Minimax-optimal and consistent estimation of all change-points for dynamic stochastic block models irrespective of their sparsity level

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Abstract

We consider the offline (possibly multiple) change point estimation problem in the context of multilayer networks with communities, and obtain the minimax detectability threshold involving the relevant signal strength without any a priori assumption about either the sparsity or the finiteness of the number of communities for the input network, when the input is generated from multilayer stochastic block models and one or more of the following phenomena occur at each of the change-points: (a) merging of communities, (b) splitting of communities, and (c) changes in the connection probabilities among the communities. We develop a polynomial-time model-agnostic algorithm for estimating all the change-points present in the input data, provide rigorous theoretical analysis and finite sample estimates evaluating the performance of the proposed method when the input is generated from multilayer stochastic block models, and show that the proposed algorithm can estimate the change point consistently when the relevant signal strength is above the minimax detectability threshold, provided the average degree of the input networks goes to infinity arbitrarily slowly. Finally, we validate the performance of our methods using simulated data sets and demonstrate the superiority of our algorithms over relevant existing approaches.