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Sequence Complexity and Work Extraction

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Abstract. We consider a simplified version of a solvable model by Mandal and Jarzynski, which constructively demonstrates the interplay between work extraction and the increase of the Shannon entropy of an information reservoir which is in contact with a physical system. We extend Mandal and Jarzynski's main findings in several directions: First, we allow sequences of correlated bits rather than just independent bits. Secondly, at least for the case of binary information, we show that, in fact, the Shannon entropy is only one measure of complexity of the information that must increase in order for work to be extracted. The extracted work can also be upper bounded in terms of the increase in other quantities that measure complexity, like the predictability of future bits from past ones. Third, we point out to a partial extension to the case of non–binary information (i.e., a larger alphabet), and finally, we extend the scope to the case where the incoming bits (before the interaction) form an individual sequence, rather than a random one. In this case, the entropy before the interaction can be replaced by the Lempel–Ziv (LZ) complexity of the incoming sequence, a fact that gives rise to an entropic meaning of the LZ complexity, not only in information theory, but also in physics.

Keywords: information exchange, second law, entropy, complexity.