An Event-Based Approach for the Statistical Analysis of Complex Intermittency in Brain Data

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Understanding critical brain events is central to neuroscientific and biophysics research. The Operational Architectonics model proposed by Fingelkurts and Fingelkurts [1, 2] provides the first framework for detecting crucial events in the brain, focusing on metastable neural assemblies characterized by distinct birth and death phenomena. These Rapid Transition Events (RTEs) are evident in electroencephalographic (EEG) recordings through alternating periods of relatively long-time quasi-stationary states (due to neural assemblies) and rapid transitions between a selforganized neural assembly and a non-organized condition (death event) or vice versa (birth event). During non-organized states, most neurons near an electrode are either in a hyperpolarized state or lack coordinated activity. Conversely, during self-organized states, the overall activity of neurons becomes highly synchronized.
This work shows a novel algorithm for detecting RTEs in temporal signals. This mathematical framework was tested against artificial signals generated in specific frequency bands. The derived sequence of events defines a point process. In the case of multichannel data, such as EEG [3], each channel is associated with such a point process and the superposition of these point processes can be used to characterize the complexity of the entire system. The superposition of derived point processes can also be exploited to derive the well-known neural avalanches of self-organized criticality (SOC) [4]. Here we also show an application of this algorithm to EEG pathological signals and to signals coming from neural models.