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Return Times and Waiting Times as Entropy Estimators: History and Law of Large Numbers

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Poincaré's theorem and Kac's lemma on recurrence are basic results that one typically encounters quite early on when studying dynamical systems. Perhaps less well known is a 1993 result of Ornstein and Weiss on the time R_n it takes for the n first symbols in a sequence sampled from an ergodic measure $\mathbb{P}$ on a one-sided shift to reappear down this same sequence: they build on ideas of Wyner and Ziv to equate, $\mathbb{P}$-almost surely, the growth rate in n of these return times to the entropy of the measure $\mathbb{P}$. In other words, there is a strong law of large numbers for $n^{-1} \ln R_n$ with limit $h(\mathbb{P})$. In this sense, observations of recurrence provide a universal entropy estimator. I will discuss analogous results for pairs of measures and their application to the theory of entropy production. These new results, obtained in collaboration with G. Cristadoro, M. Degli Esposti and V. Jaksic, hold under decoupling conditions on the measures involved.

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