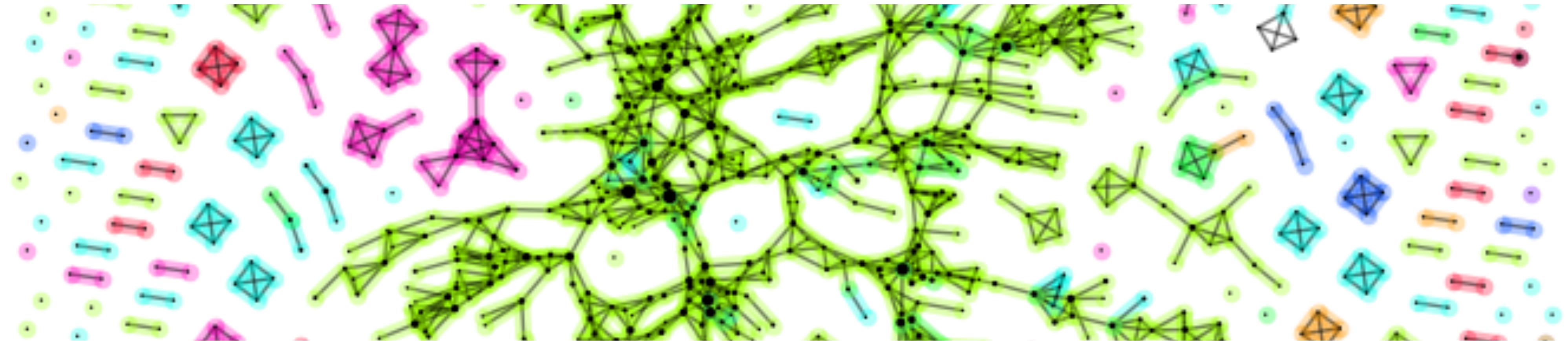


Shape of Collaborations and Simplicial Configuration Model

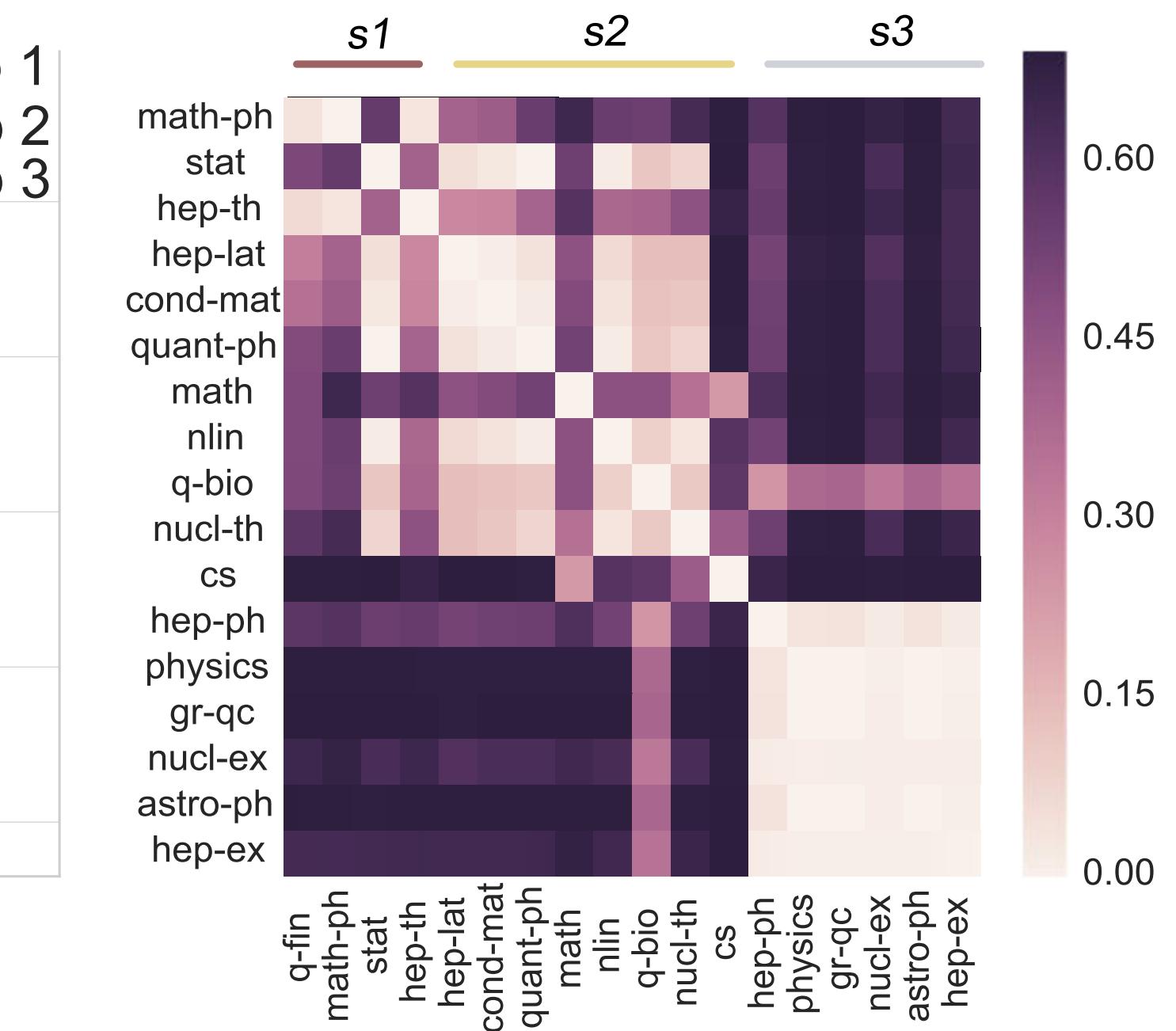
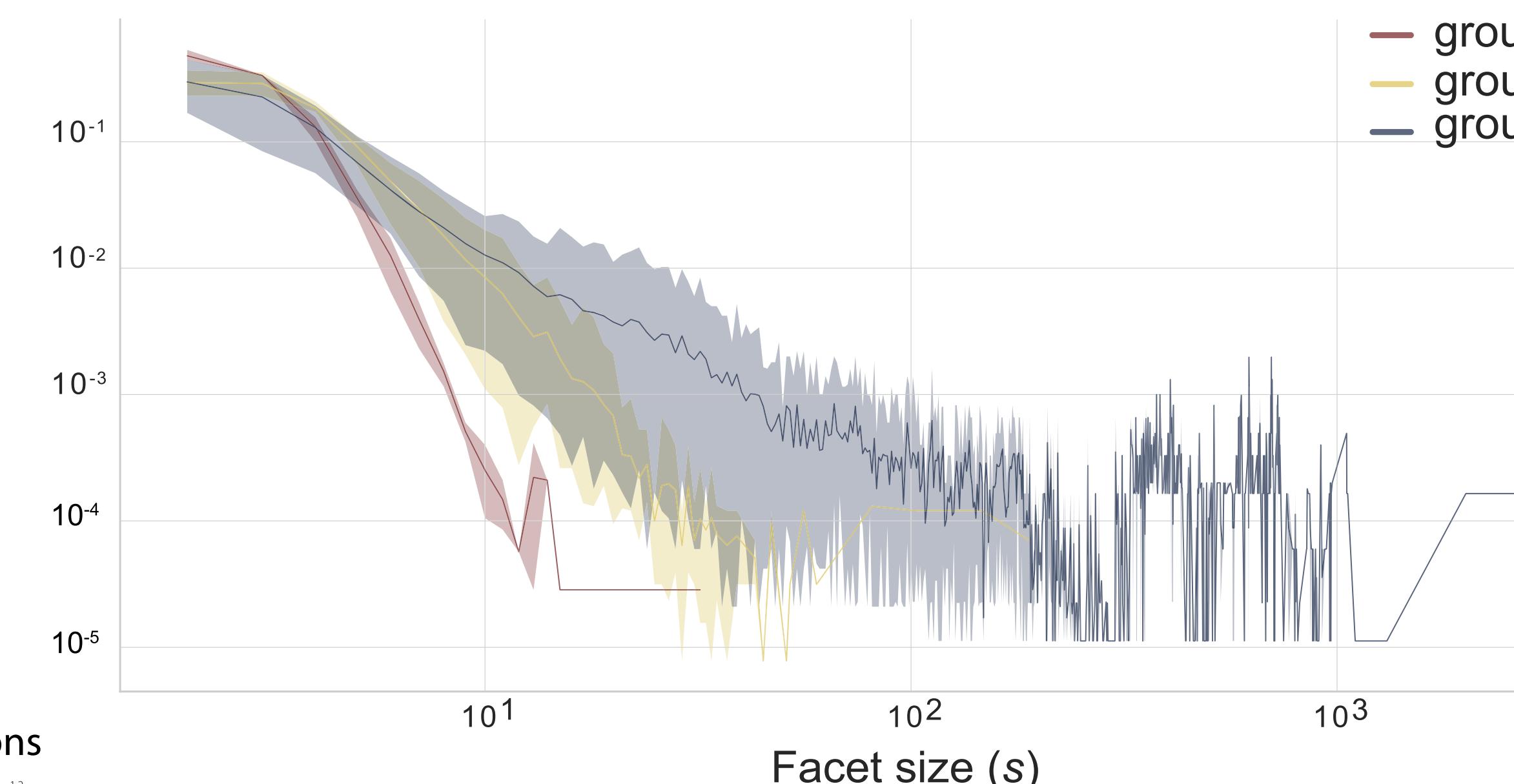
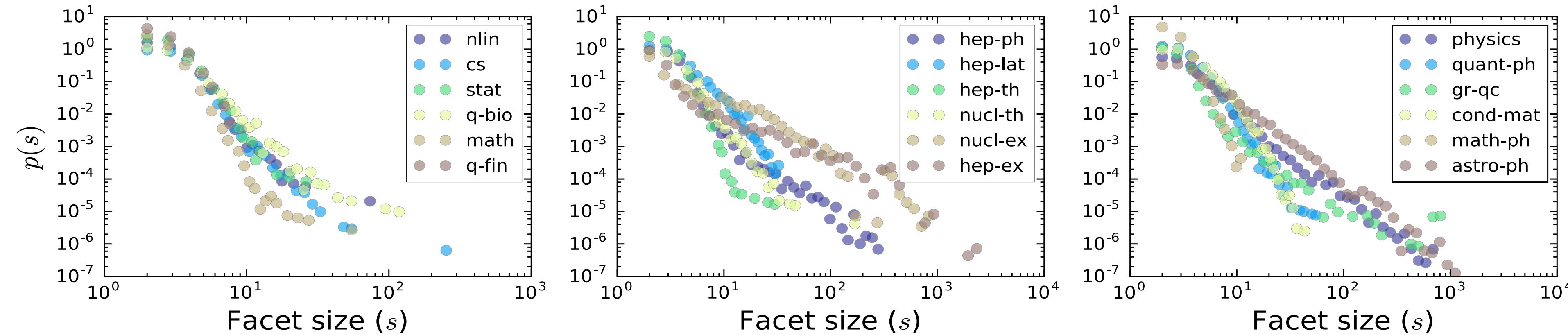


G. Petri/P. Expert

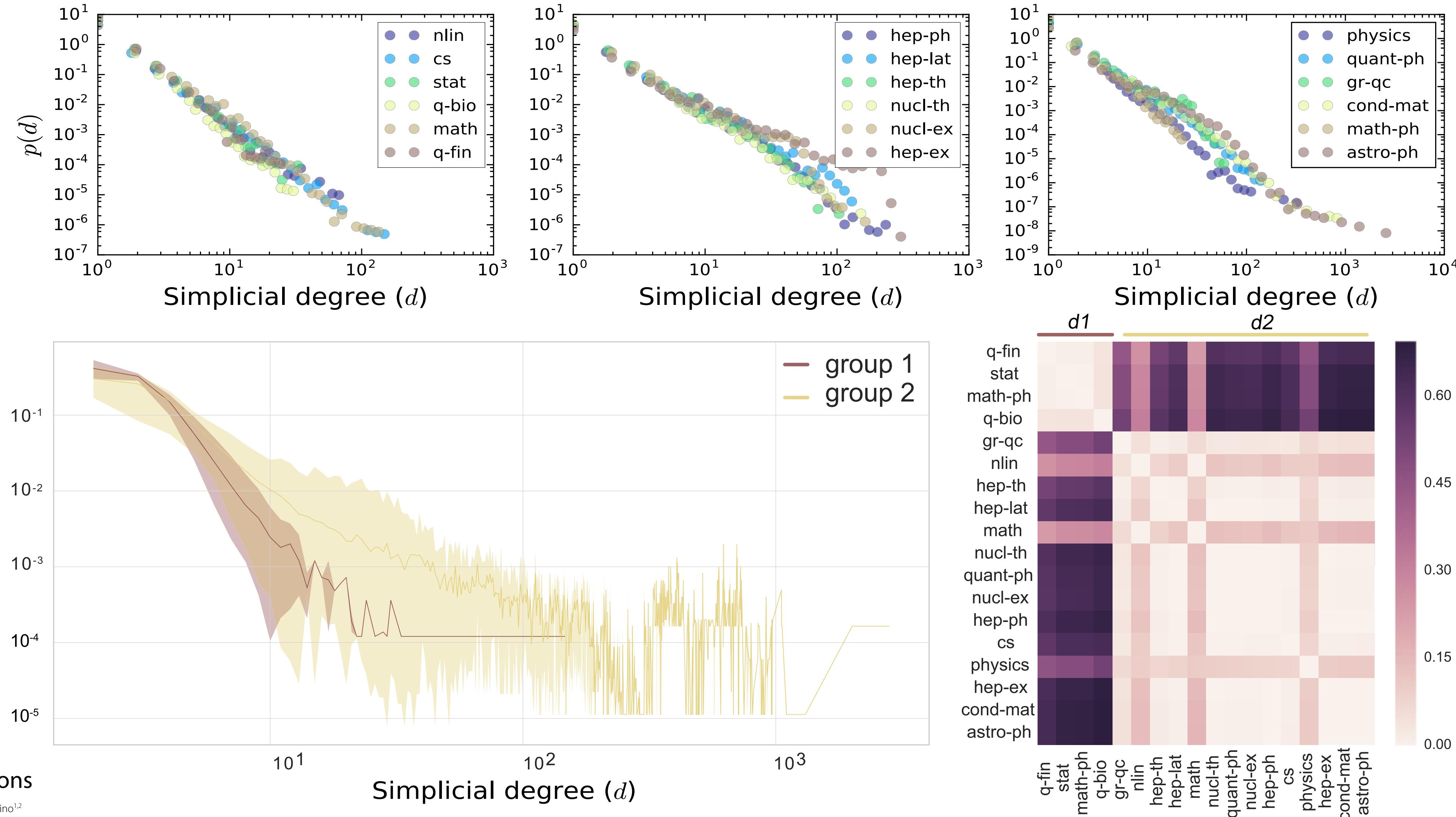
ISI ISI Foundation
& ISI Global Science
Foundation

CNTDA2019 , UKM, Kuala Lumpur
Sept 2019

Are high-order interactions meaningful?



