Erroneous concepts of prominent scientists: C.F. Weizsäcker, J. A. Wheeler, S. Wolfram, S. Lloyd, J. Schmidhuber, and M. Vopson, resulting from misunderstanding of information and complexity

Mariusz Stanowski
E-mail: stanowskimariusz@wp.pl

Abstract

The common use of Shannon's information, specified for the needs of telecommunications, gives rise to many misunderstandings outside of this context. (e.g. in conceptions of such well-known theorists as C.F. Weizsäcker and J. A. Wheeler). This article shows that the terms of the general definition of information meets the structural information, and Shannon's information is a special case of it.

Similarly, complexity is misunderstood today as exemplified by concepts of reputable computer scientists such as S. Lloyd, S. Wolfram and J. Schmidhuber. These theorists use an algorithmic definition of complexity and the so-called logical depth, neither of which meets the intuitive criterion of complexity. Hence, their misconceptions of beauty, art and the universe. It will be shown that the intuitive criterion is met by Abstract Complexity Definition. This definition also fulfils the criterion for a general complexity definition, as it defines complexity of the most general/abstract structure of our reality, i.e. binary structure. It also explains such fundamental issues of information theory as the information-energy relationship and the value of information, which are still discussed and need to be clarified.

Keywords

Definition of interaction, definition of contrast; complexity and information definitions; information-energy relationship; value of information; erroneous concepts of information/complexity theorists.

Introduction

Fundamental concepts such as information, complexity, interaction, contrast, beauty, value are currently not entirely clear or misunderstood and require precise definitions. Nevertheless, new and often erroneous concepts are being created on their basis. An example is the common use of Shannon's information, specified for the needs of telecommunications which gives rise to many misunderstandings. (e.g. in conceptions of C.F. Weizsäcker, J. A. Wheeler and M. Vopson). The purpose of this article is not only to draw attention to this problem, but above all to provide the missing knowledge at the fundamental level. On the one hand, this knowledge has an explanatory and corrective character and, on the other hand, it can be the beginning for further inquiries revising ossified views and ideas.

The article is based on the recent findings concerning the foundations of our knowledge formulated in the book: *Theory and Practice of Contrast: Integrating Science, Art and Philosophy* [1] and addresses the understanding of the issues of complexity and information, which seem particularly relevant today. A misunderstanding of them hinders the development of many fields, including the development of artificial intelligence (the problem of creativity and self-awareness), physics (the concept of the universe), philosophy (aesthetics, axiology, epistemology, ontology) and cognitive science.

First of all, a new definition of contrast will be introduced as a **tension resulting from the interaction of common and differentiating features** (as opposed to the existing understanding of contrast as contradiction or major difference). Understood in this way, **contrast is equivalent to interaction** which deepens the understanding of what interaction is in a general sense. It is also an element that explains and integrates other foundations of our knowledge such as development, complexity, information, value, beauty, creativity, emergence, consciousness and being.

Next, information and complexity will be defined. It will be shown that the terms of the **general definition of information meets the structural information, and Shannon's information is only a special case of it**. Similarly, complexity is misunderstood today as exemplified by concepts of S. Lloyd, S. Wolfram and J. Schmidhuber. These theorists use an algorithmic information content (AIC) and the so-called logical depth, neither of which meets the intuitive criterion of complexity. Hence, their misconceptions of beauty, art and the universe. It will be shown that **the intuitive criterion is met by Abstract Complexity Definition**. **This definition also fulfils the criterion for a general complexity definition, as it defines complexity of the most general/abstract structure of our reality, i.e. binary structure.** It also explains such fundamental issues of information theory as the information-energy relationship and the value of information, which are still discussed and need to be clarified.

These general considerations will be applied to the analysis of widely disseminated concepts by well-known (aforementioned) authors and demonstrate their fallacy.

Interaction is equivalent to contrast

To understand what information and complexity are in a general sense, we need to enter a more general level of consideration. Our reality is composed of entities (objects, features, structures) that we can somehow distinguish. These structures interact with each other through common and differentiating features, that is through contrast. **The common features cause the different features to be compared/combined. This creates a tension, which is the very essence of any interaction.** One can easily verify that this is what every interaction in nature, whether physical or mental, is based on.

