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Characterizing complexity of complex networks based on topological heterogeneity

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Studies on complex networks have developed steadily since the onset of network science, around 2000. However, despite the central role in this field, the definition of the concept of 'complexity' remains somewhat elusive. In the present work, we address the key problem of how to measure the complex network complexity. Usually, this characterization has been interpreted relatively to the degree distribution heterogeneity of some network models, specially Erdős-Rényi and Barabási-Albert. While the former model is often characterized by degree homogeneity, being considered a 'simple' model, the latter is known as a 'complex' counterpart, justified by its diversity in degree distribution having both few nodes highly connected, named hubs, as well as the majority number of nodes with low connection. However, it has been shown that the complexity of a network cannot be fully characterized just by the heterogeneity of its degree distribution since it is possible for a network to have all its nodes with the same degree and yet exhibit an entangled topology. (1) In this sense, it becomes necessary to consider other topological measurements in the complexity evaluation. For this reason, to evaluate the overall complexity of a network in a broader way, we propose a measure, the *complex index* (CI), that is derived from the standard deviations of a diverse set of topological measurements. In particular, we use features that can be estimated from nodes and edges of the network. (2) In this work, they include: (i) node degree; (ii) average and (iii) standard deviation of the shortest path length for all pair of nodes; (iv) clustering coefficient of each node; betweenness centrality for (v) nodes and (vi) edges; (vii) matching index for every pair of nodes that shared an edge; (viii) Laplacian eigenvalues; and (ix) second and (x) third hierarchical degree of each node. We are evaluating the CI applied in theoretical network models (Erdős-Rényi, Barabási-Albert, Waxman, Random Geometric Graph and Watts-Strogatz with 10% and 100% of probability rewiring) and in real networks.

Palavras-chave: Complex networks. Complexity. Topological measurements.

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