few number of strings (realities) a short program can be written. Therefore, we have three solutions:

1. to accept this limit
2. to reduce the accuracy of the representations, making partitions in the set of strings, thus generating a seemingly enlarged space for the process of formalization (many insignificant (?) facts can be "filtered" out, so "cleaning" up the reality by small details (but attention to the small details!))
3. to accept that the reality has deep laws that govern it and these laws can be discovered by an appropriate approach which remains to be discovered.

The last solution says that we live in a subtle and yet unknown Cartesian world, the first solution does not offer us any chances to understand the world, but the middle is the most realistic and optimistic in the same time, because it invites us to "filter" the reality in order to understand it. The effective knowledge implies many subjective options. **For knowing, we must filter out.** The degree of knowledge is correlated with our subjective implication. The objective knowledge is sometimes a nonsense.

Algorithmic information theory is a new way for evaluating and mastering the complexity of big systems.

2.3. Giulio Tononi: Integrated Information Theory

Giulio Tononi is interested in developing his *Integrated Information Theory* to help him understand and explain the phenomenon of consciousness. His approach starts with Shannon's classical definition of information.

Thus, a phenomenological analysis indicates that consciousness has to do with the ability to integrate an adequate amount of information and that such integration takes place on a characteristic spatio-temporal scale. Conscious processes can only take place in a context where the amount of information is properly sized to become meaningful to the human user. The integrative mechanisms imagined by Tononi brings the amount of information, defined in the Shanonian sense, to the level at which the interpretive mental mechanisms highlight meanings capable of triggering conscious mechanisms.

The process of integrating a very large amount of information results in an encapsulation which has as its main effect the appearance and increase of the received significance. Thus, the result of integration produces that level of (syntactic) order that corresponds to the optimal human capacity to associate meanings through which a perception is realized. The example from which Tononi starts is a video image generated with millions of pixels. The information calculated according to Shannon's theory is huge, and the receiver's mind is not able to perceive it unless an integration process is initiated by which large groups of pixels are interpreted integratively resulting in the emergence of representations that have a correlation in everyday experience. (For example, pixels that represent a dog in a TV picture cannot be perceived independently. Only the relationship that is established by integration between a huge number of pixels is the one that is consciously interpretable.)

It seems that the information is approached by Tononi also in a quantitative manner, with the amendment that a mechanism is revealed by which the amount of information is adjusted (usually by reduction) to become significant to the human receptor. But the process by which one tends to associate a meaning is encouraging, because it is a process by which the purely quantitative approach seems to be overcome.

3. Qualitative Theories of Information

So is information real, or just a convenient way to think about complex processes? There is no consensus on this matter, though I am going to stick my neck out and answer yes, information does have a type of independent existence and it does have causal power.
Paul Davies

We believe that research that has gone beyond purely quantitative aspects deserves to be highlighted, offering theoretical approaches and interpretations that answer the question of what information is. In addition to the quantitative aspects investigated from various angles, does it make sense to highlight qualitative aspects that answer the question? We think so. In this way, the scientific community will be able to make notable distinctions and shed light on the fundamental effects that information induces at different existential levels.

3.1. Mihai Drăgănescu's General Information

Mihai Drăgănescu in [7] outlines a general theory that provides a theoretical framework for the concept of information.

Definition 6. *The* generalized information *is:* $N = < S, \mathscr{M} >$ *where: S is the set of objects characterized by a syntactical relation, and* $\mathscr{M}$ *is the* meaning *of S.* $\diamond$

In this general definition, the meaning associated to S is not a consequence of a relation in all the situations. The meaning must be detailed, emphasizing more distinct levels.

Definition 7. *The* informational structure *(or syntactic information) is: $N_0 =< S >$ where the set of objects S is characterized only by a syntactical (internal) relation.* $\diamond$

The informational structure N_0 is the simplest information, we can say that it is a *pre-information* having no meaning. The informational structure can be only a good support for the information.

The first actual information is the semantic information.

