EEG's, permutations and the Kolmogorov-Sinai entropy

Karsten Keller, University of Luebeck, keller@math.uni-luebeck.de

The quantification of complexity of brain dynamics on the base of EEG data is a challenging problem. One reason for this is that many well-motivated theoretical complexity concepts are 'infinite', e.g. are given by a 'limit procedure', but the data are finite. The purpose of this talk is to discuss the alternative concept of permutation entropy of Bandt and Pompe, which coincides with the Kolmogorov-Sinai entropy in a special case ([2]), in a wider context.

We consider ordinal patterns which are central for the definition of permutation entropy and show that the partitions of the state space associated to the systems of ordinal patterns of given lengths contain the substantial information for determining the Kolmogorov-Sinai entropy ([1]). On this base, it is shown that the Kolmogorov-Sinai entropy is bounded from above by a quantity which generalizes the concept of permutation entropy to a system of observables. Moreover, the determination of the Kolmogorov-Sinai entropy of a multidimensional system by use of only a single one-dimensional observable and Takens' theorem is addressed, and the use of permutation entropy and variants of it in EEG analysis ([3]) is demonstrated.

References

[1] A. Antoniouk, K. Keller, S. Maksymenko. Kolmogorov-Sinai entropy via separation properties of order-generated sigma-algebras, *Discrete Contin. Dyn. Syst. Ser. A* 34 pp. 1793–1809, 2014.

[2] C. Bandt, G. Keller, B. Pompe. Entropy of interval maps via permutations, *Nonlinearity* 15 pp. 1595–1602, 2002.

[3] K. Keller, A.M. Unakafov, V.A. Unakafova. Ordinal Patterns, Entropy, and EEG, *Entropy* 16 pp. 6212–6239, 2014.