Brain states characterization via off-equilibrium Fluctuation-Dissipation Theorem

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Aiming to find precise signatures of different brain states we apply the generalization of the Fluctuation–Dissipation Theorem (FDT) for systems evolving off-equilibrium. We then study the deviations from the equilibrium dynamics in order to characterize brain states by their distance from equilibrium.
For in-equilibrium systems, the FDT stands that a response function describing the effects of a small perturbation applied on a system is linearly related, via the equilibrium temperature T, to a correlation function C of the system in the absence of the perturbation [1].
As brain states evolve continuously off-equilibrium, a generalization of the FDT for systems out of equilibrium should be considered. From the many generalizations of the FDT for off-equilibrium systems, we follow in particular the formulation developed by Cugliandolo [2] (see also[3, 4, 5]), in which a set of functions denoting the deviation from equilibrium can be obtained for systems governed by a Langevin dynamic.
Then, we fit a linearized Hopf model [6] to the empiric BOLD signal for different brain states, therefore obtaining a system described by a set of coupled Langevin equations with which simulated time series are generated in order to evaluate the deviation from equilibrium.
Details on the formalism, simulations and the role of noise (in analogy with thermal fluctuations) together with preliminary results will be presented during the Conference.

References

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