Definition 8. *The* semantic information *is: $N_1 =< S,\mathbf{S} >$ where: S is a syntactical set, and $\mathbf{S}$ is the set of significations of S given by a relation in $(S \times \mathbf{S})$.* $\diamond$

Now the meaning exists but it is reduced to signification. There are two types of significations:

- R, the *referential* signification
- C, the *contextual* signification

thus, we can write: $\mathbf{S} =< R,C >$.

Definition 9. *Let us call the* reference information*: $N_{11} =< S,R >$.* $\diamond$

Definition 10. *Let us call the* context information*: $N_{12} =< S,C >$.* $\diamond$

If in N_{11} to one significant there are more significats, then adding the N_{12} the number of the significats *can* be reduced, to one in most of the situations. Therefore, the semantic information can be detailed as follows: $N_1 =< S,R,C >$.

Definition 11. *Let us call the* phenomenological *information: $N_2 =< S,\sigma >$, where: σ are senses.* $\diamond$

Attention! The entity σ is not a set.

Definition 12. *Let us call the* pure phenomenological *information: $N_3 =< \sigma >$.* $\diamond$

Now, the expression of the information is detailed emphasizing all the types of information:

$$N =< S,R,C,\sigma >$$

from the objects without a specified meaning, $< S >$, to the information without a significant set, $< \sigma >$.

Generally speaking, because all the objects are connected to the whole reality the information has only one form: N. In real situations one or another of these forms is promoted because of practical motivations. In digital systems we can not overtake the level of N_1 and in the majority of the situations the level N_{11}. General information theory associates the information with the meaning in order to emphasize the distinct role of this strange ingredient.

3.2. John A. Wheeler's *It from Bit*

"No element in the description of physics shows itself as closer to primordial than the elementary quantum phenomenon, that is, the elementary device-intermediated act of posing a yes-no physical question and eliciting an answer or, in brief, the elementary act of observer-participancy. Otherwise stated, every physical quantity, every it, derives its ultimate significance from bits, binary yes-or-no indications, a conclusion which we epitomize in the phrase, it from bit.*"*

John A. Wheeler [22] (p. 309)

According to John Wheeler, our existence is shaped in the form of knowledge through *yes/no* answers to the simple questions that the experiments designed by researchers investigate realities. In this sense, *"it-from-bit"* represents a mechanism by which existence reveals its content bit by bit in an informational process. Thus, Wheeler grants information a status of vehicle that allows existence to manifest in relation to the knowing mind. He expresses hope that in the foreseeable future we will be able to adjust to the procedures by which we will understand physics in the language of information.

For Wheeler, information is not a companion of matter, as Mihai Drăgănescu speculates, postulating in the depth of existence *infor-matter*, a symbiotic entity having, all at once, material and informational character [6]. But what is important in Wheeler's approach is that he considers the information from the perspective of the function it has, putting the quantitative aspects in the background. Information as a vehicle brings us closer to an image that assigns a *role* by the fact that information reveals a *meaning* through the answer to the questions that the experimental interrogation of reality asks. Thus, Wheeler approaches the Draganescian definition through the idea of *role*, thus providing partial support for the approach we propose in this work, without going beyond the exclusively communicative aspects associated with information, as follows:

> *"This granted, we continue to accept – as essential part of the concept of it from bit – Føllesdal's guide line [12], "Meaning is the joint product of all the evidence that is available to those who communicate."* [22] (p. 320)

3.3. Luciano Floridi's Philosophy of Information

The philosopher Luciano Floridi aims to answer the question "*ti esti*?" regarding information. He is therefore concerned with a qualitative definition of information, as the first task of an emerging philosophical field: the philosophy of information. But he sees the philosophy of information in a broader sense that includes its implications for addressing philosophical issues in general. We quote in this regard:

> *"(D) philosophy of information $(PI) =_{def}$ the philosophical field concerned with (a) the critical investigation of the conceptual nature and basic principles of information, including its dynamics, utilisation, and sciences, and (b) the elaboration and application of information theoretic and computational methodologies to philosophical problems"* [10] (p.137)