Are high-order interactions meaningful?



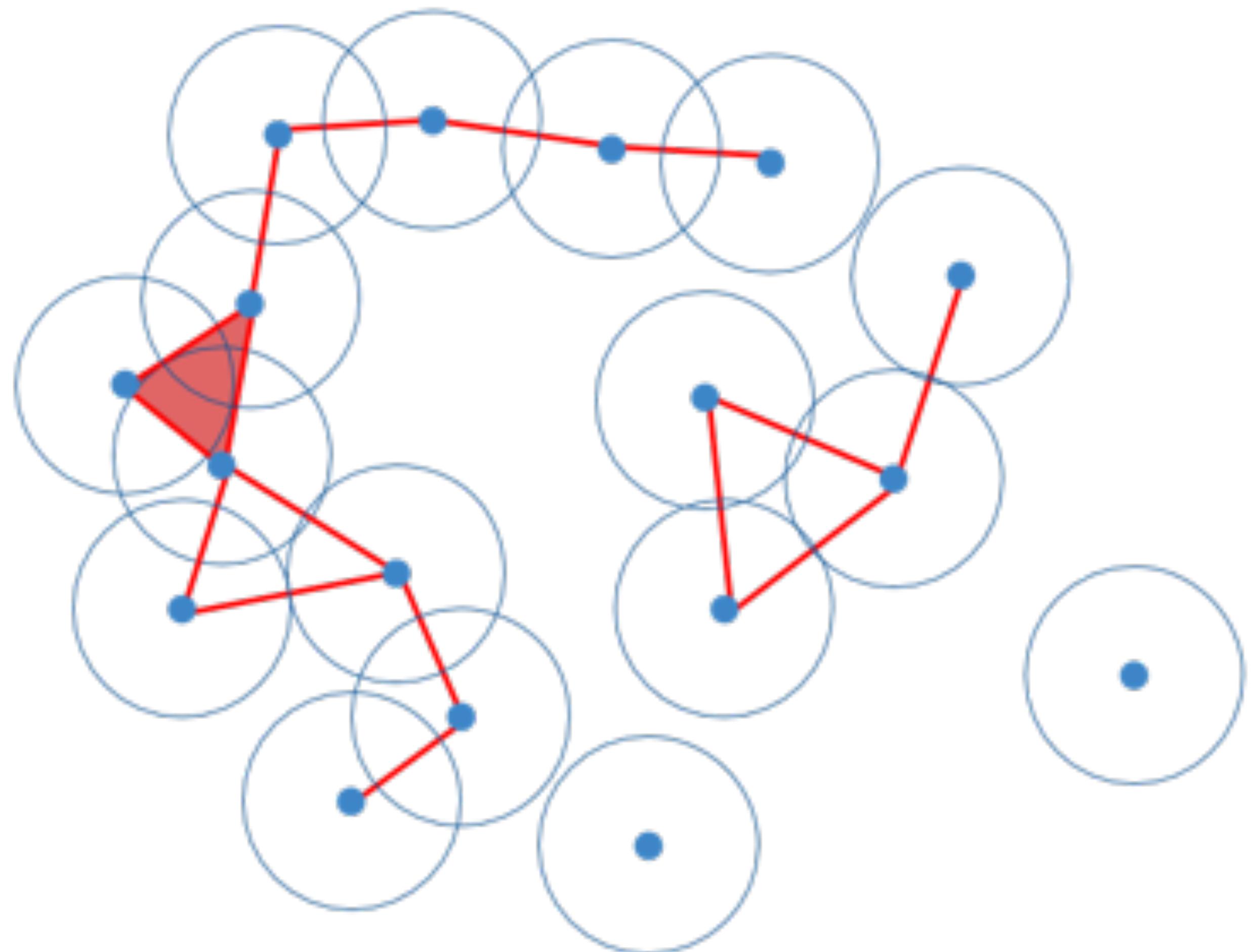
The shape of collaborations

Alice Patania^{1,2*}, Giovanni Petri¹ and Francesco Vaccarino^{1,2}

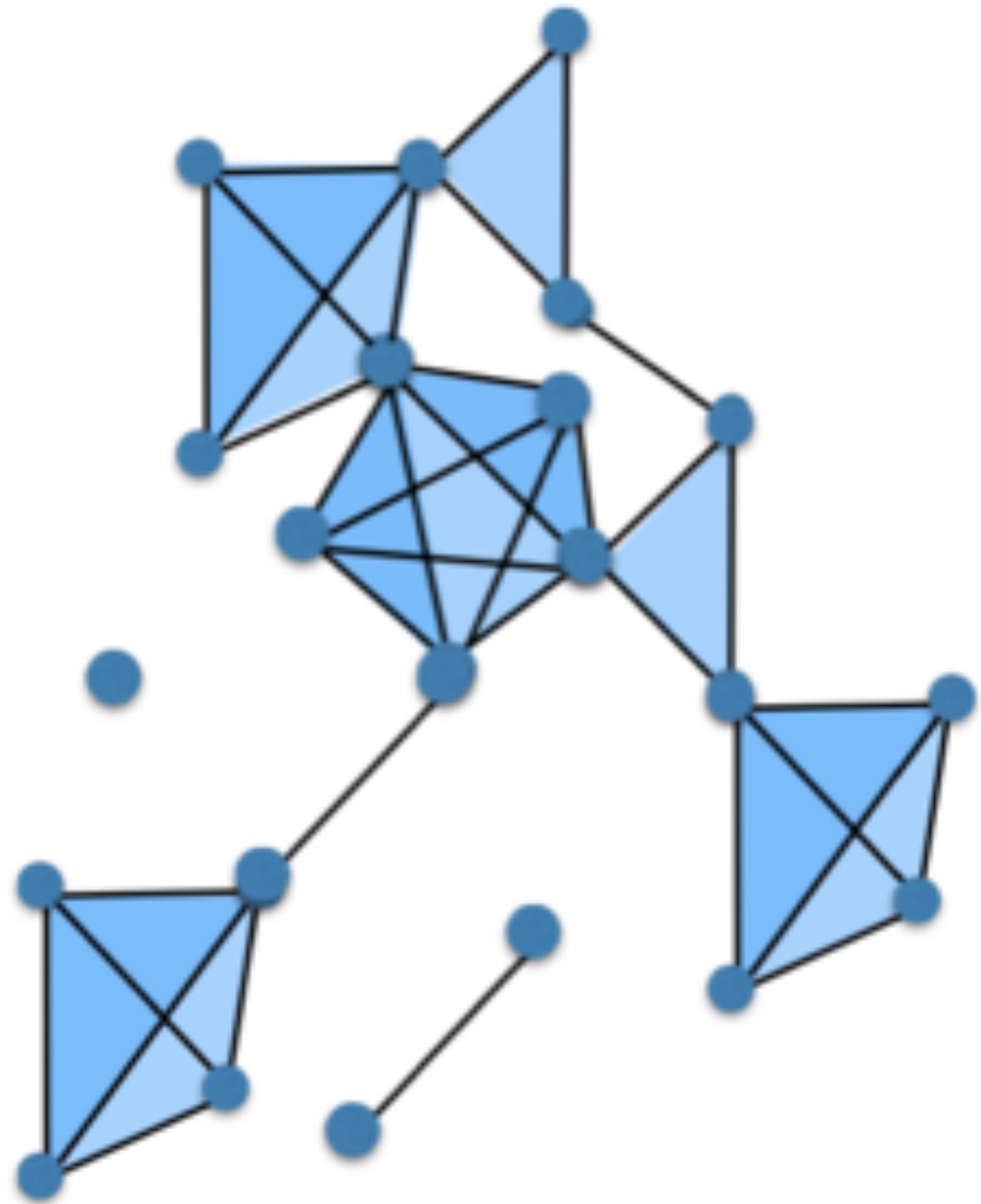
Simplicial complex reduction



