Monte Carlo methods for generation of random graphs

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Random graphs are widely used for modeling complex networks such as the internet, transportation or social networks. Many models have been proposed to catch their specific features as for instance power-law degree distribution and small diameter. These models, based on some simple rules for growth and rewiring of links, explain well observed structural properties. However, to study dynamical phenomena taking place on networks, it is desirable to have a general algorithm which is able to produce a variety of random graphs. Here we present a method based on a random walk in the space of graphs. By ascribing to each graph a certain statistical weight we are able to set up a sort of Markovian process that generates networks with the desired probability. One can change the typical properties simply by tuning the weight function and thus can generate networks of different types. The method works for both growing and equilibrated graphs, that is for graphs where all nodes are statistically equivalent. This algorithm allows also for a multicanonical simulation, known, e.g., from Ising-like models, which alters the probability of rare events and therefore gives a possibility to study such effects as finite-size cutoffs in the degree distribution or the distribution of a maximal degree.