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Leaders in Communities of Real-World Networks *

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Abstract

Community structures have important influence on the properties and dynamic characteristics of the complex networks. However, to the best of our knowledge, there are not much attention given to investigating the internal structure of communities in the literature. In this paper, we study community structures of more than twenty existing networks using ten commonly used community-detecting methods, and discovery that most communities have several leaders whose degrees are particularly large. We use statistical parameter, variance, to classify the communities as leader communities and self-organized communities. In a leader community, we defined the nodes with largest 10% degree as its leaders. In our experiences, when removing the leaders, on average community's internal edges are reduced by more than 40% and inter-communities edges are reduced by more than 20%. In addition, community's average clustering coefficient decrease. These facts suggest that the leaders play an important role in keeping communities denser and more clustered, and it is the leaders that are more likely to link to other communities. Moreover, similar results for several random networks are obtained, and a theoretical lower bound of the lost internal edges is given. Our study shed the light on the further understanding and application of the internal community structure in complex networks.

Keywords: small-world network, community detecting, leader community, clustering coefficient.

1 Introduction

Network science has witnessed many developments in the last decades because many real-world networks were found to have a variety of topological structures [1, 5, 9]. The small-world network model of Watts and Strogatz (WS) [12] and scale-free network's [4] emergence makes complex network unprecedented popular in the last 30 years. Data analysis has revealed that the scale-free property is found in social [8, 11], biological [3, 6, 7], technological [2, 10], and many other types of networks. Some authors also find that the sizes of

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