Epileptic seizures can be anticipated by geometric-topological entropy analysis

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Epilepsy is a complex brain disorder characterized by an hypersynchronous activity of neural ensemble in the brain. Nowadays electroencephalography (EEG) is the golden standard for studying, monitoring and diagnosing epilepsy. Signals (time series), recorded by EEG, represent a description of the dynamics of the brain. Epilepsy is an emergent behavior given by a phase transition between a non-epileptic state (pre-ictal state) and an epileptic one (ictal state) of the neural hypergraph [1-2]. Traditional linear techniques applied to EEG show some limitation to identify these transitions while the non-linear ones seem to be more promising. The understanding of the underlying mechanisms of ictogenesis and propagation requires a suitable formal method to compute the model that supports the anticipation of ictal states. Recently, Topological Data Analysis and topological entropy [3-4], the so-called persistent entropy, are proven to be encouraging for distinguishing healthy from unhealthy patients by showing numerical evidence of the occurrence of phase transitions. We extend the previous work by providing a theoretical justification, based on statistical indexes (skewness and kurtosis), persistent entropy and topological invariants (Betti numbers), of the preliminary numerical results which describe the occurrence of a phase transition; moreover, we also intend to investigate the role of geometric entropy in quantifying the complexity of the networks since a change of complexity is also an indicator of a phase transition [5].

References

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