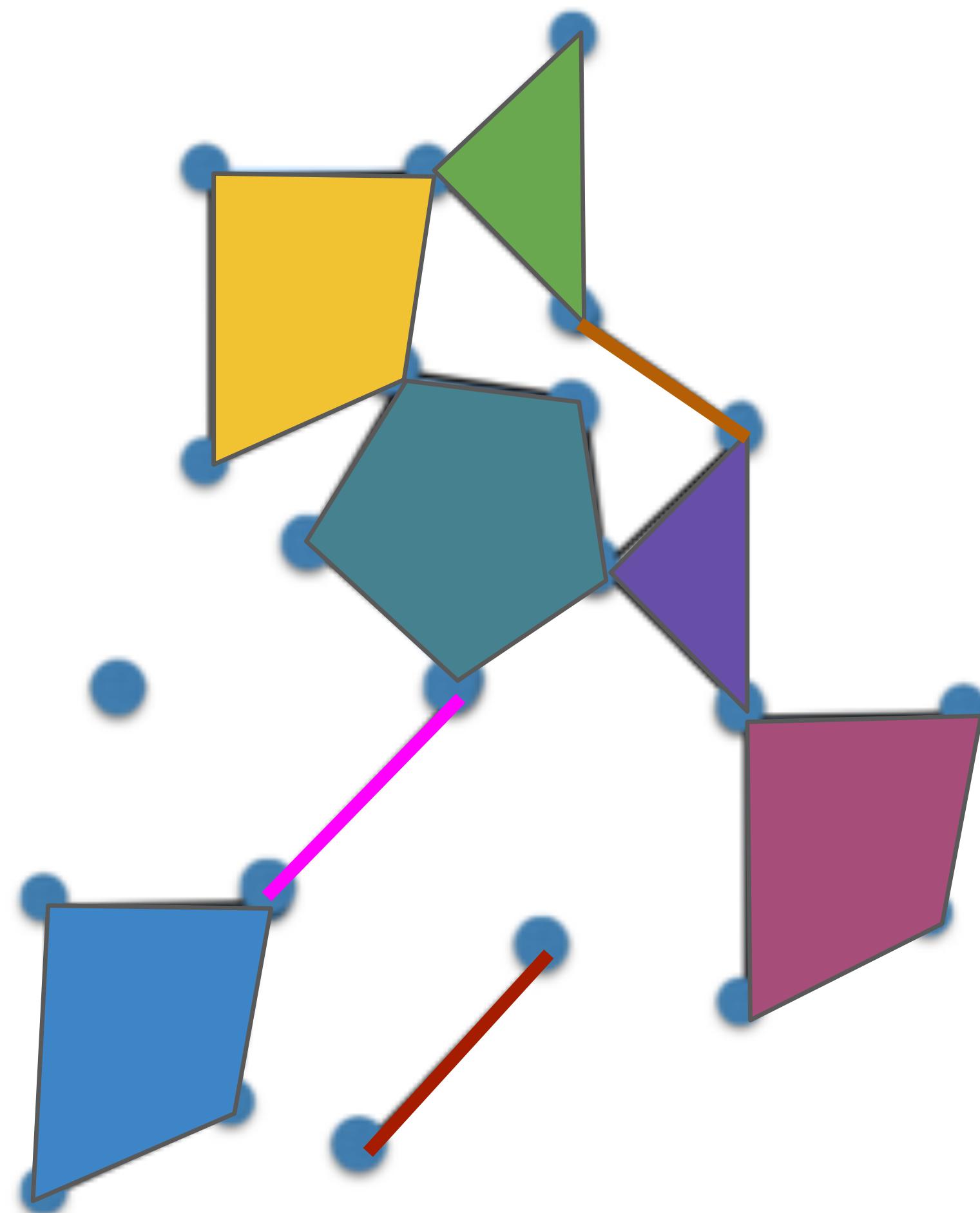
Simplicial complex reduction



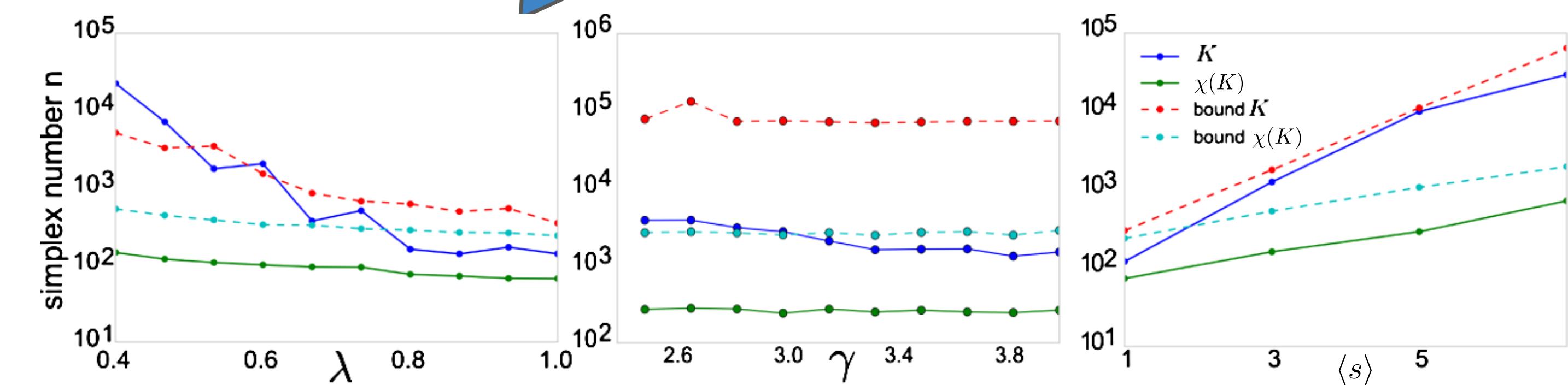
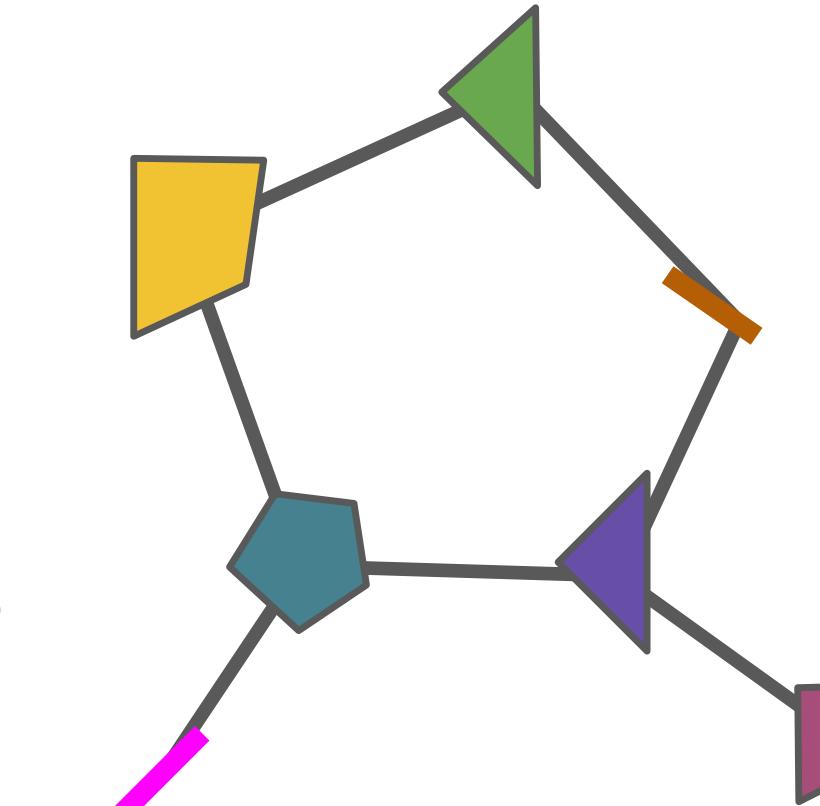
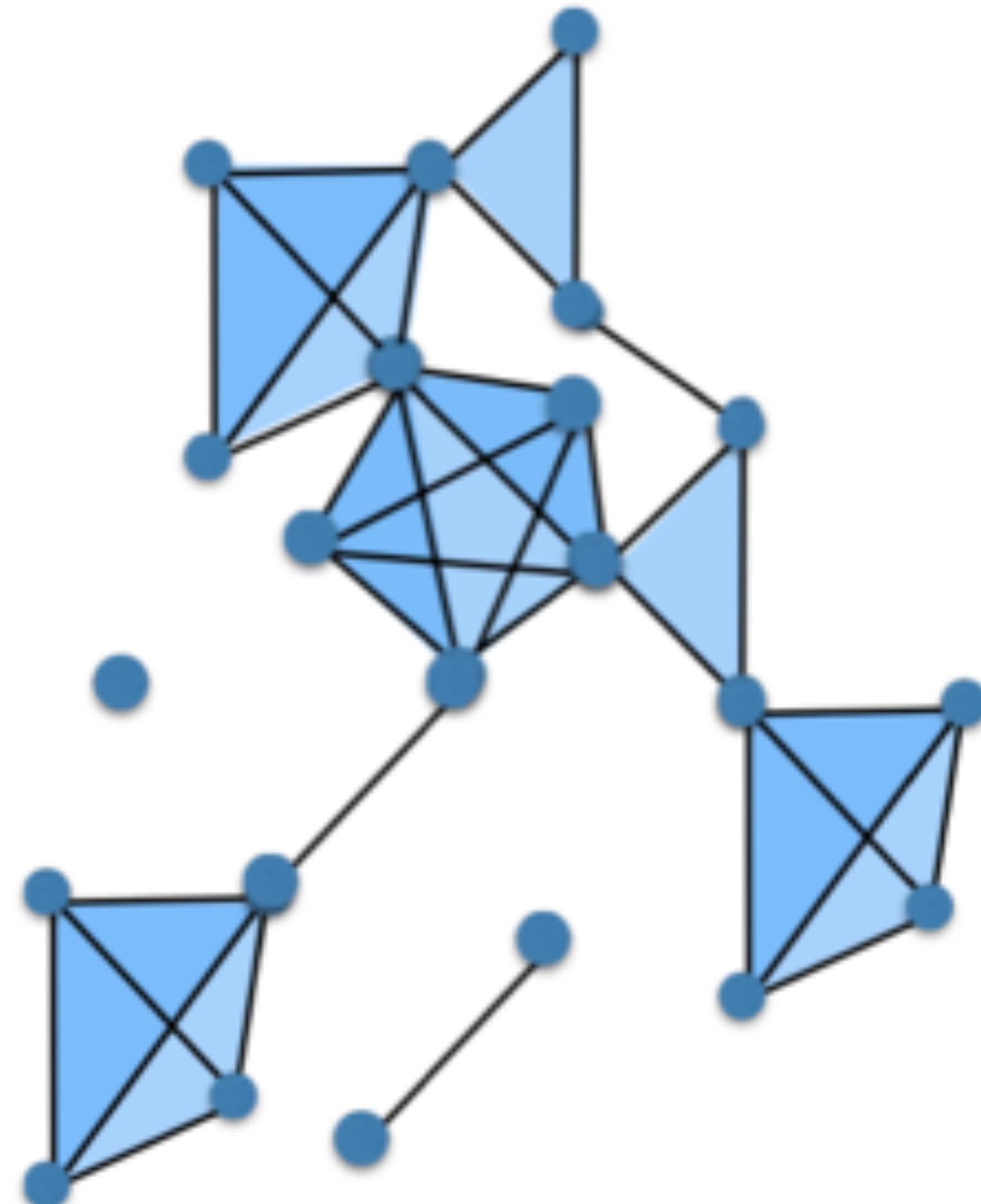
Simplicial complex reduction



