Review of: "On the statistical arrow of time"

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Potential competing interests: No potential competing interests to declare.

The paper argues for a point of view that increase in entropy is due to the growing ignorance of an observer. While this viewpoint is by no means new and has appeared in the scientific literature for more than 100 years, it is not universally accepted. This paper is well written and well understandable for a non-scientist, and reading it easy to get the main gist of the idea and the philosophy behind this viewpoint.

I have a few comments on the main mathematical points of the paper. The desiderata i-v in section “Entropy”, do not necessarily lead to Shannon entropy, although Shannon entropy is one of the measures that satisfies them. See, for example,

Csiszár, I. Axiomatic Characterizations of Information Measures. Entropy 2008, 10, 261-273.

for a more rigorous approach of axiomatic characterizations of entropy measures.

Further, the formula for entropy that the author arrives at, eq (23), is called, among other names (such as Shannon entropy), the entropy of measurement. While this measure has a desired property that it increases, even for isolated systems that follow the Liouville evolution, I and others argued that this is not a good measure to associate to the system. Eq. (23) is the amount of uncertainty an observer has about the measurement of the system, but not the system itself. This is because it is upper-bounded by the logarithm of the number of outcomes, thus depending on the type of measurement, but not on the size of the system. A better but similar quantity that describes the thermodynamic grow of the uncertainty an observer has about the system (rather than about the uncertainty about the measurement outcomes) is given by observational entropy, which includes an additional weight in the logarithm given by the size of each macrostate. As a result, observational entropy is upper bounded by the logarithm of the size of phase space, rather than of the number of measurements. Idea of observational entropy is also not new and it resurfaced many times over the years. Among other names, it was also called “coarse-grained entropy”. See review

D Šafránek, A Aguirre, J Schindler, JM Deutsch, “A brief introduction to observational entropy” Foundations of Physics 51 (5), 101 (2021)

that includes both classical and quantum systems and paper

D Šafránek, A Aguirre, J M Deutsch, “Classical dynamical coarse-grained entropy and comparison with the quantum version”, Physical Review E 102 (3), 032106 (2020) regarding the classical systems for more details, and the references within.