This conclusion emerged during aesthetic considerations and in particular an attempt to understand visual interactions. The result was a new definition of contrast as "**interaction or tension caused by the impact of common ("attracting") and differentiating ("repelling") features of the objects under consideration. Contrast grows stronger as the number/strength of common and differentiating features held by contrasting objects increases.**" This definition is general and covers all kinds of contrasts between any objects, including contrasts that arise between perceived objects and our mind. It proved to be the universal law of nature and principle of being, as well as a powerful explanatory tool.

Let's consider what makes this definition different from existing general definitions of contrast? For example, in French dictionary contrast is defined as: "**opposition (contradistinction) between two or more things, emphasized and highlighted by their closeness or a mutual relationship**".

In the first place, the new definition enables to analyze contrast which is understood here as the impact of varying value (contrast may be stronger or weaker), whereas existing definitions describe contrast as some extreme value: opposition, contradiction or a major distinction.

The second modification is that we take into account common features of contrasting objects, which, just like differentiating features, may differ in terms of impact power and effect they have on the magnitude of contrast.

The third change has to do with the nature of contrast being understood as tension resulting from the impacts of common and differentiating features.

And the fourth change is that contrast so far has been understood as a big difference or contradiction, and, in consequence, it took into account only one feature (one quality) of contrasting objects – it is the opposition within the same feature (for example: small-large or light-dark). The new definition of contrast takes into account all features of contrasting objects (all common and differentiating features) and thus takes into account the diversity and complexity of objects.

Contrast is equivalent to development and complexity

Contrast, understood in this way, is linked to other fundamental issues e.g. **development.** The common features unite the contrasting objects into a new structure possessing the features of those objects, so contrast can be identified with development. A similar general view we can find in Whitehead's cosmology [2].

Another important association is with the intuitive criterion of complexity, which can be formulated as follows: **"the complexity of an object/structure is greater the more elements can be distinguished in it and the more connections there are between them"** [3]. If we replace "connections" with "common features" and "distinguishable elements" with "differentiating features", we get a definition of contrast. **Thus, we can also equate contrast with complexity.**

Note: The concept of a feature can be attributed to objects both inside and outside our mind. Common features are precisely what connects objects, i.e. we can say that they are connections, e.g. the common feature/connection between two visual objects: a red square and a green square is the feature of shape (square). The statement that common features connect or are connections is a tautology. The differentiating feature here, on the other hand, is the different colour (red and green) and it can be said that we distinguish between the objects-squares thanks to them, or that they are distinguishing elements.

Binary Model of Visual Interactions

The essence of complexity and contrast is expressed by a **binary model** consisting of three eight-element binary structures: **10010110, 10101010, 10100011**; each contains 4 ones and 4 zeros but with a different arrangement, which implies a different number of substructures that can be extracted in them – in the first structure – 8, in the second – 1 and in the third – 3. Let us see how they were counted (note that the extraction should be regarded as somewhat approximate).

In order to examine them as visual structures, we count the contrasts and the number of features present in each of them.

In the structure 10010110 we notice the following contrasts/substructures:

1. Symmetry: **10|01**0110
2. Symmetry: 1001**01|10**
3. Inverse symmetry: 1001|0110
4. Ones: **1**00**1**0**11**0
5. Zeros: 1**00**1**0**11**0**
6. Symmetry of ones and zeros (4 and 5): 1001|0110
7. Single elements : **1**00**10**11**0**
8. Doubled elements: 1**00**10**11**0