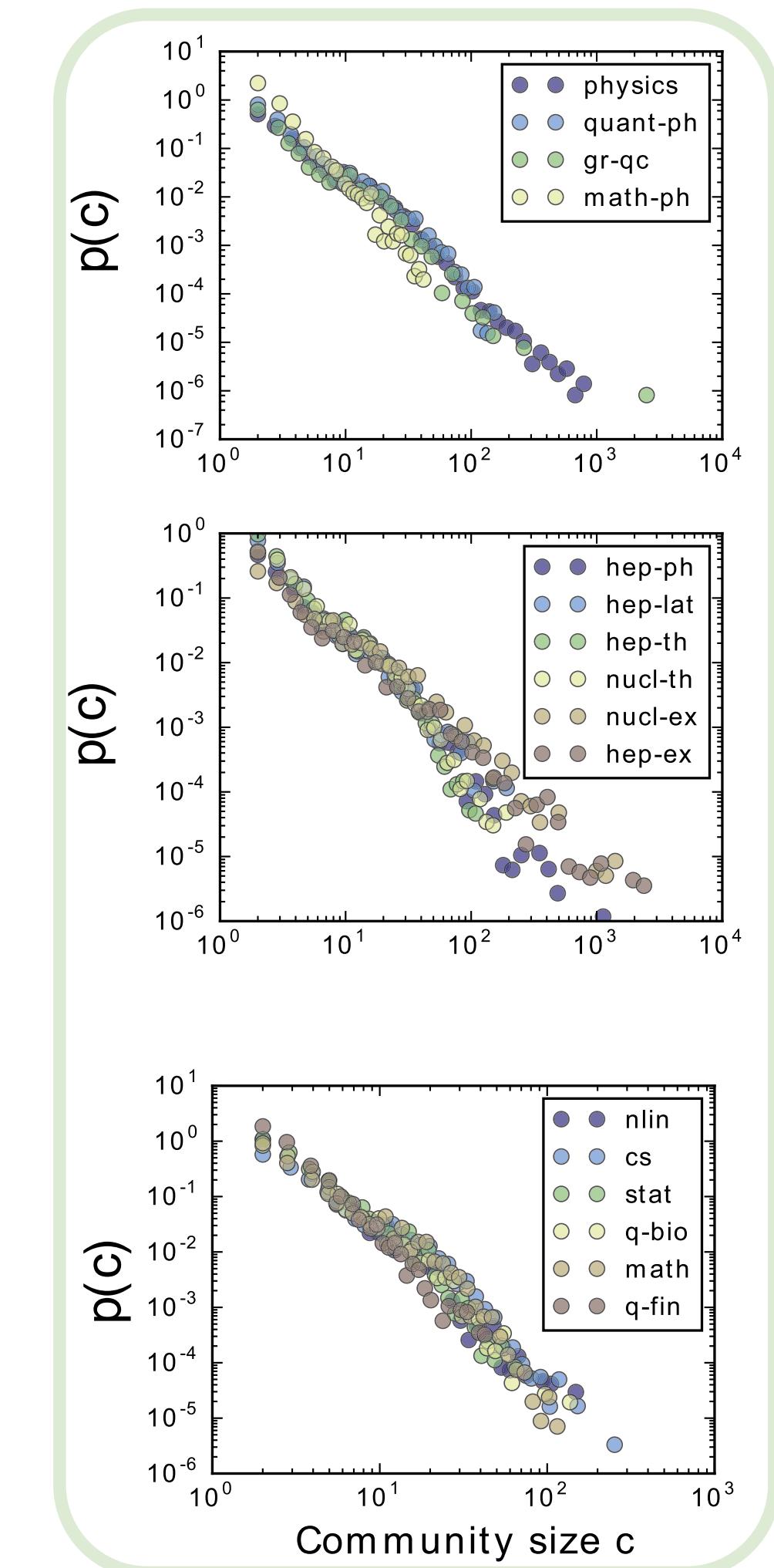
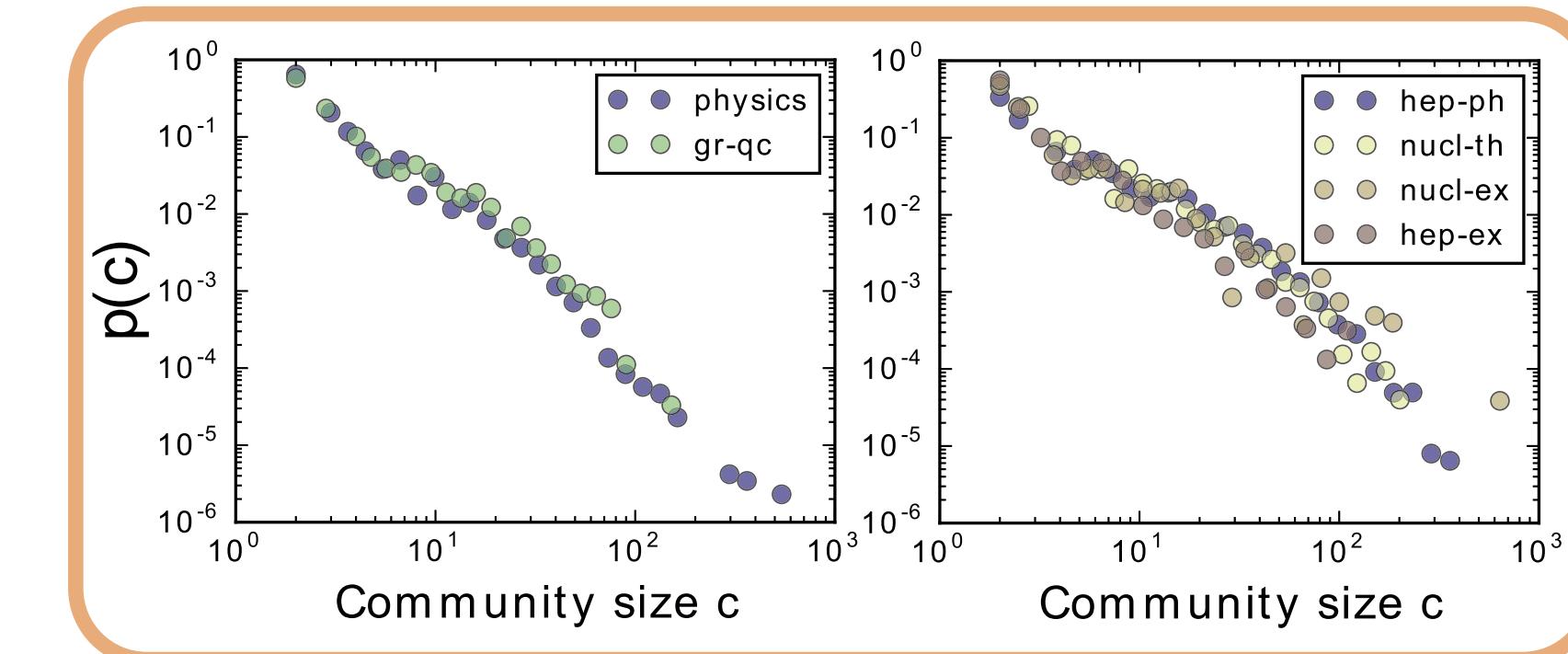
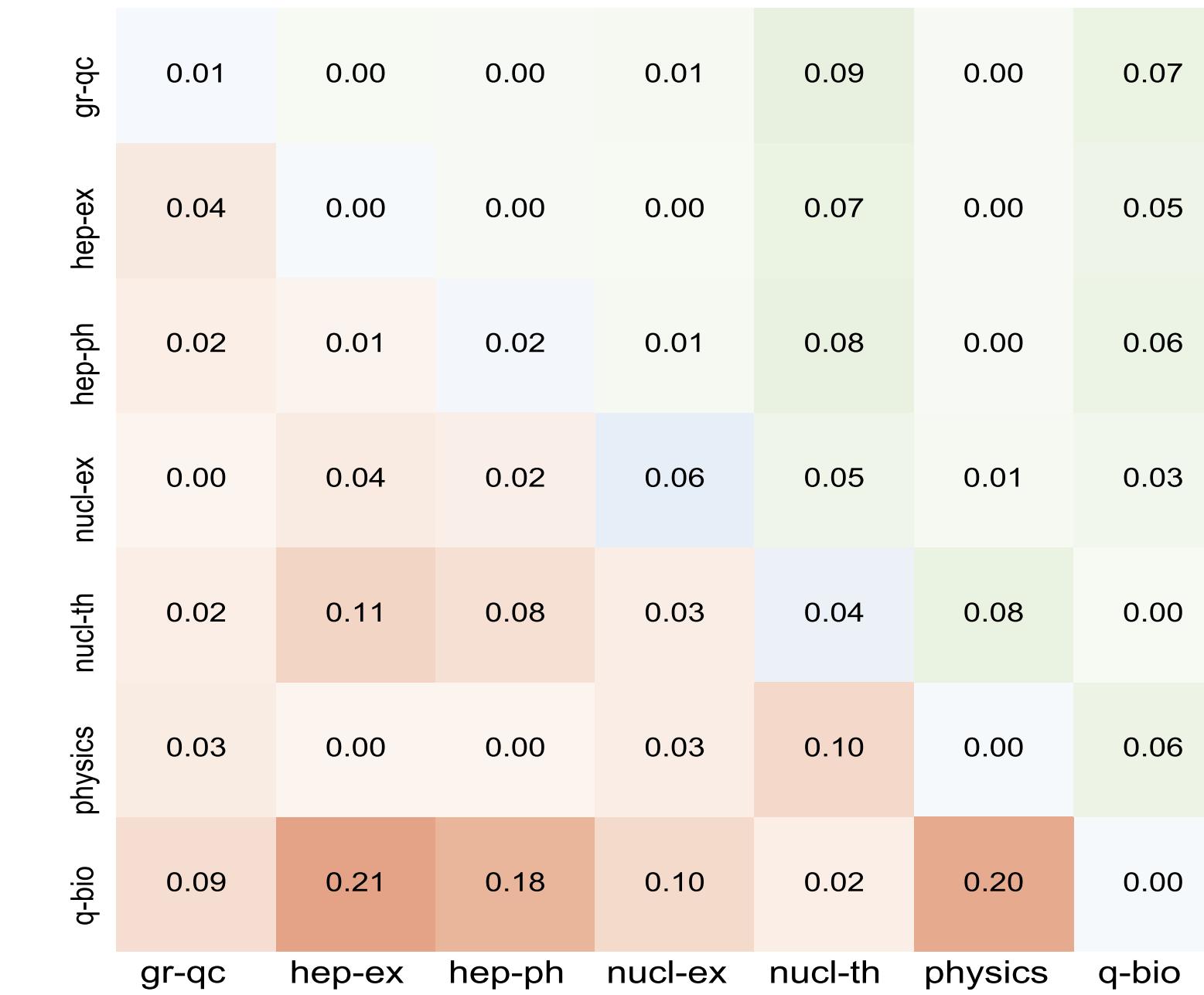
Simplicial complex reduction



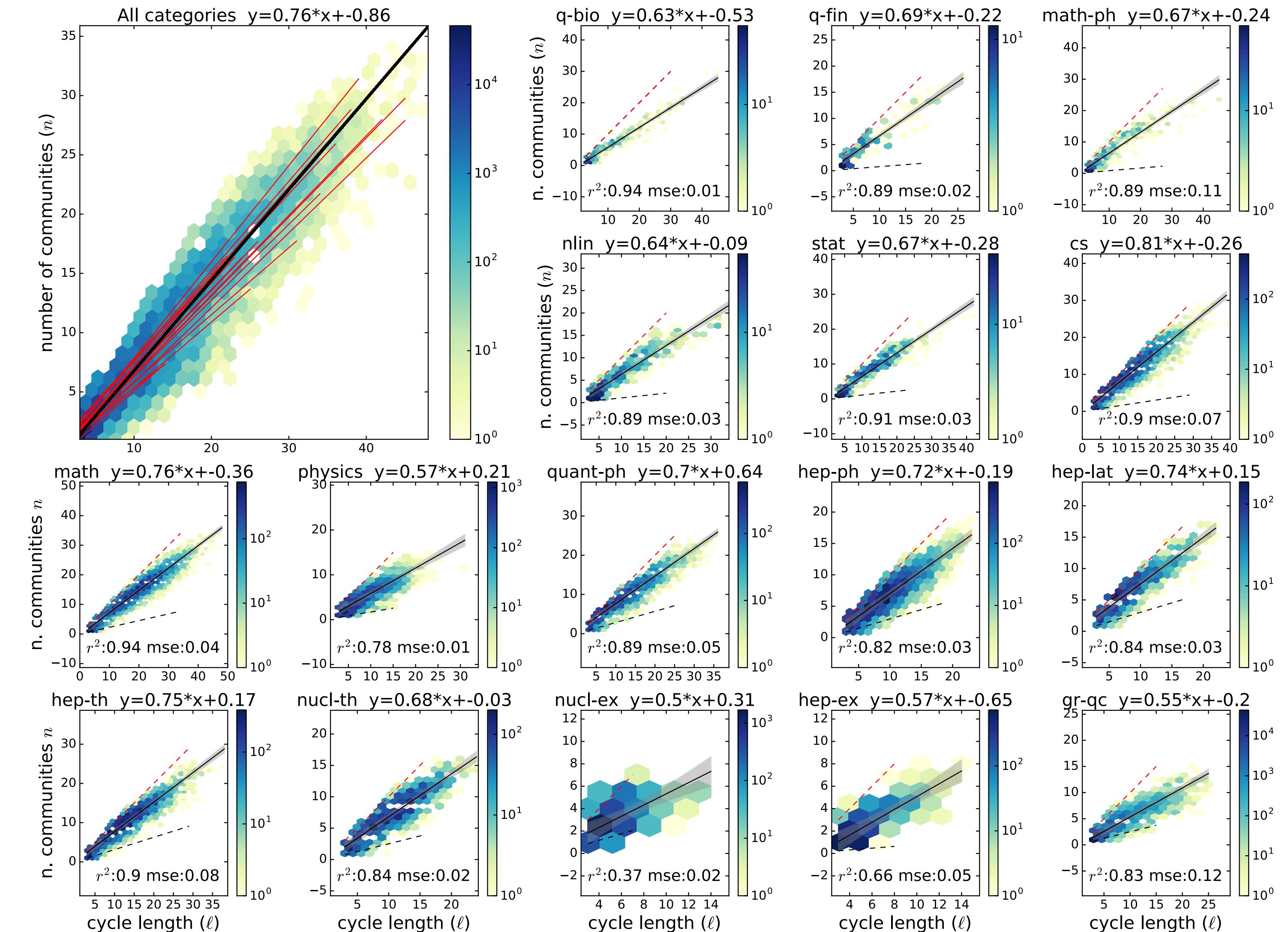
Simplicial complex reduction



Do community distributions change?



Are cycles socially meaningful?



