Contribution ID : **72** Type : **not specified**

The role of criticality in the structure-function relationship in the human brain

mercoledì 11 giugno 2025 09:00 (30)

Healthy brains exhibit a rich dynamic repertoire with flexible and diverse spatiotemporal pattern replays across microscopic and macroscopic scales.We hypothesize that the system must operate near a critical regime for the functional repertoire to be fully explored, and flexible dynamics to emerge.To test this hypothesis, we employ a modular Spiking Neuronal Network model, where each group of Leaky Integrate-and-Fire neurons represents a cortical region.A learning rule based on Spike-Timing-Dependent Plasticity (STDP) is used to encode patterns of activations that prop- agate between modules.The patterns exploit empirical information on the number of white-matter fibers between regions. The model [1] displays two distinct dynamical regimes: an uncorrelated low-rate state and a strongly correlated state, marked by a high Order Parameter value (indicating the similarity of spontaneous activity with one of stored patterns).These regimes are separated by either a first-order or second-order phase transition, depending on the strength of global inhi- bition and structured connections. When the hysteresis loop shrinks, a continuous phase transi- tion occurs, and it opens up an extended region with high order parameter fluctuations (close a Widom line with maxima of fluctuations).The model predictions are compared with empirical data from magnetoencephalographic (MEG) recordings in healthy adults. We show that the structural- function correlation is maximized when the model is the extended critical regime.Then, the Lev- enshtein distance is used to quantify the similarity between the sequences of region activations in neural avalanches from both the empirical data and the model simulations.Notably a similar reper- toire of sequence is observed in synthetic data and MEG, only when the model operates within the critical extended regime.

[1]The role of criticality in the structure-function relationship in the human brain. M.Angiolelli S.Scarpetta et al. Physical Review Research 2025

Role

Primary author(s) : Prof. SCARPETTA, Silvia (Dept. of Physics ”E.R.Caianiello” University of Salerno Laboratorio di Reti Neurali ”Maria Marinaro)

Presenter(s) : Prof. SCARPETTA, Silvia (Dept. of Physics ”E.R.Caianiello” University of Salerno Laboratorio di Reti Neurali ”Maria Marinaro)

Session Classification : Session 4