1. Bold elements create a symmetry (contrast) between two zeros located in the middle and two ones. The common feature is the presence of identical elements on both sides of the symmetric axis, while the differentiating feature is their reverse arrangement.
2. Bold elements create a symmetry (contrast) between two ones in the middle and two outside zeros. The common feature is the presence of identical elements on both sides of the symmetric axis, while the differentiating feature is their reverse arrangement.
3. Symmetry 1 and 2 create an inverted symmetry (contrast), which is marked with number 3. The common feature is a symmetrical arrangement of elements, while the differentiating feature is their value.
4. Ones (double and single) produce a contrast of quantity. The common feature is value, while the differentiating feature is quantity.
5. Zeros (single and double) produce a contrast of quantity. The common feature is value while the differentiating feature is quantity.
6. Elements ones and zeros (4 and 5) create a symmetry (contrast). The common feature is the placement of ones and zeros, while the differentiating feature is value.
7. Single elements (zeros and ones) create a contrast of value. The common feature is quantity (singleness), while the differentiating feature is value.
8. Double elements (white and black) create a contrast of value. The common feature is quantity (doubleness), while the differentiating feature is value.

There are eight contrasts and 16 features present (the latter have been identified together with the contrasts). Observe that each contrast creates a distinguishable substructure. Elements of each of these substructures contain common and differentiating features, which is the condition for any substructure to become distinguishable and, simultaneously, the condition for contrast to emerge. In order to estimate the contrast present in a binary structure, it is therefore sufficient to identify and count its substructures (note: analyses of visual structures [1] show that the contrasts/interactions occurring in a given structure add up to form an aggregate contrast). This is a convenient method, which furthermore helps to define complexity of a binary structure. When analysing contrasts, we have not taken into account the differentiating features resulting from the placement of individual elements, because these are uniform for all elements and are of minor importance. Consequently, we have not considered, for example, substructures composed of “single ones” or “single zeros” because their elements do not create any contrast (have no differentiating features).

In the structure 10101010 it is possible to distinguish following substructures:

1. Ones: **1**0**1**0**1**0**1**0
2. Zeros: 1**0**1**0**1**0**1**0**

Contrasts:

1. Here a contrast is created by zeros and ones. The common features is quantity of elements, while the differentiating feature is their value.

Thus, we have here one contrast. Let’s see how many substructures can be distinguished. Two substructures stand out: “zeros” and “ones”. However, we should reject them because, as we have pointed out, their elements contain no differentiating features. However, these two substructures connect and produce a contrast to create a structure:

1. Single elements (zeros and ones).

These elements can be considered as a “substructure” superimposed on the entire structure under analysis. Therefore, we have one substructure and a single contrast, which also confirms the observation that the number of contrasts equals that of distinguishable substructures.

In the structure 10100011we can isolate the following substructures:

1. Single elements: **101**00011
2. Zeros: 1**0**1**000**11
3. Ones: **1**0**1**000**11**

Other distinguishable elements are a double element and a triple element. However, they will not be taken into account here since they are not substructures and do not create contrasts as single elements.

The following contrasts correspond to the identified substructures:

1. Single elements (zeros and ones) create a contrast. The common feature is quantity, while the differentiating feature is value.
2. Zeros (a triple zero and a single zero) create a contrast. The common feature is value, while the differentiating feature is quantity.
3. Ones (a double one and single one) create a contrast of quantity. The common feature is value, while the differentiating feature is quantity.

For the same number and type of elements (4 zeros and 4 ones), the greatest number of contrasts is offered by the structure 10010110. That structure is also the most complex (which is consistent with the intuitive criterion) and seems to be the most attractive/interesting visually. We can also see – and this is very important—that the abstract binary structure may be analysed in the same way as visual structures. Thus, it may be stated that the present example establishes the connection between visual impacts and the area of abstract (most general) "impacts". Consequently, the latter can be taken as the model for impacts of any kind (provided that "impacts" are understood as the connecting of structures of any type and the contrasts between those structures). Each substructure, i.e. each distinguishable regularity in a given structure, can be considered as a single bit of structural information.

This simple model provides important conclusions:

1. Among structures with the same number of elements, the most complex (creating the greatest contrast) is the one that has the greatest number of distinguishable substructures (according to the definition of contrast and complexity).
2. In a more complex structure the same amount of energy which here is represented by four ones (energy quanta) is needed to obtain more information. The perception of a complex structure is therefore more economical (cost-effective) and thus preferred. This is also where our aesthetic preferences and beauty come from. An example is the golden division which has more features/information than any other division (the additional feature is the well known golden proportion/division).
3. The energy-information relationship and the value of information is explained here. The model shows that more complex, organised and therefore more valuable information requires less perceptive energy. This kind of organisation can be defined as information compression because it saves energy.