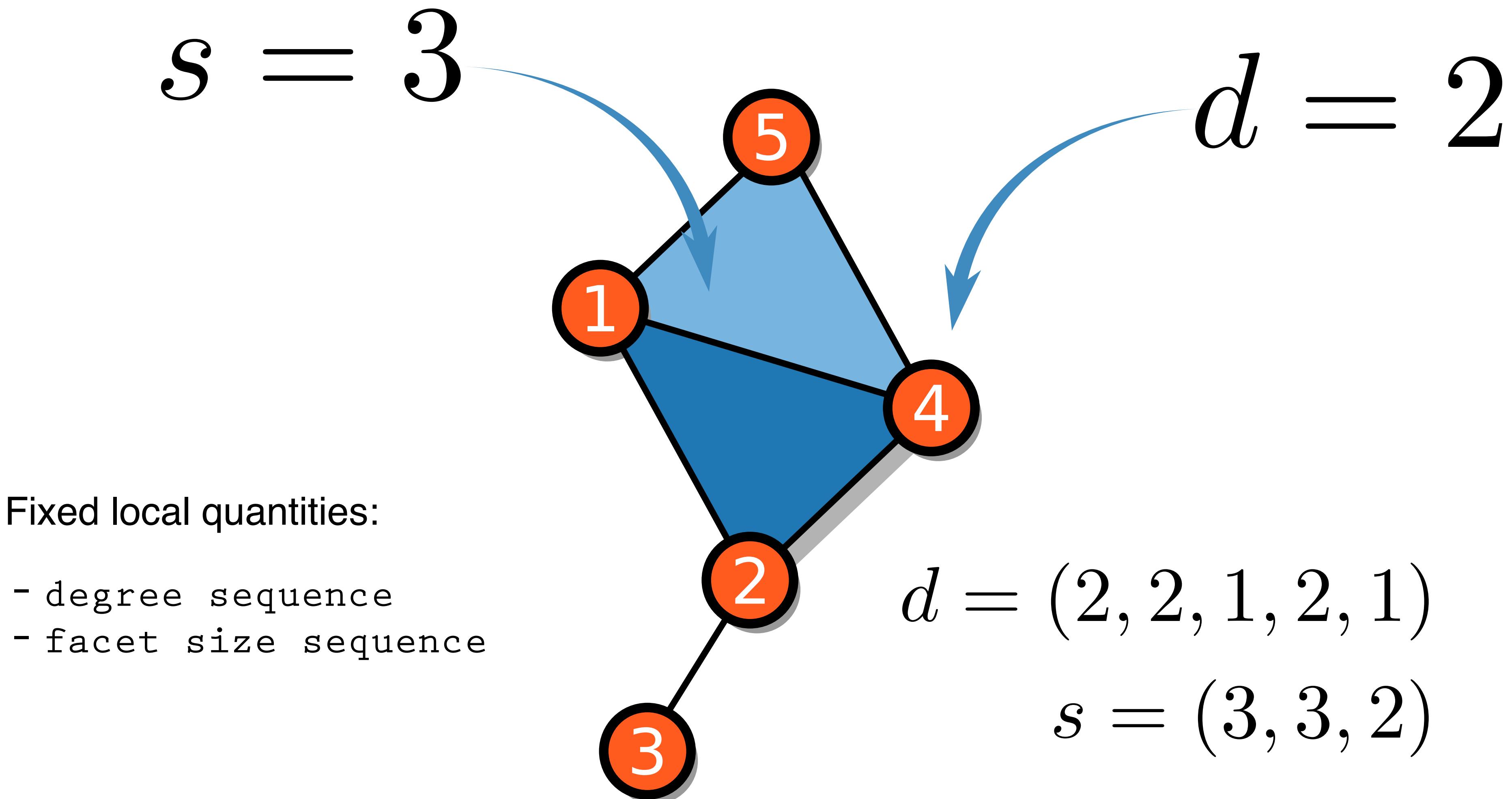
Simplicial Configuration Model

Simplicial Configuration Model

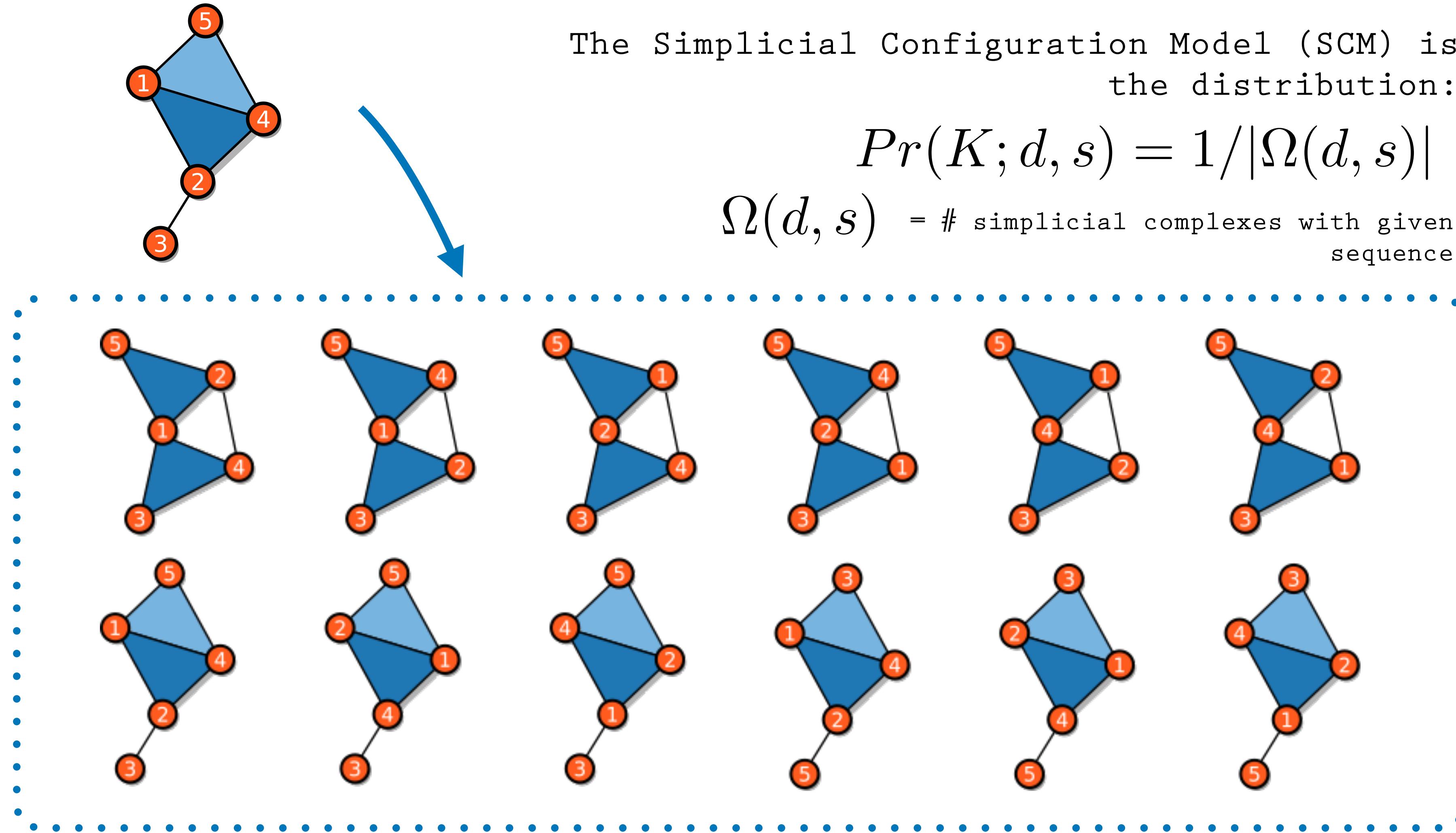
What's missing?

Simplicial Configuration Model for data

SCM: Ingredients

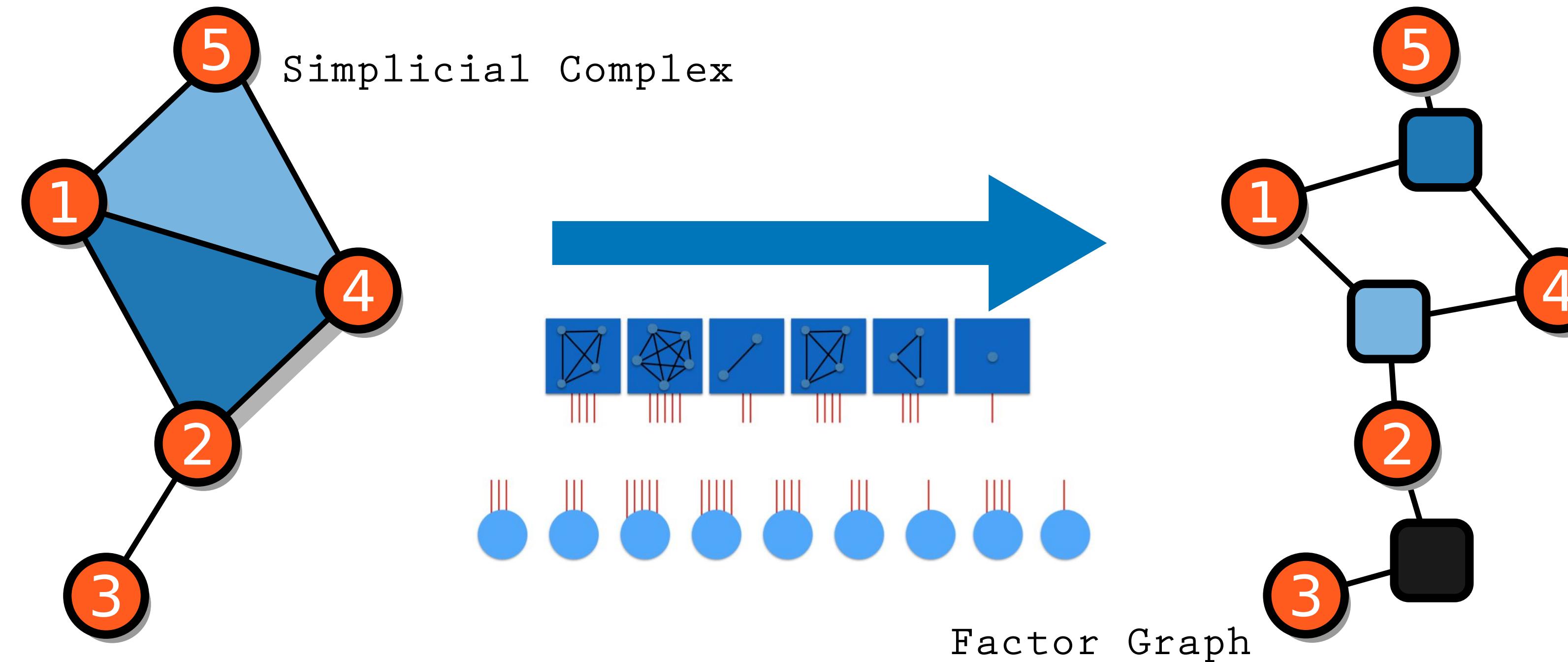


SCM: Formal definition



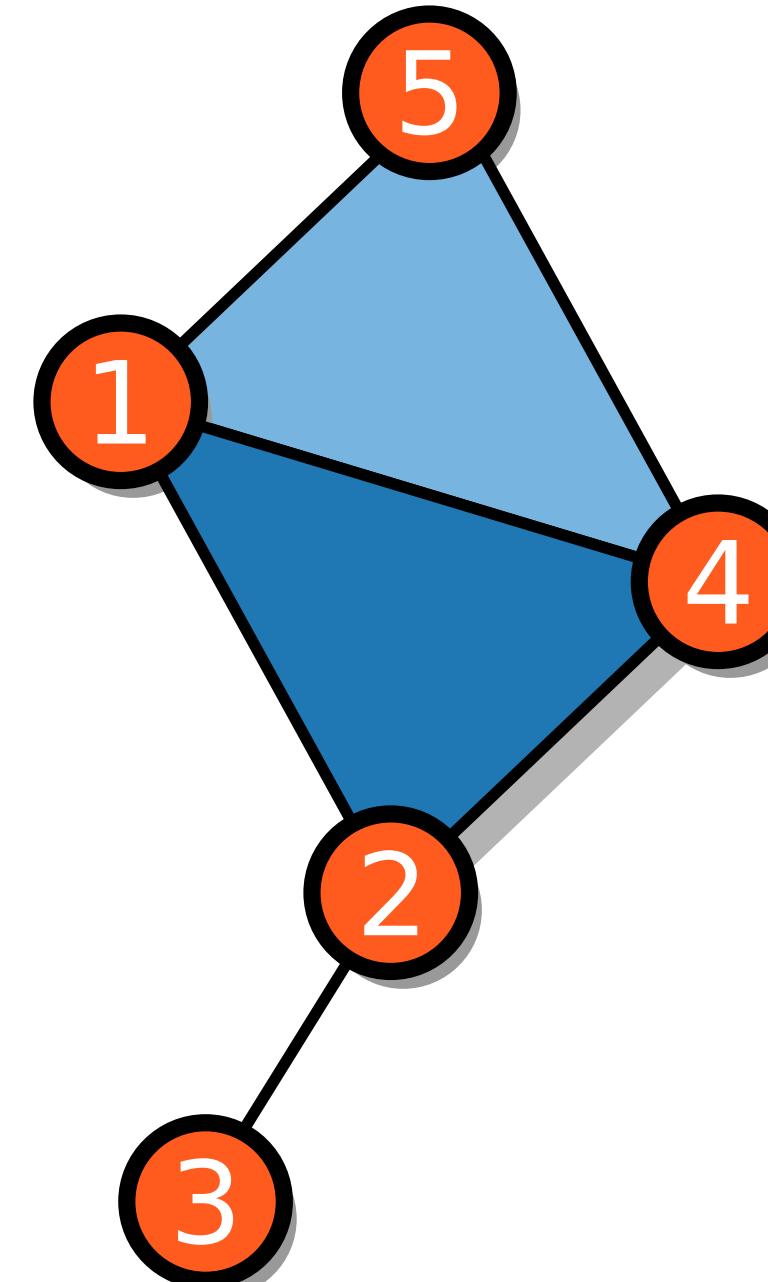
Generalizes Courtney, Bianconi (PRE, 2016) to any dimension but loses analytical tractability

SCM:change of representation



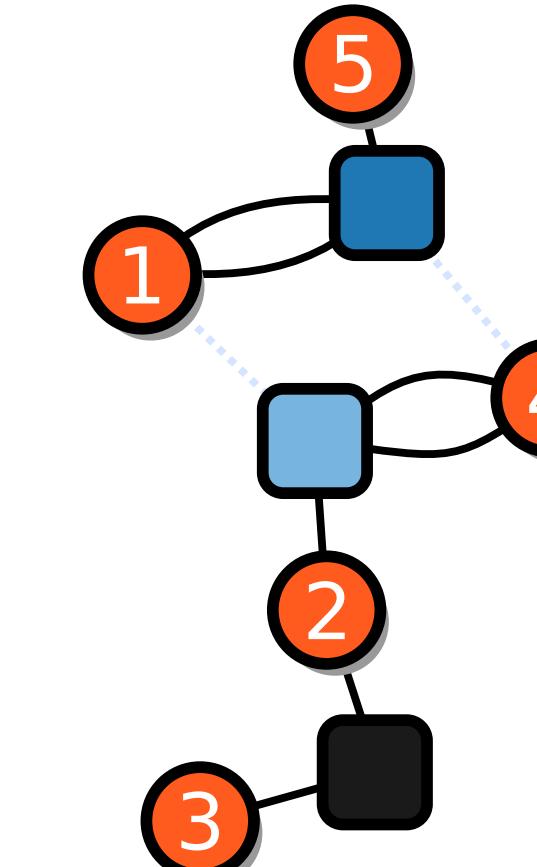
Factor graph ensemble with degree sequences $(d, s) \dots$
... and two additional constraints (mapping not bijective)
- No multiedges
- No included neighborhoods

