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An improved algorithm for generalized community structure inference in complex networks

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In recent years, the research of the community detection is not only on the structure that densely connected internally, but also on the structure of more patterns, such as heterogeneity, overlapping, core-periphery. In this paper, we build the network model based on the random graph models and propose an improved algorithm to infer the generalized community structures. We achieve it by introducing the generalized Bernstein polynomials and computing the latent parameters of vertices. The algorithm is tested both on the computer-generated benchmark networks and the real-world networks. Results show that the algorithm makes better performances on convergence speed and is able to discover the latent continuous structures in networks.

Keywords: complex system; community detection; statistical inference; generalized community

1. Introduction

In the network science, the influence between structure and function is extremely complex. Researchers expect a better understanding about how the network works by detecting the community structures. In recent years, many scientists spent a lot of effort on the study of the community detection [1]. Many achievements have been made, especially on social and biological networks [2], which have shown great research value. As one of the important research methods, statistical influence method [3, 4] is able to infer the community structure with the network models. However, some limitations exist both on the model and structure.

First, on the model, the common-used network models are usually over-designed. These models tend to generate networks with certain properties as designed, but make poor performances in other aspects. For an example, the stochastic block model [5] can generate networks with community structure, but some other properties cannot match with the real-world networks, such as degree distribution, scale-free. Second, on the structure, the real-world networks have been proved to have a variety of structures, such as the overlapping community [6], the core-periphery structure [7], the hierarchical structure [8]. The structure that densely connected internally, or called traditional community structure, is only a simple one in these structures. And for simplicity, we call the structure of the many patterns as generalized community structure. Actually, the traditional community detection becomes unable to meet the needs of the application to the more and more complex networks.

The problems are challenging and the research is proceeding. In 2015, Newman proposed an algorithm under the influence of the latent space models and the “graphon” models [9]. The results are