This section is a quotation from [1].

Abstract Complexity Definition

In the Abstract Complexity Definition [4], information compression, defined as the degree of organization D is one factor of complexity and expressed by the number of substructures (N), divided by the number of elements, zeros and ones (n) – the another factor is the size of compressed area (because it is more difficult to compress larger area) expressed by the number of substructures (N). So Abstract Complexity Definition defines complexity (C) as number of substructures (N) to the power of two, divided by number of zeros and ones (n).:

$$C = D \cdot N = \frac{N}{n} N = \frac{N^2}{n}$$

This formula directly refers to the binary structure and can be applied to any domain that can be formalized in digital form (e.g. music) which (theoretically) means all structures of reality (the first to note the possibility of binary simulation/recording of all physical processes/objects of any complexity was L. Bertalanffy [5]). It also allows to understand the essence of complexity and information compression in the most general (abstract) sense, and therefore apply to any structure of reality in the sense that it helps to find the way of information compression and complexity in any particular area. This makes it possible to pursue complexity more consciously (an example could be any text, where we try to be most concise).

It is worth noting that information compression is common wherever development in the broad sense of the term takes place. We deal with it during perception, learning, cognition and creativity. It also is the objective cause of contrast, interaction, complexity, development, our preferences, pleasure, beauty, value and goodness [1], [6].

Realizing what value is in general seems to be important for us especially today, when actually all values are questioned (according to the postmodern paradigm).

Erroneous concepts

The above understanding of information (as each distinguishable substructure or a form of energy) is structural and general, and can be applied to all areas of reality. The exception is the technical application of information (e.g. in telecommunication or computer science), where each information must be distinguished and identified unambiguously, to avoid confusion in processing. Therefore, Shannon's information [7] is not related to a system/structure, but to the state of a set, which is a combination of equally distinct elements. Thus we are not dealing here with complex systems/structures of coherently connected elements, but with collections, which can also be classified as structures, but with poor coherence. Information understood in this way has found an analogy in thermodynamics because the possible states of a collection of gas atoms (at a certain volume and temperature) can be compared to the individual codes of a given set/code table. This is why the Shannon information was considered universal. In reality, however, alongside sets and collections there are structures and complex systems in which the information (feature, form) is understood as everything that can be extracted from them. A general model of (structural) information understood in this way is the binary model presented above.

Shannon's information is therefore a special case of structural information and in fact limited to narrow technical area. Nevertheless, it is widely used beyond the technical context as a general and universal definition, together with associated algorithmic definition of complexity. Many misunderstandings arise from this:

1) An example of such misunderstanding could be the algorithmic complexity which is also called the algorithmic information content (AIC) [8] applied to the concept called Low-Complexity Art, by computer scientist—Jürgen Schmidhuber [9], where he concludes that the aesthetic attractiveness of objects (e.g. Leonardo da Vinci artworks) is inversely proportional to their complexity which is counter-intuitive because we consider both complexity and works of art to be valuable. From our considerations it appears exactly the opposite – that greater contrast, value, art and beauty is where complexity is greater, that is, where receiving information we save more energy what was discussed above.

The algorithmic complexity of a text or a bit string is equal to the length, in bits, of the shortest computer program that produces that text or bit string as output. This definition, however, does not refer directly to the object itself, but characterizes its complexity through a description. Highly regular, periodic or monotonic strings may be computed by programs that are short and thus contain little information, while random strings require a program that is as long as the string itself, thus resulting in high (maximal) information content. This is clearly counterintuitive, as shown by the example of a monkey typing a text that is more complex than J. Joyce's Ulysses. Algorithmic complexity captures the amount of randomness of symbol strings, but is inadequate for applications to coherent structures such as biological, neural or visual systems. It also contradicts computational definition, since short programs computed for a long time have a high computational complexity and small AIC, while random strings with maximal AIC have relatively small computational complexity. However, this definition is widely used in many fields where these applications are not adequate, e.g. in visual perception studies [10]. It probably happens because the definition is most popular and well grounded in science (links to thermodynamics and information theory).