SCM:potential constrain violation

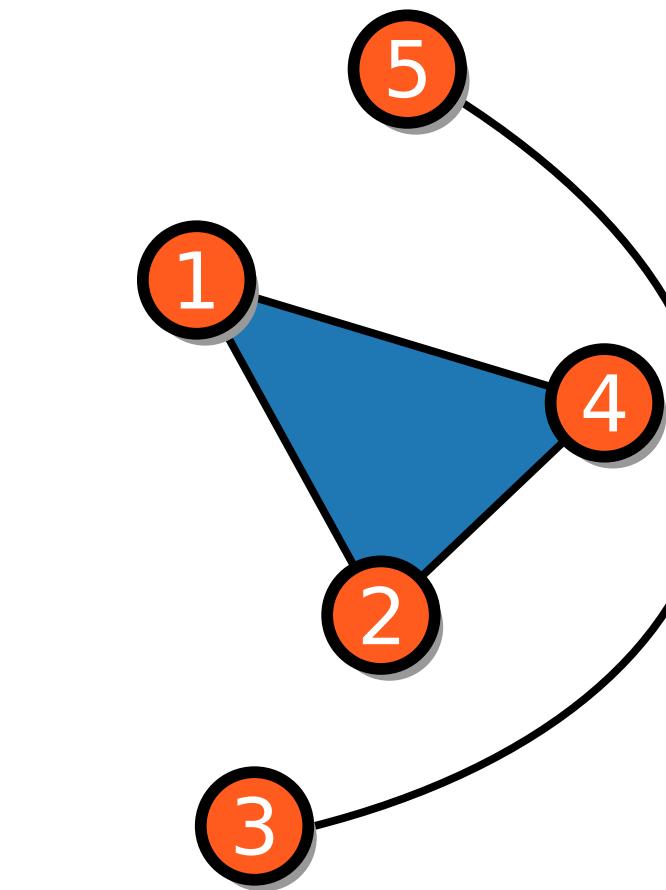
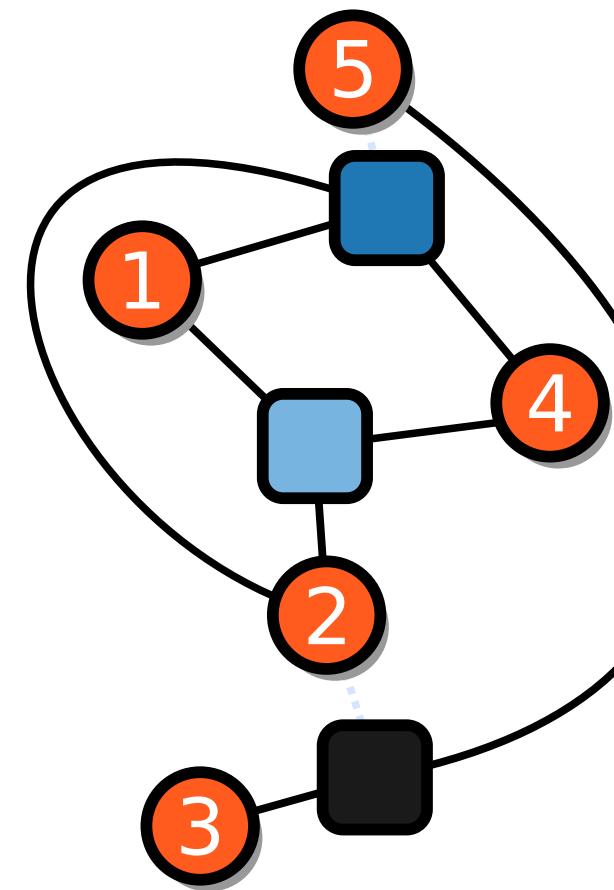
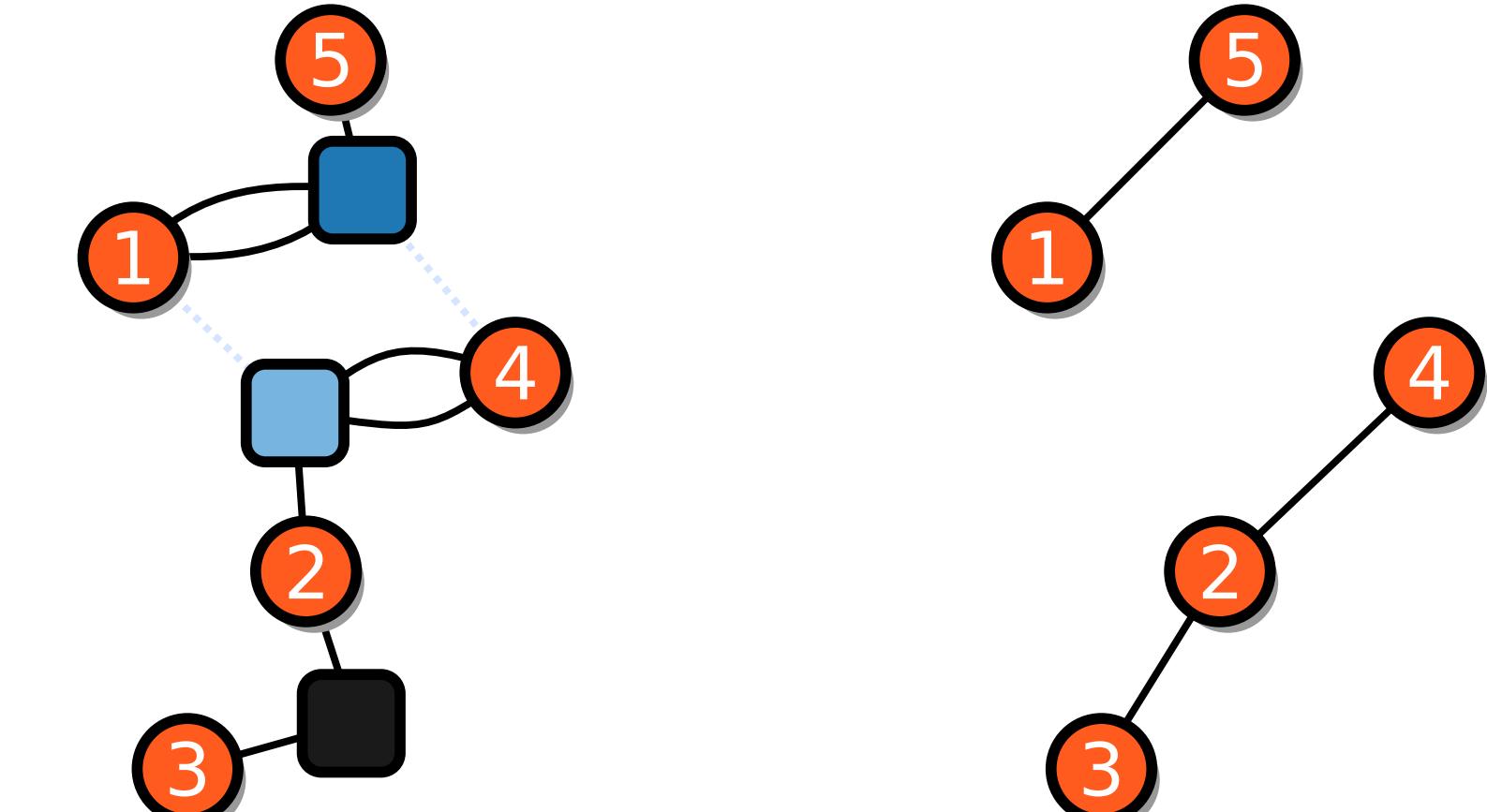


NO inclusions

Bipartite graph



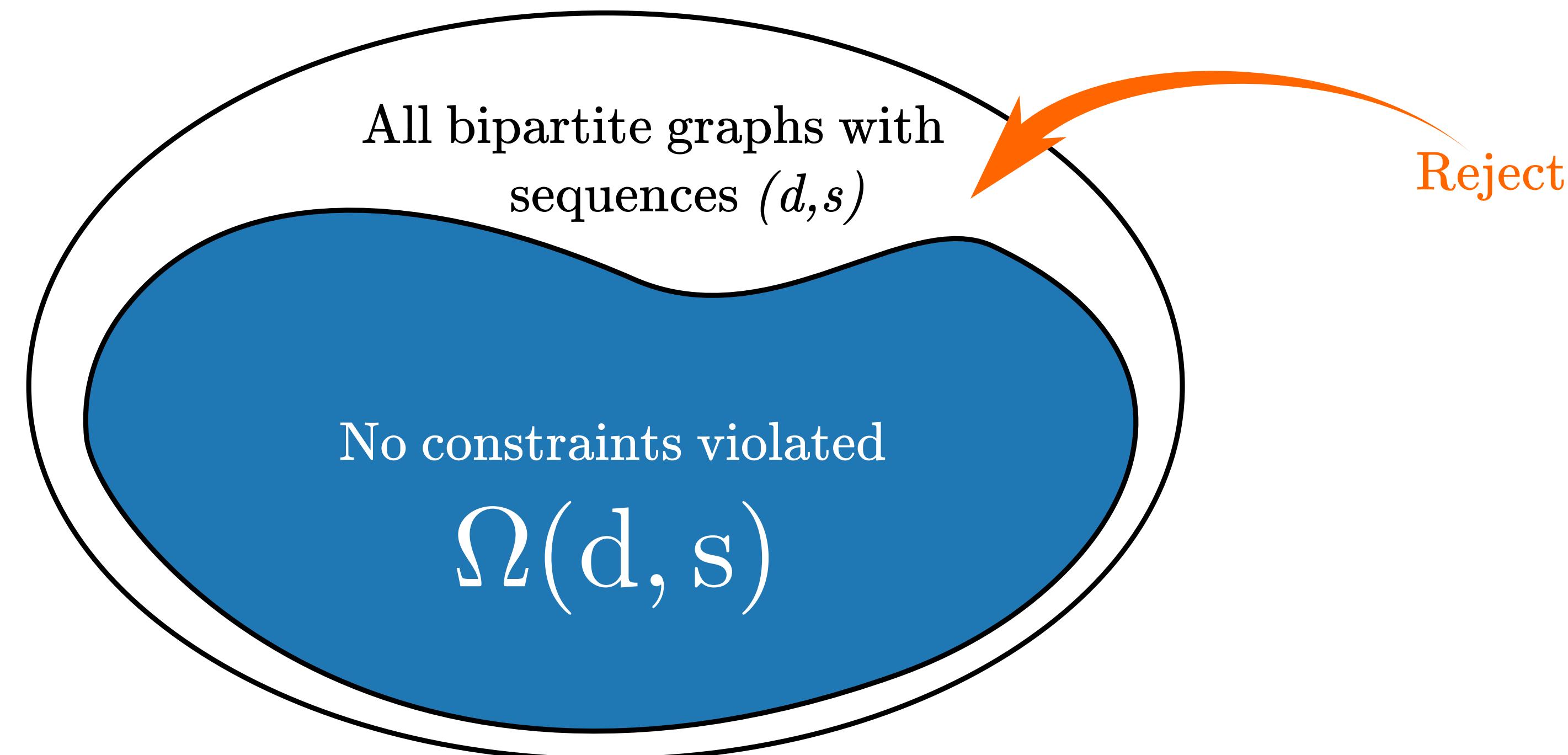
Simplicial complex



SCM: Inefficient rejection

Fraction of BG without parallel edges tends to:

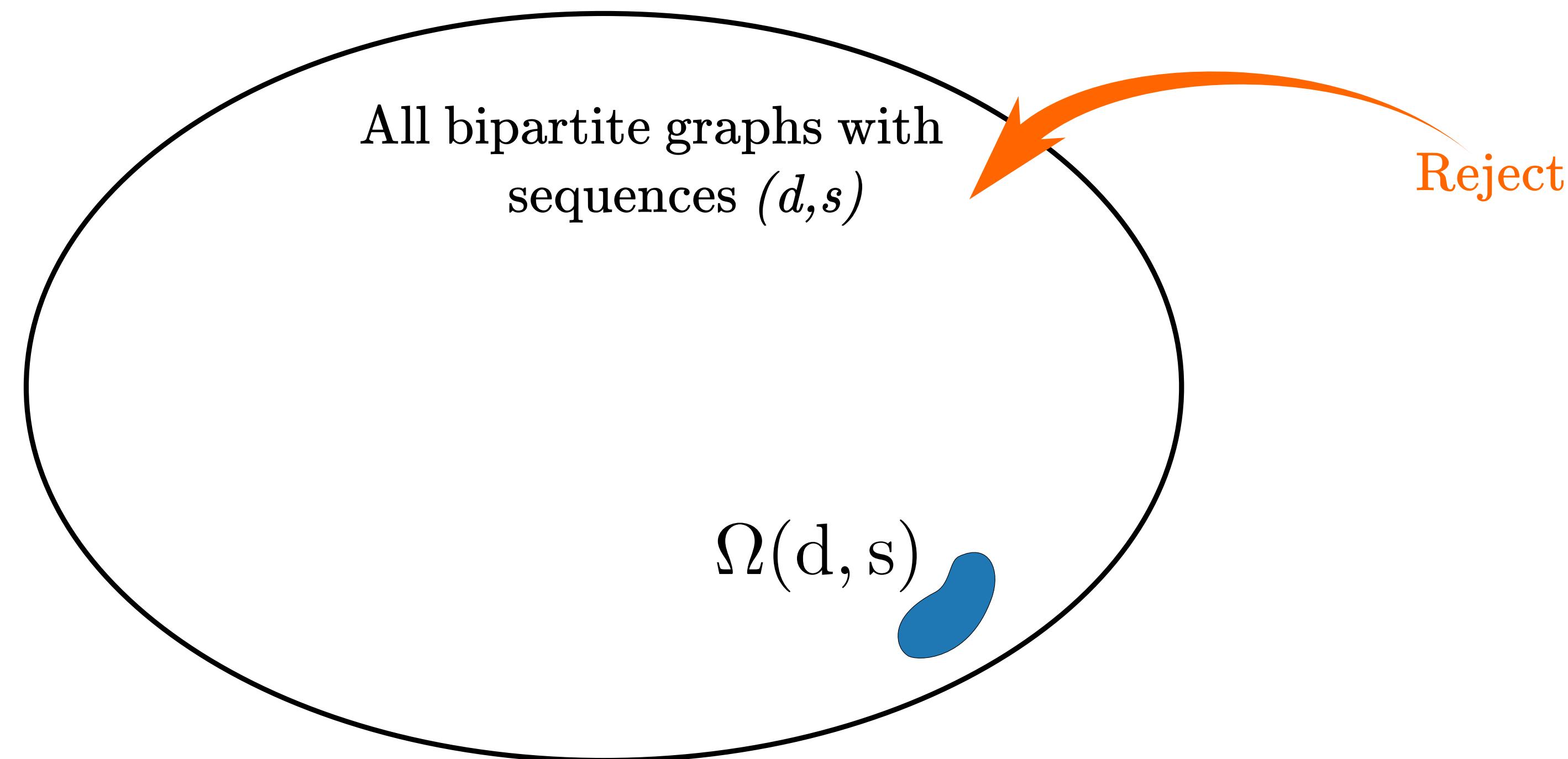
$$\phi = e^{-\frac{1}{2}(\langle d^2 \rangle / \langle d \rangle - 1)(\langle s^2 \rangle / \langle s \rangle - 1)}$$



