Exploring the Solution Space of Community Detection Methods

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Discrete categorization of entities has been a fundamental means to understanding complex data. In network science, such endeavor has been largely realized by community detection method which extracts topologically cohesive subsets of a network by looking at its patterns of clustering. However existing community detection methods produce highly heterogeneous and inconsistent partitions for a single network [1,2]. Although this problem has been repeatedly addressed in many studies and a huge number of studies in various disciplines have used different types of community detection methods, no study has yet provided systemic investigation of relationships between the solutions and their properties. Here, we provide meta-analysis of a solution space constructed using community partition vectors obtained from various community detection methods. Investigated methods include both modularity-based methods and modularity-free methods, and both deterministic and stochastic methods. Exhaustive computation with social, natural and artificial networks demonstrates that although solutions obtained from several finest community detection methods produce very similar modularity values, the resulting solutions are highly heterogeneous for most of the networks analyzed. The patterns of clustering in the solution space indicate fundamental bifurcation of the analyzed detection methods into different meta-classes depending on their optimization schemes.

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