

Modularity, community structure, and the spectral properties of networks^{*}

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ABSTRACT

Many networks of interest in the sciences are found to divide naturally into communities or modules. The problem of detecting and characterizing this community structure has been the subject of a considerable volume of recent research. One highly effective approach is the optimization of the quality function known as “modularity” over the possible divisions of a network. The modularity can in turn be expressed in terms of the eigenvectors of a particular characteristic matrix for the network, which we call the modularity matrix, and this expression leads to a new spectral method for community detection that returns results as good or better than competing methods in shorter running times. We illustrate the method with applications to a variety of networks from different fields.

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