SCM: Inefficient rejection

Fraction of BG without parallel edges tends to:

$$\phi = e^{-\frac{1}{2}(\langle d^2 \rangle / \langle d \rangle - 1)(\langle s^2 \rangle / \langle s \rangle - 1)}$$

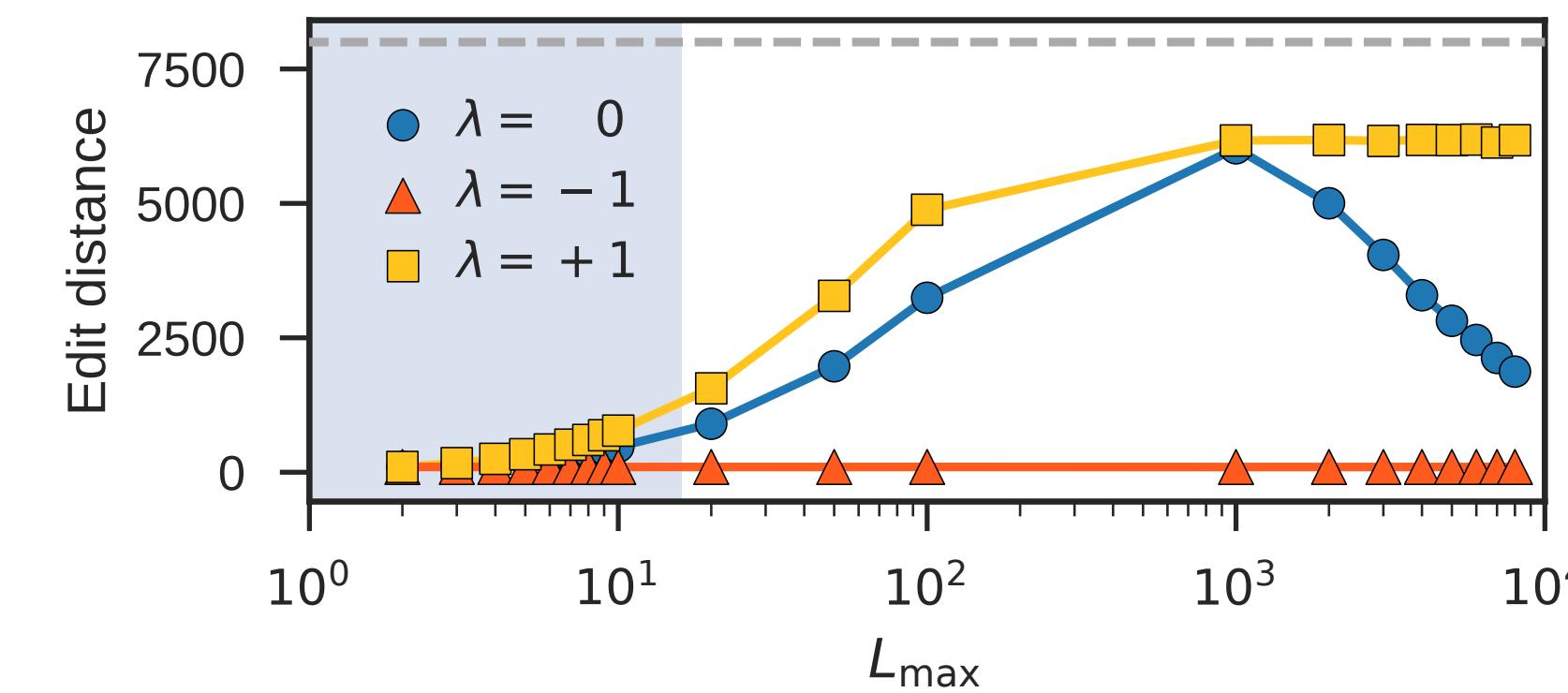


MCMC

Move set:

1. Pick $L \sim P$ random edges in bipartite graph.
2. Rewire edges. If multiedge or included neighbors, reject.

$$P \text{ arbitrary} \rightarrow \Pr[L = l] = \exp[\lambda l]/Z$$

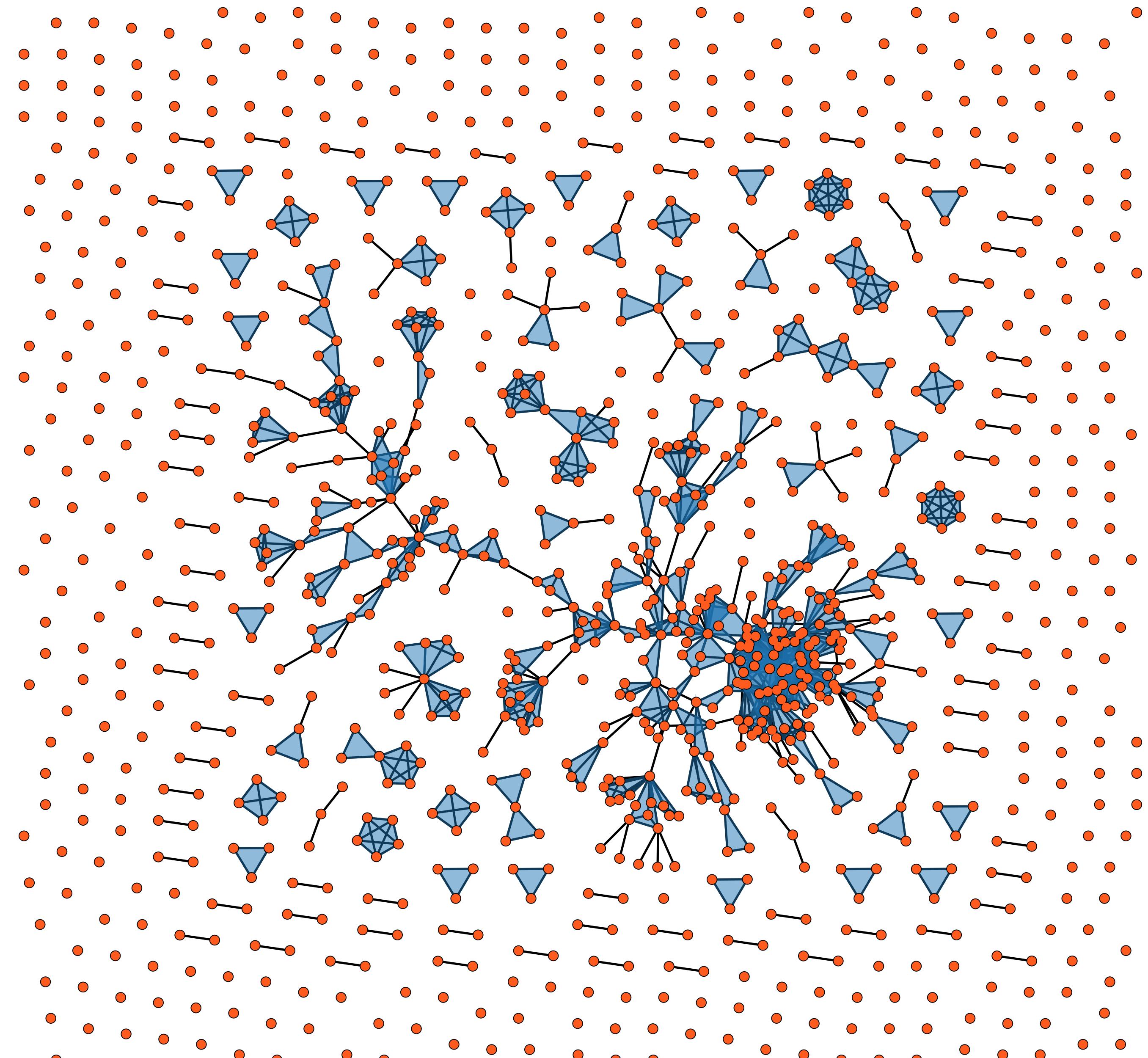


Checks:

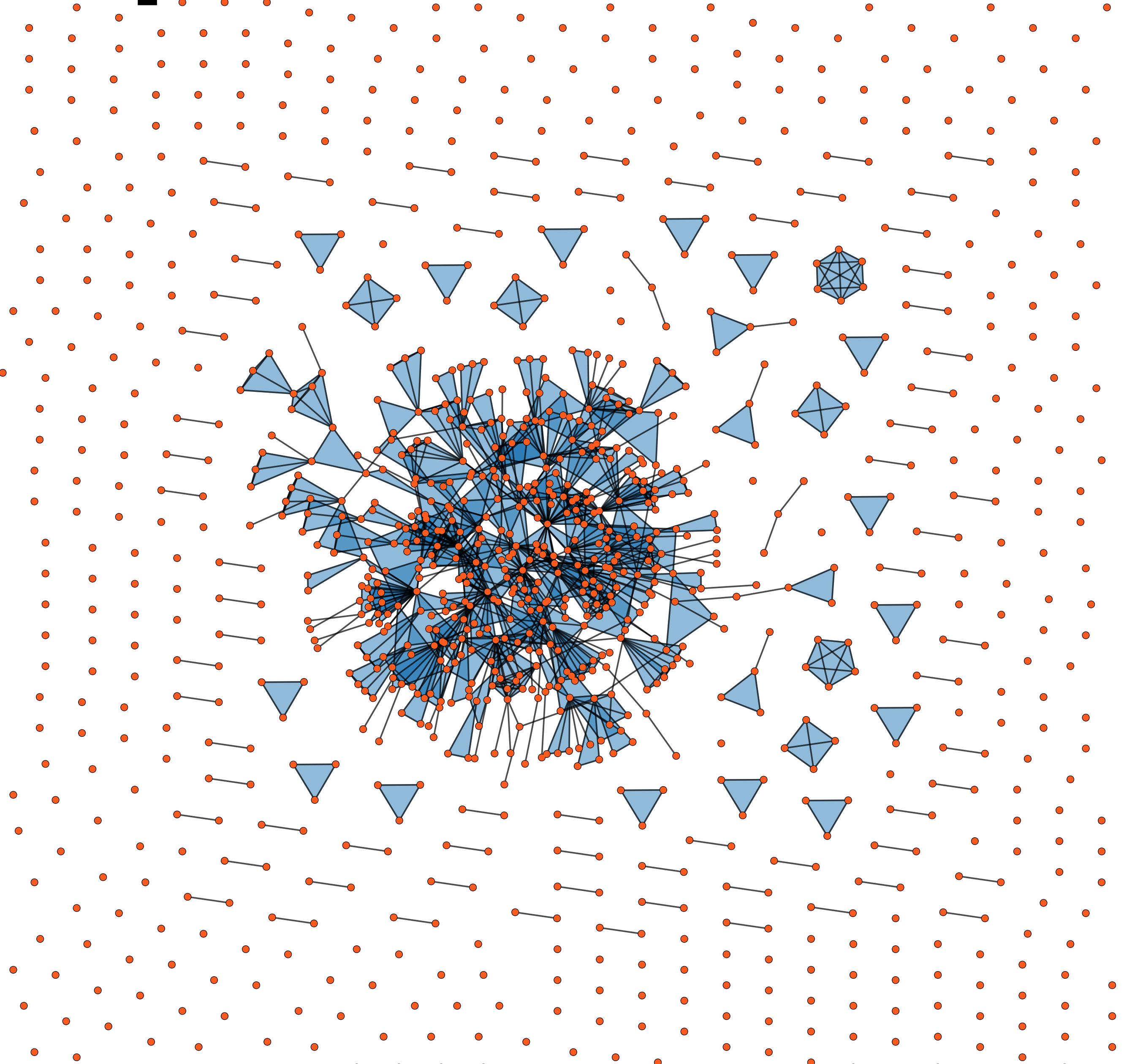
- MCMC is uniform over $\Omega(d, s)$
- Move set yields aperiodic chain
- Move set connects the space