2) Understanding what complexity and organization is, also allows to understand how highly organized structures/objects such as living organisms are created and what is their evolution and development. **Development as well as contrast, complexity and compression of information (that is, the economy resulting from energy savings) can be identified with the value in general, hence with the value of information.** In the above sense, valuable information should also include the so-called free energy. Let us see how Seth Lloyd explains it [11]:

> The laws of thermodynamics guide the interplay between our two actors, energy and information. To experience another example of the first and second laws, take a bite of an apple. The sugars in the apple contain what is called free energy. Free energy is energy in a highly ordered form associated with a relatively low amount of entropy. In the case of the apple, the energy in sugar is stored not in the random jiggling of atoms but in the ordered chemical bonds that hold sugar together. It takes much less information to describe the form of energy present in a billion ordered chemical bonds than it does to describe that same energy spread among a billion jiggling atoms. The relatively small amount of information required to describe this energy makes it available for use: that's why it's called free.

Therefore, free energy is a "highly ordered form", which is exactly what we have defined as a more complex system/structure. The availability of energy contained in this system is explained by the small amount of information needed to describe it: *The relatively small amount of information required to describe this energy makes it available for use: that's why it's called free*. On the one hand, the above conclusion seems logical: less information can be absorbed more quickly (and therefore easier) than more information. Let's check, however, if this principle is general and consider another example in which the description of energy is also shorter.

If we take, for example, sand or polyethylene instead of sugar, then here we also deal with chemical compounds and not with the accidental movement of atoms, therefore the description of their energy requires less information (it is shorter). According to the above explanation, energy should also be available here for us. However, this does not happen, which contradicts the explanation. The explanation by S. Lloyd should therefore be considered incorrect.

The above example shows the application inadequacy of the algorithmic information and complexity outside the technical context, where the information values are various and not determined only by their quantity (an example is a monkey writing a text more complex than

Shakespeare's novel). Important is the value of information, not the length of its description. Considered an example of apple consumption, in the light of our considerations, it can be interpreted as follows: the availability of (free) energy depends primarily on a sufficiently large number/strength of features (information) common to our body (digestive system) and the product that we want to digest (that is – a given form of energy which we would like to join), hence from the possibility of contrast/interaction. This contrast (that is – a value of the product consumed) will be the greater the stronger will be the common features of the organism and the product (while maintaining the impact of different characteristics).

Also, the magnitude of contrast of the atomic system and not the length of its description is significant when comparing the set of disordered atoms and the chemical compound. Orderly atoms have more (stronger) characteristics than chaotic ones. Strengthening the impact of common features while maintaining the impact of differentiating features is associated with increased contrast and complexity. Important differentiating features here, are isolated (different) atoms that do not cease to be separated after strengthening common features. On the other hand, irrelevant (less distinctive) differences in the random motion of atoms disappear. Thus, chemical compounds are characterized by greater complexity, that is, higher value of information contained in them than the value (of a larger number) of information contained in disordered atoms.

3) Another example of a counter-intuitive definition of complexity is "logical depth" (formulated by C.H. Bennett [12]). It combines two complexity definitions: algorithmic complexity and computational complexity (defined as the minimal amount of computational resources (time, memory) needed to solve a given class of problem). Complexity as logical depth refers mainly to the running time of the shortest program capable of generating a given string or pattern. Similar to algorithmic complexity, complexity as logical depth is a measure of a generative process and does not apply directly to an actually existing physical system or dynamical process. Computing logical depth requires knowing the shortest computer program (which is un-computable), and thus the measure is subject to the same fundamental limitation as algorithmic complexity.

The logical depth functions as a confirmation of high complexity of the fractal patterns that make up e.g. snowflakes, shoreline, or cellular automata. These patterns, although simple at first, get very complicated over time. The question arises whether they are also complex and if so by what criterion? The criterion is that the generation of a particular pattern emerged after a certain time or number of steps (e.g. by a computer) requires the repetition of all these steps.

