

As a student I was both fascinated and confused by the mysterious remarks of some of my lecturers concerning the apparently “deep” connection between the concepts of entropy and information (or sometimes the claim of the total absence thereof). This resulted in my extensive reading of more or less popular scientific presentations of the subject. This, however, not always contributed to greater enlightenment, which I usually attributed to my general lack of understanding of the matter.

With his present book, Arieh Ben-Naim’s declared aim is to point out some of the basic relationships between information and entropy, and simultaneously do away with the plethora of unjustified generalizations or abusive use of these terms, especially in popular literature. The author—Professor Emeritus for Physical Chemistry at the Hebrew University of Jerusalem—has been dealing with this topic for decades and has already published several books on the subject.

The basic idea of the present book can be summarized quite succinctly: colloquially, the term “information” has a certain meaning to all of us, but it can be quite difficult to quantify. The special case of “Shannon information” (the author uses the term “Shannon’s measure of information”—SMI—throughout the text) can only be applied to statistical distributions that describe the probability of the results of certain experiments (or, e.g., symbol frequencies in sequences). Thus, SMI is a measure of our ignorance with respect to the outcome of a random experiment, which is described by the corresponding distribution. In the special case that the underlying probability distribution describes a thermodynamic system at equilibrium, the SMI associated with the distribution is in fact identical with the entropy—but only then.

Ben-Naim has strong reservations against the unwarranted confusion of these terms and the consequent derivation of bold—and in his opinion mostly untenable—interpretations. In this context, he quotes a large number of examples from popular literature where “entropy” is used in a non-thermodynamic context, and is then further identified with “information” in the colloquial sense. This includes statements such as “it from bit”, “the universe is made of bits”, “information can be neither created nor destroyed”, etc., which the author sharply rejects.

Ben-Naim’s book is divided into four major sections. The first two sections discuss the concept

of information and Shannon’s information measure and give a good, fairly elementary introduction to the concept of entropy in thermodynamics. The two following, much shorter sections are devoted to the—often incorrect or simply meaningless—application of these concepts to life phenomena and the universe as a whole.

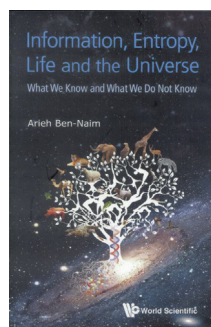
In the course of the book, quite a number of famous ideas and concepts are addressed and analyzed in the light of the precise definitions of entropy and SMI. In this context the author makes a variety of surprising statements. For example, Maxwell’s demon poses no mystery to the author at all (as the discussion is pointless as long as you can neither define the entropy of the demon or of the universe). Further, there is no correlation between the second law and the “arrow of time”, and also the identification of entropy and disorder is not fundamentally justified (the author gives counterexamples). Also Schrödinger’s cat is an ill-conceived problem, since the wave function of a “living” or “dead” cat cannot be specified (otherwise we could somehow define the “living state” itself—which we can’t).

With all its profoundness the book is very understandable and easy to read and should be accessible to a wide audience with a general scientific background. Occasionally the repetitive discussion of the tenor of the book (entropy is not equal to SMI and SMI is not information in general) may feel a little tiring. What is particularly amusing, however, is the caustic analysis of a large number of quotes from popular science books—many of which written by famous authors—in which sloppy statements and inaccurate formulations are mercilessly dissected.

Overall, the book provides a pleasantly dry look at a subject matter that frequently plays a role in popular science literature when it comes to explaining the really big picture (what is life, what is time, what is the future of the universe?). While here some authors get carried away and come up with extreme generalizations or blurred and florid statements, Ben-Naim keeps strictly to the definitions of the underlying concepts. What may be a little disillusioning in the end is that—in his judgment—most of the grandiose ideas and theories put forward in this context are either imprecise, irrelevant, or simply wrong.

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