$$L_{\max} < 2 \max s$$

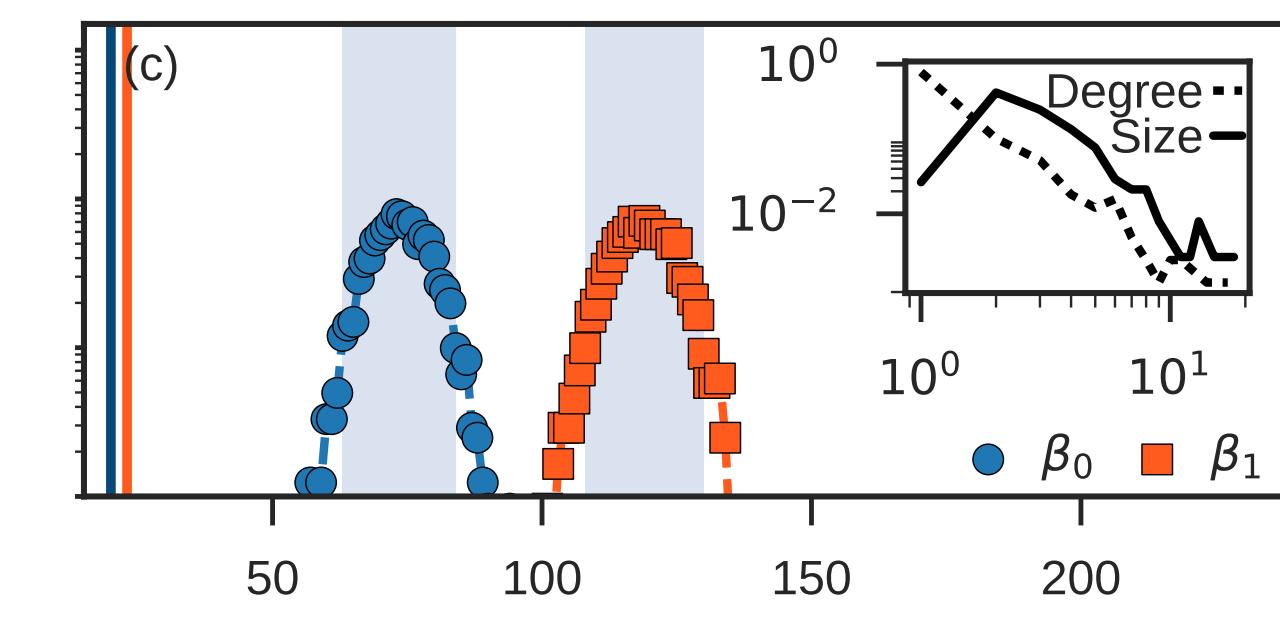
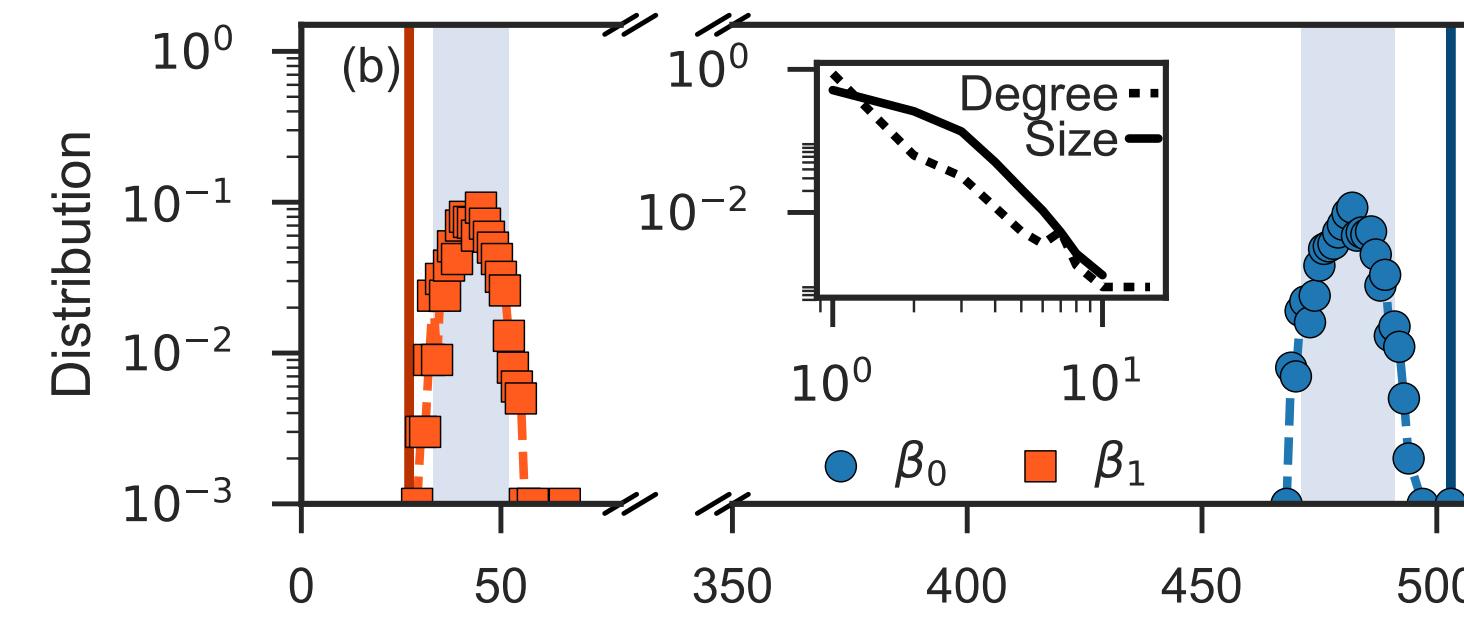
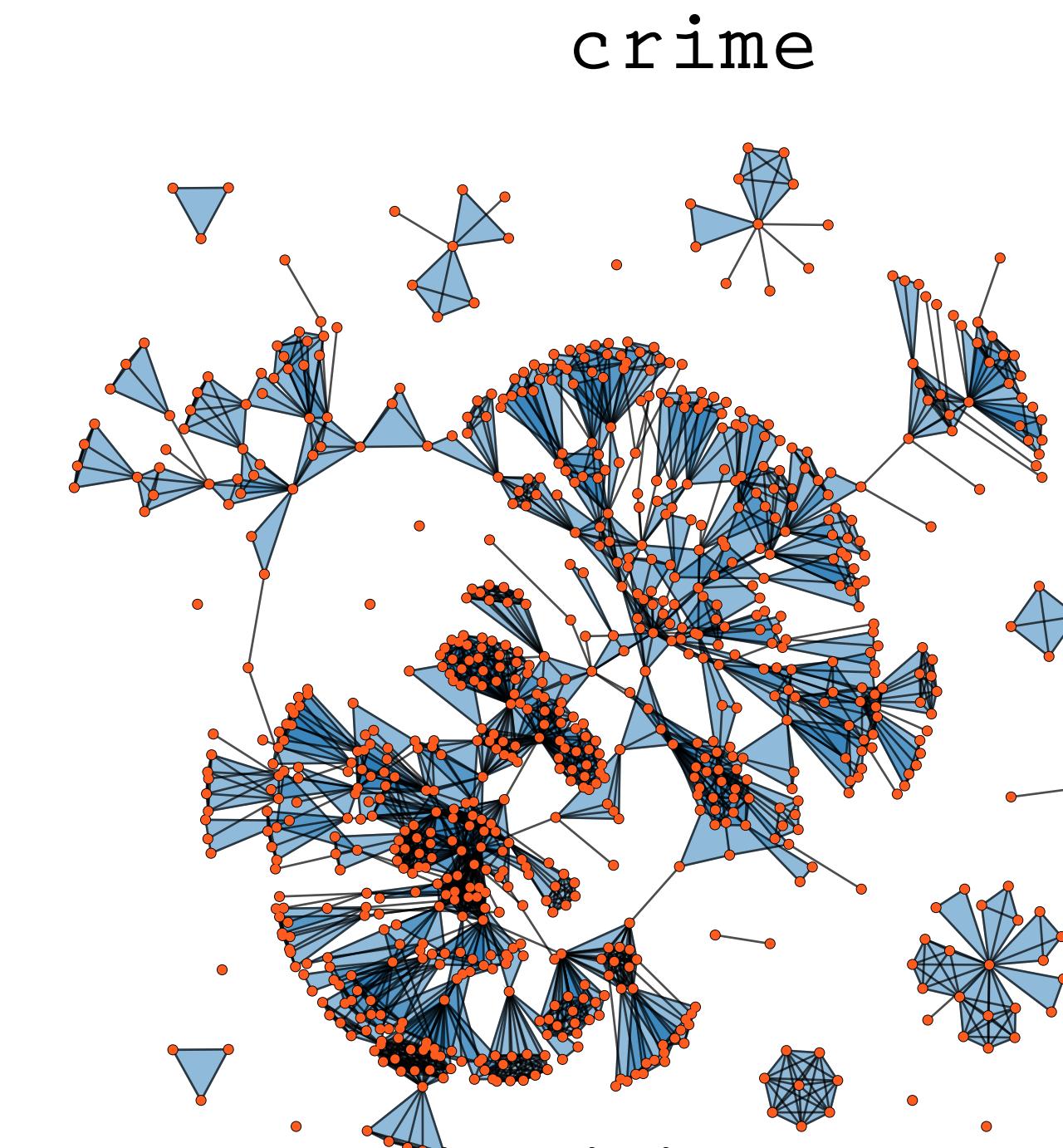
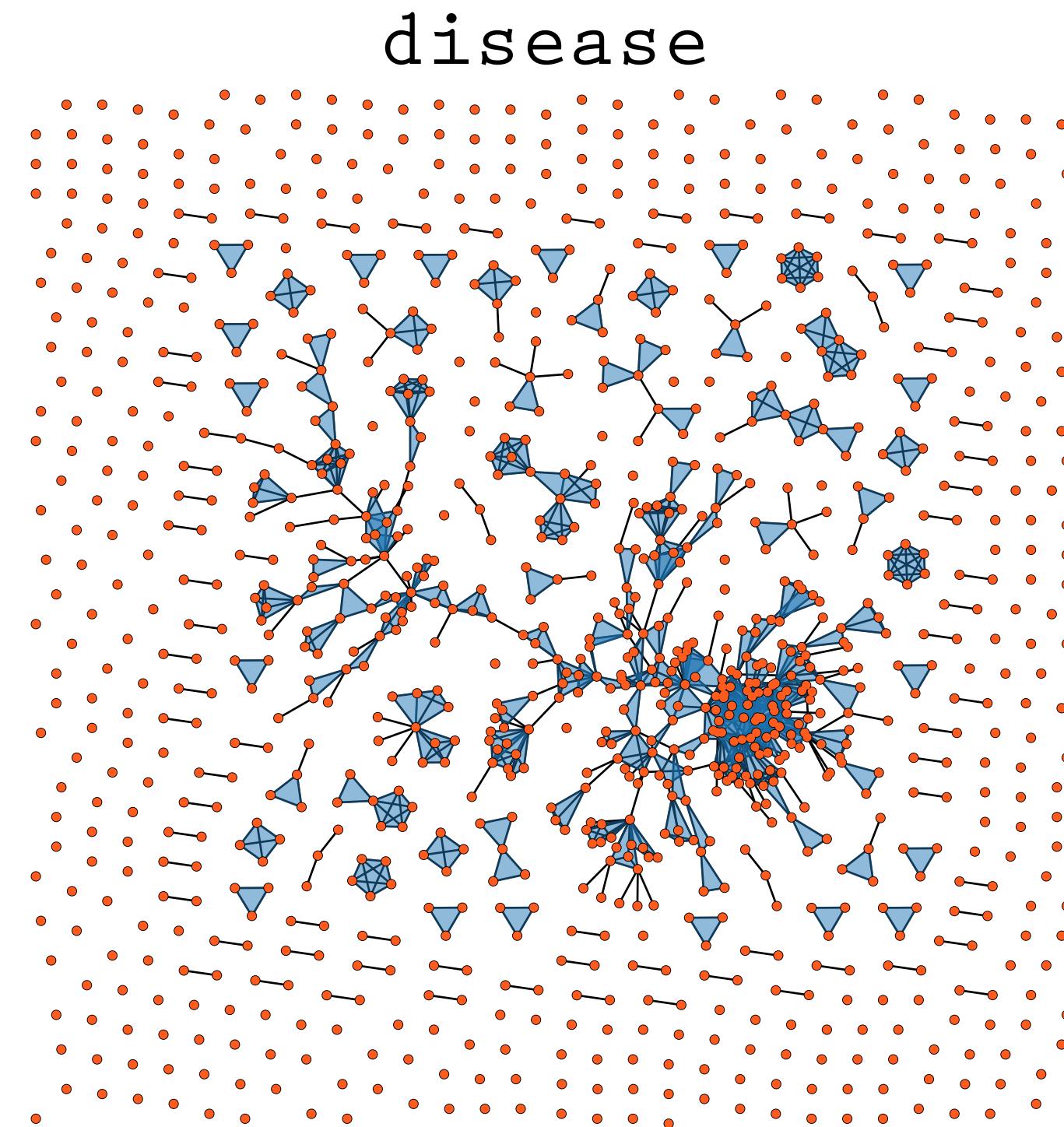
SCM example: disease



SCM example: disease



Homology as significant structure



Homology as significant structure

