Dynamical informational structures characterize conscious states.

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Abstract

The dynamical activity of the human brain depicts an extremely complex energy landscape that changes over time. We propose here a novel mathematical formalism for characterizing how the attractors landscape sustained by a dynamical system evolves in time. Furthermore, we demonstrate that this mathematical formalism serves to distinguish quantitatively and rigorously between different brain states, e.g., awake from deep sleep. In particular, by using a whole-brain dynamical model integrating the underlying anatomical structure with the local node dynamics based on a Lotka-Volterra description, we compute analytically the instantaneous global attractors of this cooperative system and their associated directed graphs, called the informational structures. The informational structure of the global attractor of a dynamical system describes precisely the past and future behavior in terms of a directed graph composed of invariant sets (nodes) and their corresponding connections (links). We characterize a brain state by the time variability of these informational structures. This theoretical framework is potentially highly relevant for the development of biomarkers in translational applications in the context of clinical patients with damaged consciousness levels as in coma.