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Topology of evolving networks: the role of growth signals

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Complex networks theory provides methods and tools for studying the structure and dynamics of various complex systems. Real complex networks, although representing very different complex systems, have some common properties. They have broad degree distribution, small average shortest path compared to their size, high clustering, and degree-degree correlations. Knowledge about how these properties emerge in complex networks and the fundamental mechanisms is imperative if we want to understand complex systems' dynamics and function. Complex network models represent a unique tool for uncovering essential factors that govern the emergence of complex network properties. We have detailed knowledge on how different linking rules shape network topology. However, we are still lack comprising understanding of the role of the growth signal.

In this work, we study how the growth signal's properties that describe the addition of new nodes in the evolving network influence its structure. In complex network models, we typically add one or a constant number of nodes each time step. However, real complex systems' growth is usually not linear, and signals have long-range correlations, trends, and cycles. We modify the model of aging nodes to enable non-linear growth of the network. We use two growth signals from real systems from MySpace data and TECH Meetup community that are multifractal signals with long-range temporal correlations quantified with Hurst exponent and three random signals with short-range correlations and no cycles or trends.

We use D-measure to quantify the difference between the structure of networks generated with time-varying growth signal and ones with constant growth. This work shows that networks obtained with time-varying growth signals have a different structure than ones grown with linear growth. The D-measure has the highest value for the networks with power-law degree distributions, and the networks grown with multifractal signals with long-range correlations. Our further analysis shows that these networks are correlated and clustered. Our results confirm that the growth signal properties determine the structure of the obtained networks and should be considered prominently in models of social systems.

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