Floridi formulates a clear General Definition of Information (GDI) in [11] as follows:

GDI) σ is an instance of information, understood as semantic content, if and only

- **GDI.1)** *σ consists of n data (d), for $n \geq 1$;*
- **GDI.2)** *the data are* well-formed *(wfd);*
- **GDI.3)** *the wfd are* meaningful *($mwfd = \delta$).*

The similarity of this definition (stated in 2009) with that given by Mihai Drăgănescu (stated in 1983) is obvious. This encourages us to consider the association of a *syntactically ordered structure* with a *meaning* as an essential gain on the path leading to the understanding of the concept of information. Floridi also sends us to other authors whose conception is related to the concept of meaning when it comes to information. Thus, information may be understood as

> *"... that which occurs within the mind upon the absorbtion of a message."* [15]

Even if some approaches offer circular definitions, the association with the result of a process directs our thought beyond the simple association with a meaning. Floridi sends us, in this sense, to another author:

> *"Information is always informative about something, being a component of the output or result of the process. ... We suggest here a general definition of information: information is produced by all processes and it is the values of characteristics in the processes' output that are information."* [14]

Through "all processes" the author suggests a ubiquitous connection between physical and informational processes, a connection which, we concede, is becoming closer as we approach the depths of existence. We can thus provide additional support for speculation regarding Mihai Drăgănescu's *infor-matter* [6].

4. The Meaning Acting in Context

Let us expand the generalized information defined by Mihai Drăgănescu by adding a new component and its relation with the meaning, $\mathscr{M}$, associated to S in Definition 6.

Definition 13. *The* generalized information *is:* $N = < S, \mathscr{C}\mathscr{M} >$ *where: S is the set of objects characterized by an internal syntactical order, and* $\mathscr{M}$ *is the* meaning *of S which is used to* ***act*** *on the context* $\mathscr{C}$. $\diamond$

We consider that information must be defined in the context where it acts. In this way we differentiate information from data. Data is a passive entity while information is an active one. In the following subsections we will exemplify the information in computers, in nature and, only speculatively, in existence.

4.1. Information in Computers

A notable distinction appears from the beginning with the definition of the Universal Turing Machine (UTM) [21]. By defining UTM, the tape of a Turing Machine (TM), on which a string of symbols is recorded, has been split by Alan Turing in two. One portion contains the description of a particular TM, M, and the second portion represents the contents of the string, D, on which M is working. The finite automaton (FA) of UTM uses the description M to modify the content of D. Thus, we can say that, in the context of UTM, FA uses the *meanings* associated with the string M ***to act*** on the contents of the string D. Both strings, M and D, are structured according to a syntactic order, but in UTM they play completely distinct roles. M describes an action that is performed by the FA modifying the string D. M has a meaning at the UTM level, while D is a passive structure that supports the action defined by M and performed by the FA. In this sense we say that M ***acts*** on D in the ***context*** of UTM.

Consequently, the abstract computer models (von Neumann and Harvard) contain two symbolic structures in their memory/memories: ***programs*** and *data*, corresponding respectively to the M and D zones of the UTM's band.

In a computer, the *information is represented only by programs*, and the data can represent information for the computer's user in the context in which the computer is used. So, it is fair to say that a computer processes data through program's information. The computer processes data, not information. The result of the computation can be instantiated in information only at user level.