This is probably where the name "logical depth" comes from. Thus, the high complexity of these patterns is evidenced by the time of generation (which says nothing about the object-pattern itself, besides, we also observe cyclical changes of complexity in nature, which contradicts this definition) and the visual impression (largely subjective).

A special supporter of such confirmation is computer scientist Stephen Wolfram fascinated by the beauty and “complexity” of these patterns, He believes that the universe functions analogously to a cellular automaton and emerges from simple rules much like fractal patterns as described in his book *New Kind of Science* [13].

The complexity of fractal patterns, as well as their aesthetic value, is not confirmed. Judging by the absence of such patterns in art (i.e. as valuable artworks) , their aesthetic value (and therefore complexity) is not among the highest. The value of beauty and art is not only influenced by visual patterns (even extremely attractive ones), but also by the meanings associated with them. Art is ambiguous of which a layperson may not be aware. Also, complexity, understood here as “logical depth”, which is supposed to be a confirmation, does not meet the intuitive criterion of complexity discussed earlier. S. Wolfram's concept of the universe should therefore be considered erroneous because it is based on faulty assumptions.

4) There are also conflicting views on the subject of energy-information relations to this day. Some theorists believe that information can be identified with energy, others think in the opposite way. E.g. Carl, Friedrich von Weizsäcker in his book: *The Unity of Nature* [14] states the identity of form and matter and measuring them - information (measuring the amount of form) and mass (measuring the amount of matter). This understanding, however, is valid only for Shannon information understood as an element of the collection (states of a system), that is, where every information corresponds to a single, specific portion of energy—needed for recording, erasure or transmission of information (the code structure of the information is not taken here into account), but it is not right where (distinguishing) elements form a coherent organized entities (as a result of relationships with other elements). Here the energy of recording and transmission of information is identified with the energy contained in the structure of a given information (number of ones) and may be different for different information. **In such well-organized objects/structures (e.g. such as the brain) thanks to information compression and the associated energy savings, the amount of information per unit of energy is greater than in less complex/organized objects.**

Energy is necessary for the existence and transmission of information (matter/energy, speaking Aristotelian is the possibility of form). No form exists without energy—hence the erroneous view of some theoreticians (Weizsäcker) that information identifies with energy), but not all information requires the same amount of energy—hence the view of some theoreticians e.g. N. Wiener [15] that information is not energy. The truth, instead, is that information is not energy, but a form of energy, which, however, does not exist without energy.

5) In (1990), J. A. Wheeler has written [16]:

> It from bit. Otherwise put, every it — every particle, every field of force, even the space-time continuum itself — derives its function, its meaning, its very existence entirely — even if in some contexts indirectly — from the apparatus-elicited answers to yes-or-no questions, binary choices, bits. It from bit symbolizes the idea that every item of the physical world has at bottom — at a very deep bottom, in most instances — an immaterial source and explanation; that which we call reality arises in the last analysis from the posing of yes-no questions and the registering of equipment-evoked responses; in short, that all things physical are information-theoretic in origin and that this is a participatory universe.

It follows that Wheelers universe is based on immaterial information. It doesn't make sense because there is no information (no structure, no anything) without energy (causal force). It is so obvious that sometimes difficult to realize that structure e.g. 10010110 does not exist without energy quanta (ones) which only definition (only information we have about them) is that they are different from zero - the structure 00000000 does not exist (Aristotle knew this well).

6) An example of a misunderstanding the meaning of information is the concept of M. Vopson who tries to prove the equivalence of information, mass and energy on the basis of Landauer's principle [17].

> Landauer's principle formulated in 1961 states that logical irreversibility implies physical irreversibility and demonstrated that information is physical. Here we formulate a new principle of mass-energy-information equivalence proposing that a bit of information is not just physical, as already demonstrated, but it has a finite and quantifiable mass while it stores information. In this framework, it is shown that the mass of a bit of information at room temperature (300K) is 3.19 × 10-38 Kg. To test the hypothesis we propose here an experiment, predicting that the mass of a data storage device would increase by a small amount when is full of digital information relative to its mass in erased state. For 1Tb device the estimated mass change is 2.5 × 10-25 Kg. ([18].

