Abstract

In this thesis we propose parametric network models for generation of complex networks that can inherit statistical properties of real networks. The models are based on different growth processes that are observed in different social contexts, for example, preferential attachment, random attachment with local growth. The chemical process, known as nucleation is investigated as a network formation process and thus a network model is proposed inspired by nucleation. Further, the parametric model approach for generation of networks is extended and employed in to solving the problem of structural reconstruction of real scale-free networks. In this attempt, a 2-parameter network generation model, called Network-Reconstruction-Model (NRM) is developed. A reconstruction technique is introduced to reconstruct a given real scale-free network by finding optimal values of the model parameters, utilizing the power-law exponent of the degree distribution of the real network, such that the corresponding model network inherit multiple structural properties of the real network. The performance of all the models in order to inherit properties of real networks is tested with different examples of real networks. The efficiency of NRM and the proposed reconstruction technique in order to solve the structural reconstruction problem are compared with some existing network models.

Preferential attachment is one of the well known procedures that has been considered in literature to explain the existence of power-law in the degree distribution of real networks. However, often a diffusion process on a network influences the structural organization of the network and vice versa. Thus a natural question is: How do the structural dynamics and diffusion dynamics interact each other so that power-law in degree distribution arise or sustain in a network? This is thoroughly investigated in the thesis by introducing continuous and discontinuous truncated biased random walks on networks, where the diffusion process is considered as a random walk dynamics on the network. These proposed random walk dynamics could justify preferential growth of networks. Moreover, a diffusion protocol is proposed that can help detecting structural irregularities in static and dynamic networks, for example, the phenomena of link failure. Finally, a framework is proposed to identify existence of links in a network by investigating datasets of Susceptible-Infected-Susceptible (SIS) diffusion dynamics on networks.

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