Rare region effects in hierarchical networks

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Spreading processes on networks represent the paradigm for a broad variety of propagation phenomena taking place on non-trivial topologies. The way epidemics, computer viruses, rumors or cortical signals propagate is known to be affected by the topology of their underlying contact patterns, which often exhibit pronounced community structures. Communities rarely are interconnected at random. Instead, they are often organized in a hierarchical fashion, as it is commonly observed in cerebral networks[1,2].

Here we study the dynamics of spreading processes on hierarchical modular networks and discuss the emergence of rare-region effects due to the non-trivial topology of such contact patterns. We find that deep hierarchical structures are able to sustain network activity on rare regions for extremely long times. We relate this phenomenology to the degree-heterogeneity of the networks, their predicted epidemic threshold and their fractal nature. Our results are relevant for neurophysiological studies, which have recently highlighted the emergence of persistent sustained activity in cerebral cortical networks. In order to provide predictions for such systems, we discuss the complex interplay between the network topology and the dynamics implemented on it, showing to which extent simple dynamical processes are sufficient to capture the physics of rare-region effects and if a more realistic description of neuronal dynamics requires more specialized dynamical rules.

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