EC-SBM SYNTHETIC NETWORK GENERATOR: COMPREHENSIVE REVIEW

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Abstract

Cutting down on fake big ideas in network work is now a big part of network science. The EC-SBM is a model that makes graphs that keep local and big picture group links. This review paper is a close look at EC-SBM and how it grew from old SBM models. We talk about the theory, how to use it, and how EC-SBM is better than other models like degree-corrected, regularized, and correlated SBM types. The paper also covers how people use fake network makers now for tests, social work, and graph neural net checks, then ends with talk on what to do next.

Keywords

Stochastic Block Model, EC-SBM, Synthetic Network Generation, Community Detection, Correlated Networks, Network Modeling

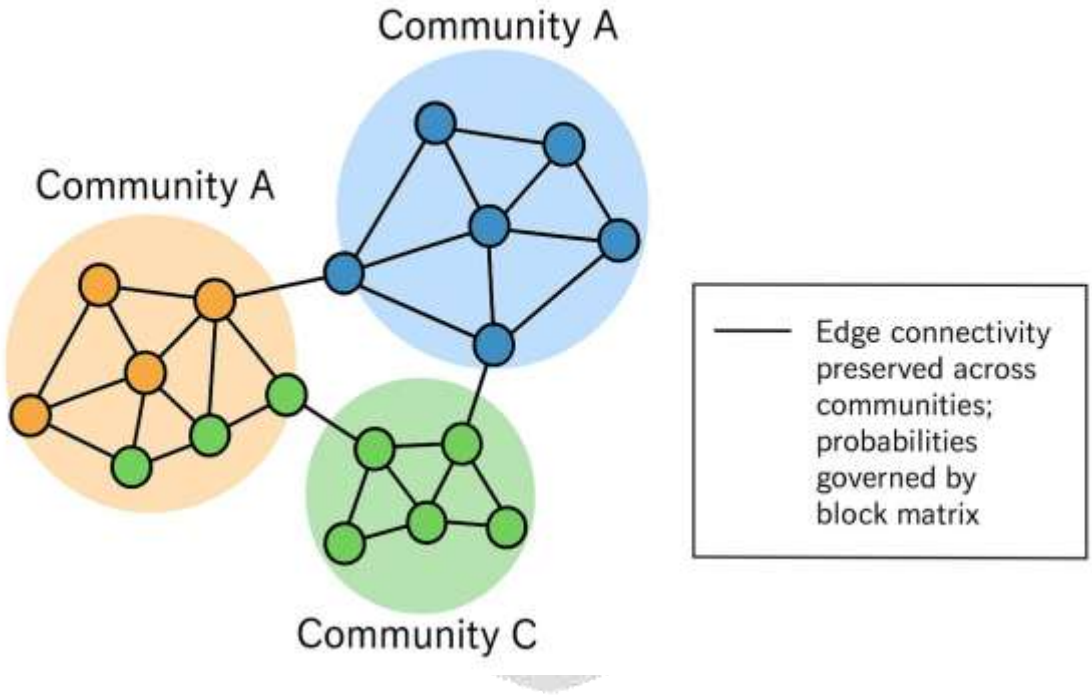
1. INTRODUCTION

The study of fake networks helps people who make them to test and check if their programs work well. Stochastic Block Models (SBMs) are one of the most used ways to do this, giving a chance to make networks with groups in them. But old SBMs can not show the variety of how many friends people have or how often friends of friends connect, which real networks do show.

The Edge-Connected Stochastic Block Model (EC-SBM) makes SBMs better by fixing these issues. It keeps the links between friends connected across groups and still works for big networks. This paper talks about EC-SBM and other new ideas so people can see how SBM fake network makers have grown over time.

2. EC-SBM MODEL AND PRINCIPLES

The EC-SBM model, created by Vu-Le et al. (2025), adds edge correlation rules directly into the random generation process. Unlike old-style SBMs that treat each pair of nodes as having a fixed chance of connection, EC-SBM bases the chance on both group membership and overall network connectivity rules. The model uses block-level probability matrices, but also makes sure that edges follow real-world clustering and degree patterns. Its open-source code allows for fast creation of large networks that keep both the modular shape and the broad realism.



3. DEGREE-CORRECTED AND EXTENDED SBM VARIANTS

Degree-Corrected SBMs (DC-SBM) by Karrer and Newman (2011) added node degree to fix varied link strength, while Regularized SBMs (Lu et al., 2019) made sparse graphs more stable. Legramanti et al. (2022) made Extended SBMs (E-SBM) that use more open priors and hidden variables to show more detailed community groups. EC-SBM is based on these models, combining degree correction with link dependence control, so it can make true-to-life fake networks.

4. CORRELATED AND EDGE-CONNECTED NETWORK GENERATION

Linked SBMs (Gaudio et al., 2022; Racz et al., 2021) added link between several graph forms to the SBM base, which helps in networks with many layers or over time. EC-SBM broadens this idea by making edges within one network linked, keeping inter-group ties strong, but stopping them from falling apart. It makes a good tool for test networks used in clustering, graph embed, and AI that needs networks to stay whole.

5. COMPARATIVE ANALYSIS

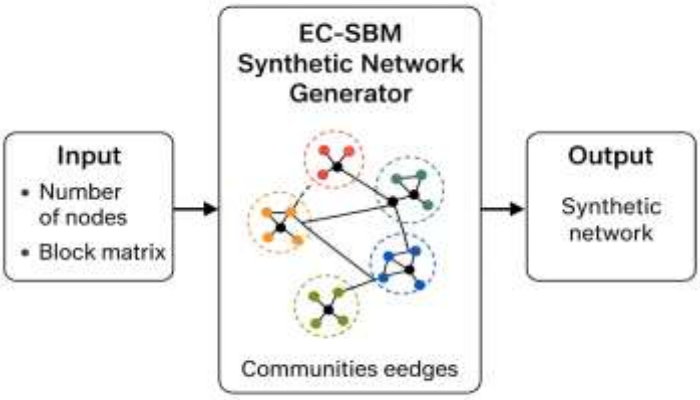
Model	**Year**	**Key Contribution**	**Edge Correlation**	**Scalability**
SBM	1983	Basic community-based generation	NO	High
DC-SBM	2011	Introduced degree correction	NO	Medium
Regularised SBM	2019	Added noise robustness	NO	Medium
Correlated SBM	2022	Multi-graph dependency modelling	YES	Low
EC-SBM	2025	Edge-connected community realism	YES	High

The above comparison shows that EC-SBM offers the best of two worlds : the size of classical SBM and the correlation realism of modern correlated models. Its main gain is that it keeps both global and community level edge connectivity, which is missing in classical models.

6. Challenges and Future Trends

Even with its gains, EC-SBM has issues in how to set its parts right and how to grow big for large nets. Next work hopes to mix EC-SBM with deep ways of learning, so it can find groups and links on its own. Other new paths are the use of EC-SBM in changing nets and in mixed models that blend ways of making and ways of choosing, so they can match how nets grow and change.

New ways also grow like using EC-SBM with graph nets for fake sets of data and using reward ways to set its parts right. As work goes on, EC-SBM can grow to be a main model for real-like net makes.



6. Conclusion

The EC-SBM Synthetic Network Generator is a big step forward in how we build network models. It brings together the ideas of stochastic block models with the ability to grow large and control how things are related. When we compare it to older models, EC-SBM can make networks that look real and can be studied easily. As synthetic networks stay important in data work, EC-SBM is a strong base for future work in finding groups, learning from data, and studying networks.

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