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Critical dynamics on a large human open connectome network

Extended numerical simulations of threshold models have been performed on a human brain network with N=836733 connected nodes available from the open connectome project. While in the case of simple spreading models like contact process, SIS or threshold model, a sharp discontinuous phase transition without any critical dynamics arises. Variable threshold models exhibit extended power-law scaling regions. This is attributed to fact that Griths effects, stemming from the topological or interaction heterogeneity of the network can become relevant if the input sensitivity of nodes is equalized. Non-universal power-law avalanche size and time distributions have been found with exponents agreeing with the values obtained in electrode experiments of the human brain. Power-law activity time dependences occur sub-critically in an extended control parameter space region without the assumption of self-organization. Probably the most important result of this study is that negative weights enable local sustained activity and promote strong rare-region effects without network fragmentation. Thus, connectomes with high graph dimensions can be subject to rare-region effects and can show measurable Griths effects. Another important observation is that power-laws may occur in a single network, without sample averaging, due to the modular topological structure. Effects of link directness, as well as the consequence of inhibitory connections are studied. Robustness with respect of random removal of links suggests that connectome generation errors do not modify the Griths effects qualitatively.

Biography

Géza Ódor has completed his PhD from Eötvös Loránd University and Postdoctoral studies at CERN Geneva. He is a Scientific Advisor of MTA-MFA, a Research Institution of the Hungarian Academy of Sciences. He got Doctor of Science degree from the Academy of Sciences in 2004. He has published more than 78 papers in reputed journals and a book on Nonequilibrium Statistical Physics.

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