General Definitions of Information and Complexity

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The presentation will be based on my book “Theory and Practice of Contrast– Integrating Science, Art. and Philosophy” (Stanowski 2021) and addresses three fundamental issues of information theory: the general definitions of information and complexity, the information-energy relationship and the value of information, which are still discussed and need to be clarified. The subject of information 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 interaction of common ("attracting") and differentiating ("repelling") features of the objects under consideration”, which is general and covers all kinds of contrasts between any objects, including contrasts that arise between perceived objects and our mind. The common features unite the contrasting objects into a new object-structure possessing the features of those objects, so contrast can be identified with development (Whitehead 1978). Another important association with this definition is the intuitive criterion of complexity: "the complexity of an object/structure is greater the more elements can be distinguished in it and the more connections there are between them" (Heylighen 1999). 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. The essence of complexity and contrast is expressed by a binary model consisting of three eight-element structures: 10010110, 10101010, 10100011; each contains 4 ones and 4 zeros but with a different arrangement, which implies a different number of regularities (substructures, features, information) that can be extracted in them (in the first structure – 8 features, in the second – 1feature and in the third – 3 features). 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 (different) regularities-substructures-information (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, or the same amount of information needs less energy. 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 proportion).
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. In the Abstract Complexity Definition (ACD) information

compression is a part of complexity which also takes into account the size of compressed area. ACD defines the complexity (C) of a binary structure (i.e. the most general one) with a given number of zeros and ones (n) as the degree of organization (D) expressed by the number of substructures (N), divided by the number of elements (n) [D=N/n] (which can be identified with information compression) multiplied by the number of substructures (N) - which informs about the size of the compressed area. The formula is as follows:

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

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). 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 area. This makes it possible to pursue complexity more consciously (an example could be any abstract, but also any text, where we try to be most concise). I would like to point out here 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 isthe objective cause of contrast, complexity, development, preferences, pleasure, beauty, value and goodness.

The above understanding of information 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 is not related to the system, 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. 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.

References

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