A simple framework for complex networks

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Abstract

The dimensionality of the space of connectivity patterns in complex networks is enormous. To simplify such networks, we present a low-dimensional model of directed networks based on first and second order statistics of network connectivity. The first order statistic is the probability of any single connection. The second order statistics capture how the presence of a single edge influences the probability of a second edge that shares a node with the first edge. These statistics are the probability of occurrence of second order edge motifs, which are patterns of two network edges. Given these statistics, we add minimal additional structure to form a probability distribution of networks connecting nodes. We refer to these networks as second order networks. We introduce the formalism of second order networks in the context of neuronal networks, develop a method to sample the networks, and discuss their properties. We demonstrate how the second order connectivity statistics form a simple, low-dimensional framework for understanding properties of complex networks.