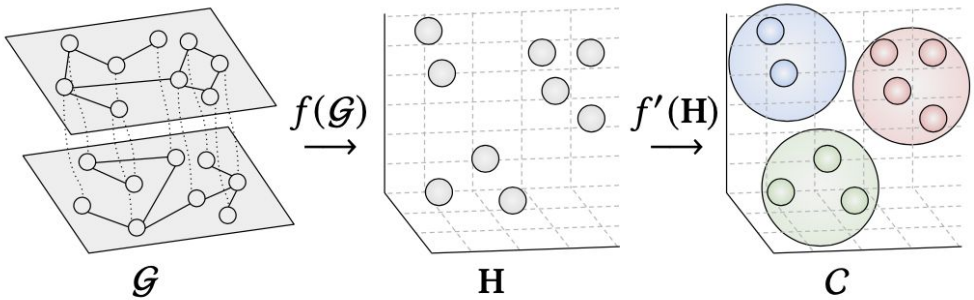
# Why "neural" community detection?

- Graph representation learning models allow exploiting a graph's (*i*) topology, (*ii*) temporal dynamics, and (*iii*) attribute features to obtain node, edge, or graph-level embeddings.




A function *f* fits (*learns*) a graph $\mathcal{G}$ and maps nodes to embeddings **H**, which are then used to obtain a set *C* of communities (*clusters*) [1].

- This joint exploration potentially improves on the detectability thresholds [2] of the graph's communities, while the obtained functions (*models*) may be used to predict unseen data.
- Real-world graphs for model evaluation are the norm in AI research → but a *flawed* one!

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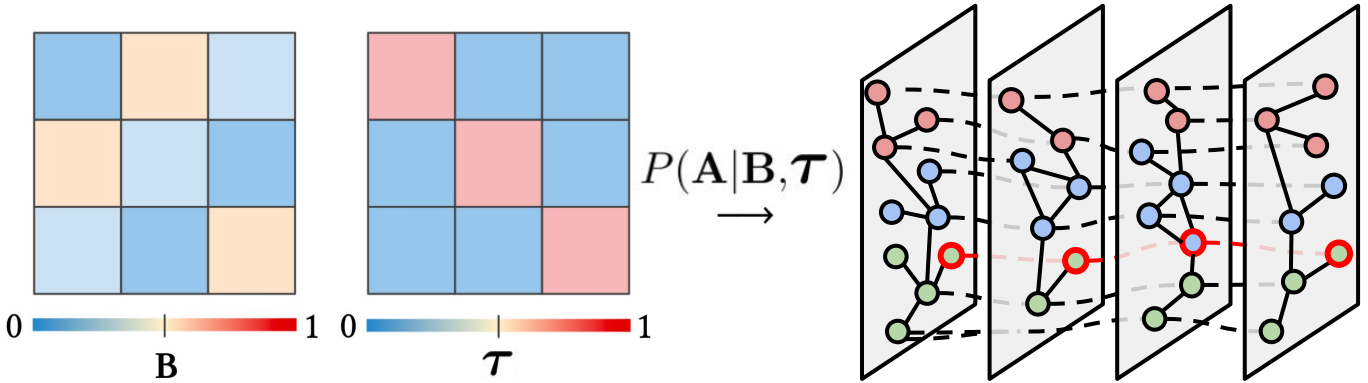
[1] Passos et al., ACM CoNEXT/GNNet Workshop, 2024.
[2] Nadakuditi & Newman, Phys. Rev. Letters, 2012.

# How to evaluate those models?

- Real-world temporal graph data is scarce, of limited scope, and ground truths are dubious [3].
- To overcome it, we introduce the **TADC-SBM** generator, a Time-varying, Attributed, Degree-Corrected Stochastic Block Model [4] based on [5, 6] for benchmarks in *controlled* scenarios.



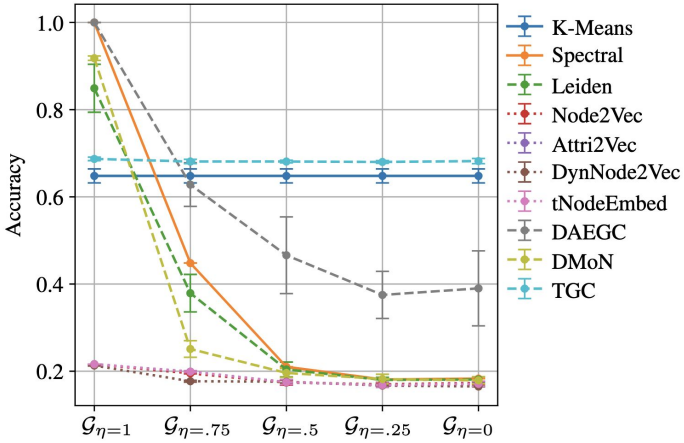

In addition to a block matrix **B**, we employ a transition matrix $\boldsymbol{\tau}$ to control the probability of nodes transitioning communities over time.

- We then focused on the "special" case where $\boldsymbol{\tau} := \eta\,\mathbf{I} + (1-\eta)\,\dfrac{\mathbf{J}-\mathbf{I}}{k-1}$ for our experiments.

[3] Peel et al., Science Advances, 2017.
[4] Passos et al., IEEE ISCC, 2025 (Accepted).
[5] Ghasemian et al., Phys. Rev. X, 2016.
[6] Tsitsulin et al., ACM Web Conference/GLB Workshop, 2021.

# Benchmarking results

- Model performance overall severely degraded as $\eta \to 0$.
- **Exception:** the TGC [7] model displayed good resilience.
- Traditional (*algorithmic*) approaches performed better or as good as SOTA neural models in most scenarios [4].
- The same in a previous study [1] with real-world graphs.
- **Main takeaway:** lots of room for further improvements, but "neural" community detection is *not* all we need.




# Limitations and future work

- Extending the model to support mixed memberships.
- Generating dynamic (node and edge-level) features.

← Preprint and code available

nelsonaloysio.github.io

[1] Passos et al., ACM CoNEXT/GNNet Workshop, 2024. [4] Passos et al., IEEE ISCC, 2025 (Accepted). [7] Liu et al., ICLR, 2024.