At a fundamental level (as we explained before), the term information means nothing else but the same as structure, feature or form. There is no structure, feature, form or information without energy, which is why information is also defined as a form of energy. However the above understanding incorrectly implies that information is some other physical/ontological entity. Considering that, the proposed experiment with estimating the mass of a data storage device, does not make sense in this context. Below we will demonstrate that also the understanding of Landauer's principle is wrong here.

Landauer's principle is based on the equation of Leon Brillouin [19] estimating the energy of one bit of information as the minimum energy of a particle (e.g. photon) that has to overcome the energy of thermal noise to carry the information (formula below). The Landauer's principle only applies this equation to erasing process (e.g. in computation). It asserts that there is a minimum possible amount of energy required to erase one bit of information, known as the Landauer limit: $E = kT\ln 2$, where k is the Boltzmann constant (approximately $1.38\times 10{-}23$ J/K), T is the temperature of the heat sink in kelvins, and ln 2 is the natural logarithm of 2 (approximately 0.69315). After setting T equal to room temperature 20 °C (293.15 K), we can get the Landauer limit of 0.0175 eV.

The first mistake here is to equate the energy required to erase a bit of information with the energy of the bit of information itself. As we showed earlier, information is not energy but a feature, structure or a form (of energy), such as a shape for a stone (in the case of structural information) and a state of a system (e.g. particles in a gas or a sequence of digits in a code) in the case of Shannon information.

The second error is to extend Landauer's limit (concerning the erasure of information in a gas-particle environment, as we find, e.g., in the case of an ordinary computer) to the erasure of information in any environment, e.g. subatomic. Therefore, the experiment proposed below does not make sense either:

> The mass-energy-information equivalence principle and the information content of the observable matter in the universe, represent two important conjectures, called the information conjectures. Combining information theory and physical principles of thermodynamics, these theoretical proposals made specific predictions about the mass of information, as well as the most probable information content per elementary particle. This experimental protocol allows empirical verification of the information conjectures, by confirming the predicted information content of elementary particles. The experiment involves a matter – antimatter annihilation process. When electron – positron annihilates, in addition to the two 511 keV gamma photons

resulting from the conversion of their rest masses into energy, we predict that two additional low energy photons should be detected, resulting from their information content erasure. At room temperature, a positron – electron annihilation should produce two ~50 mm wavelength infrared photons due to the information erasure. This experiment could therefore confirm both information conjectures and the existence of information as the 5th state of matter in the universe [20].

Conclusion

As we have tried to prove, the fallacy of the analyzed concepts lies in the application of technical/formal definitions of complexity and information (taking into account only quantity of information) in non-technical contexts such as art, chemistry, physics, philosophy, where not only the quantity of information but also its quality/value/information compression matters. The value of information is only taken into account by the principle of contrast and also by the Abstract Definition of Complexity, the basic factor of which is the degree of complexity, i.e. compression of information. The concept of information compression is not currently used outside of a technical context. Nor is the principle of energy saving in objects with higher complexity taken into account. However this principle clarifies and integrates fundamental issues such as: **contrast/interaction, art, beauty, development, value, consciousness, emergence, complexity, information, AI-creativity and self-awareness.**

It is easy to see that these concepts include both humanistic and scientific aspects, which integrate here. This integration enabled the general level of considerations on which it was possible, however, to introduce a new quality in the form of the definition of contrast-interaction. This article points out how important this definition is for understanding reality and how its absence leads to misunderstandings and misconceptions.

The crisis of contemporary science depends also in not undertaking the effort to verify fundamental issues and moving on to detailed research often on the basis of faulty assumptions. This, in turn, results in the accumulation and preservation of unnecessary knowledge that is a ballast for more insightful inquiries. The reluctance for a deeper research is also due to the commercial/formal nature of contemporary science. The drive to organise it leads to even greater specialization resulting in a measure of its value being the number of publications rather than its scientific content. The formalisation also blocks interdisciplinary research combining the foundations of distant fields such as natural sciences and humanities. Interdisciplinary fields are not to be found in any lists of university or publishing specialities, which is also related to the lack of appropriate scientific resources (scientists, reviewers, etc.).

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