Example 1. *Let be the instruction format in a RISC processor:*

```
instruction ::= {function, result, leftOperand, rightOperand}
```

Then the instruction stored in the program memory of the computer at the address `1324`*:*

```
programMemory[1342] = {add, reg5, reg12, reg4}
```

will act on the content of the Register File (RF) adding in register 5 the content of register 12 with the content of register 4 **no matter** *what values were stored in these registers. Thus, the content of the register file is* **passive** *data while the instruction stored in the program memory represent the* **acting** *information.*

In this example the context, $\mathscr{C}$*, is provided by an Arithmetic & Logic Unit (ALU) loop connected with a RF and the content of RF. The instruction selects with its four fields the operation performed by ALU, the destination register, the two operands in RF. The context,* $\mathscr{C}$*, is designed and filled up with data in concordance with the meaning associated to the symbols used in the instruction's fields. Outside of this context, the meaning associated with the fields of instruction cannot act in any way.*

$\diamond$

In the previous example, the values contained in registers 5, 12 and 4 could be information in the context in which the computer is used. For the arithmetic addition operation in the context provided by the considered processor these values have no meaning, but they can be, and usually are, significant in a broader context.

Example 2. *In the Lisp language data and programs are represented by S-expressions. Because Lisp programs are able to manipulate source code as a data structure, they are characterized by interchangeability of programs and data. The distinction between data and programs is done only in the EVAL process which consists in reducing an input S-expression to an output S-expression. In this process sometimes a big stack memory is used to deal with the recursive evaluations. During the EVAL process, which starts with an empty stack, the content of the stack is used as temporary data. At the end of EVAL the stack remains empty.*

The context, $\mathscr{C}$, in this case, consists of an EVAL engine and a big STACK, which can be called Lisp Machine *(LM). During the evaluation process we can expect a large data structure to expand in the stack memory, the data structure that is resorbed until the end of the process. Instead of the data structure contained in the RF in the previous example, the data structure in a Lisp machine has an ephemeral character. This is due to the coexistence of data and program (information) within the S-expresses that LM reduces.*
◇

The interleaving data and information in a LM is a natural step in the process of externalizing our mental abilities. We do not believe that the symbolic representations used by the human mind clearly differentiate data from information. The ability of the human mind to play different language games [23], simultaneously or in rapid succession, requires and makes the symbolic structures with which it operates to be able to switch their status quickly. In a certain language game a certain symbolic structure has the role of data, while in another language game it can have the role of information. We are dealing with very subtle mutual interactions whose modeling can be facilitated by the definition and use of S-expressions in LM.

Example 3. *Let be, in an artificial neural network, a fully connected m-input layer of n neurons. It is defined by the associated weight matrix $M_{n\times m}$. The layer of neurons is subjected to two distinct processes: training and inference. In the training process it receives at the input a series of vectors that allow the configuration of the weight matrix. In the inference process, the network receives vectors at the input, vectors that determine a certain response of the network that is according to the training to which it has been subjected.*

In the training process, $\mathscr{C}_{training}$, the content of the matrix $M_{n\times m}$ represents a data structure that is configured according to the content of the stream, S, of training vectors. In this process the input stream S represents information, because its content acts configuring the weight matrix.

In the inference process, $\mathscr{C}_{inference}$, the weight matrix is multiplied with input vectors. Now the content of the matrix $M_{n\times m}$ represents information, while the input stream of vectors represents data. The syntactic order in the matrix $M_{n\times m}$ is not obvious because it is established in a training process and is the consequence of a very subtle mechanism of identifying hidden patterns in the training stream S.

Now, the same symbolic structure, $M_{n\times m}$, play two roles depending on the context; for $\mathscr{C}_{training}$ it is data, while for $\mathscr{C}_{inference}$ it becomes information because it acts as a program established by training.
◇

While in the first example the meaning of the program is obvious because it is built applying explicit rules, in the third example the meaning associated with the content of the matrix $M_{n\times m}$ is not explicit, it exists, but in a form inaccessible to human mind. The meaning of $M_{n\times m}$ is related to the training information provided in $\mathscr{C}_{training}$ context.

4.2. Information in Nature

LIFE = MATTER + INFORMATION
Paul Davies [5]

In life sciences we take into account what is called the *central dogma* of molecular biology, the process by which instructions in DNA are converted into a functional structure. The mechanism is emphasized in 1958 by Francis Crick, the co-discoverer of the DNA structure.

