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Multiscale unfolding of complex networks by geometric renormalization

M. Ángeles Serrano, *ICREA - Universitat de Barcelona*

Complex networks display a hidden metric structure, which determines the likelihood and intensity of interactions. This quality has been exploited to map real networks, producing geometric representations that can be used as a guide for their efficient navigation and that shed light on pivotal forces –like preferentiality, localization, and hierarchization– that rule their structure and evolution. Now, the powerful methods that unveil network geometry enable to disentangle the multiple scales coexisting in real networks, strongly intertwined due to the small world property. We have defined a geometric renormalization group for complex networks embedded in an underlying space that allows for a rigorous investigation of networks as viewed at different length scales. We find that real scale-free networks show geometric scaling under this renormalization group transformation. This feature enables us to unfold them in a self-similar multilayer shell which reveals the coexisting scales and their interplay. The multiscale unfolding brings about immediate practical applications. Among many possibilities, it yields a natural way of building high-fidelity smaller-scale replicas of large real networks, and sustains the design of a new multiscale navigation protocol in hyperbolic space which boosts the success of single-layer versions.