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Random Clique Topology of the Stochastic Block Model

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The stochastic block model (SBM) is an unweighted random graph model with labelled vertices in which edges are added with probability dependent the labels of the endpoints. Therefore, vertices with the same label will connect to other vertices in a similar manner. The SBM has recently been widely used in fields such as machine learning, neuroscience, and network science in general to detect clusters of vertices with similar connectivity patterns. This is achieved using inference algorithms to recover the most likely SBM parameters that would have generated a given graph.

Algebraic-topological tools such as persistent homology are beginning to be applied to networks to study their higher order structure. Recent work has been done to better understand the expected topological behaviour of well known random graph models such as the Erdös-Renyi graphs and random geometric graphs. This was done by proving the asymptotic properties of the Betti numbers for large graphs with various model parameters, from which we can obtain asymptotic Betti curves.

As many real-world networks are increasingly seen to be well-modelled by the SBM and analyzed using persistent homology, it is important to also study the asymptotic topological nature of these networks. In this work, we investigate the clique topology of the SBM by studying similar asymptotic properties such as requirements for vanishing and nonvanishing homology.