The central dogma explains the flow of information from DNA to RNA in order to generate a protein which is a functional product. The same central dogma explains also that DNA contains the information needed to make all proteins, and that RNA represent a messenger that provides this information which is responsible for assembling amino acids into proteins. The process by which the DNA instructions are converted into the functional product has two steps: *transcription*, from DNA to RNA and *translation*, from RNA to protein.

In the process of transcription, the information in the DNA of every cell is converted into small RNA messages, while during translation, the resulting messages travel from where the DNA is in the cell nucleus to the ribosomes where they ***act*** to make specific proteins by allowing an RNA molecule to fold into a three-dimensional structure that is determined by its sequence of nucleotides.

Thus, the basic processes characteristic for living organisms in nature can now be explained as the action of information such as the response to various signals, the execution of programs encoded in A-T-C-G sequences, or the interpretation of codes.

4.3. Information in Deep Existence

Informatter is the concept introduced by Mihai Draganescu [6] to designate the intimate relation between matter and information in the deep existence. At the same level of existence he introduced the term of *phenomenological information* (see Definition 11, above). Both informatter and phenomenological information are the result of a speculative philosophical approach that comes in the extension of scientific approaches that have reached the limit beyond which Popperian falsifiability becomes inapplicable.

The understanding of a profound role of information is currently in the early speculative stage. Therefore, the incomplete development of information theory is exemplified by the several distinct meanings of *"information"* used in [4]. Although all the authors are mainly based on the Shannonian quantitative theory, when the question of qualitative interpretations is raised, the dispersion of opinions is maximum. Many scientist continue to understand only matter and energy as the foundational concepts of nature, and the information to be a derived concept. Indeed, we do not even possess a simple and unequivocal physical measure for information, as we have for mass and energy in terms of units of *gram* and *joule*.

Because we have reached the realm of speculation, we could conjecture that, if a physical measure of deep information were possible, then not only mass and energy could be mutually equivalent, but also that physical measure of deep information could be put into correspondence with mass and energy.

At one point, in the 1980s, in a discussion with Professor Mihai Drăgănescu, I allowed myself to opine that information is, in the last instance, a purely structural effect, but which takes place at very low energetic and material levels. In this case, information is only a specific model for processes that take place at these very small levels (bits in a memory or molecular structures). Indeed, I was saying, a bit in a microelectronic memory cell represents the state of a physical system, and a DNA chain is a configuration of bases A, T, C or G, each of these bases representing distinct chemical structures. The Professor's reaction was that maybe this approach would be correct, but it does not exclude the deep phenomenological information which is a reality clearly distinct from matter and energy.

It would not be surprising that we can really talk about information only in the depth of existence, where for now we can only speculate. This focus only on purely phenomenological information (see Definition 11) could be the way to find a successful approach to phenomena that are currently unapproachable; it is about consciousness, theory of everything, ...

5. Concluding remarks

Can the hypothetical existence of phenomenological information be the foundation for different informational approaches in the spaces where we can experiment (as researchers) or build (as engineers)? Can the coherence of the theories that we can develop regarding information at different accessible existential levels be a clue to validate the phenomenological information in the depths of existence? Because we are not yet prepared to give answers to these questions, we will settle for John A. Wheeler's comment:

> *"... celebrate the absence of a clean clear definition of the term "bit" as elementary unit in the establishment of meaning. We reject "that view of science which used to say, 'Define your terms before you proceed.' The truly creative nature of any forward step in human knowledge," we know, "is such that theory, concept, law and method of measurement — forever inseparable — are born into the world in union." If and when we learn how to combine bits in fantastically large numbers to obtain what we call existence, we will know better what we mean both by bit and by existence."* [22] (p. 322)

In the effort to clarify both the bit and the existence (it), M. Drăgănescu introduced the concept of *informater* through which the *"it from bit"* [22] and *"bit from it"* [8]dilemma is overcome before it appeared. Through this paper, we have tried to provide a content to the *it-bit* relationship by highlighting the information as a symbolic, bit structure that ***acts*** by its meaning in a specific context.

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