

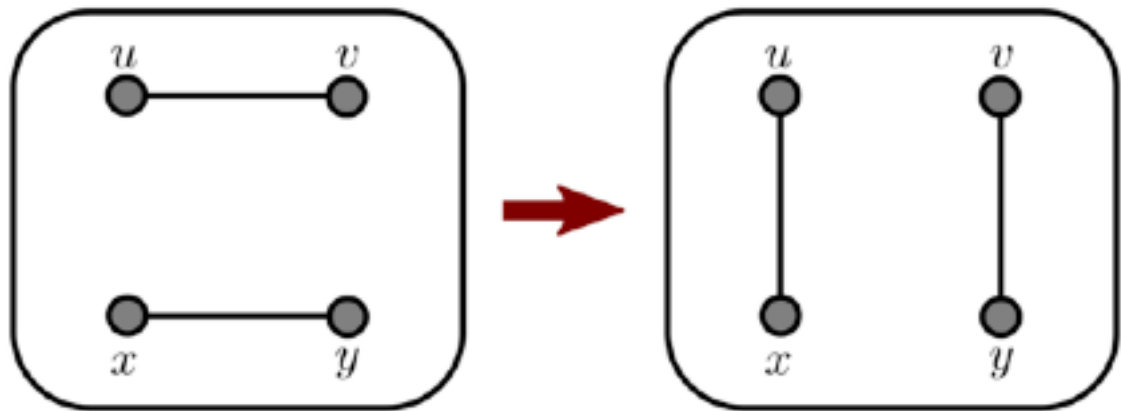


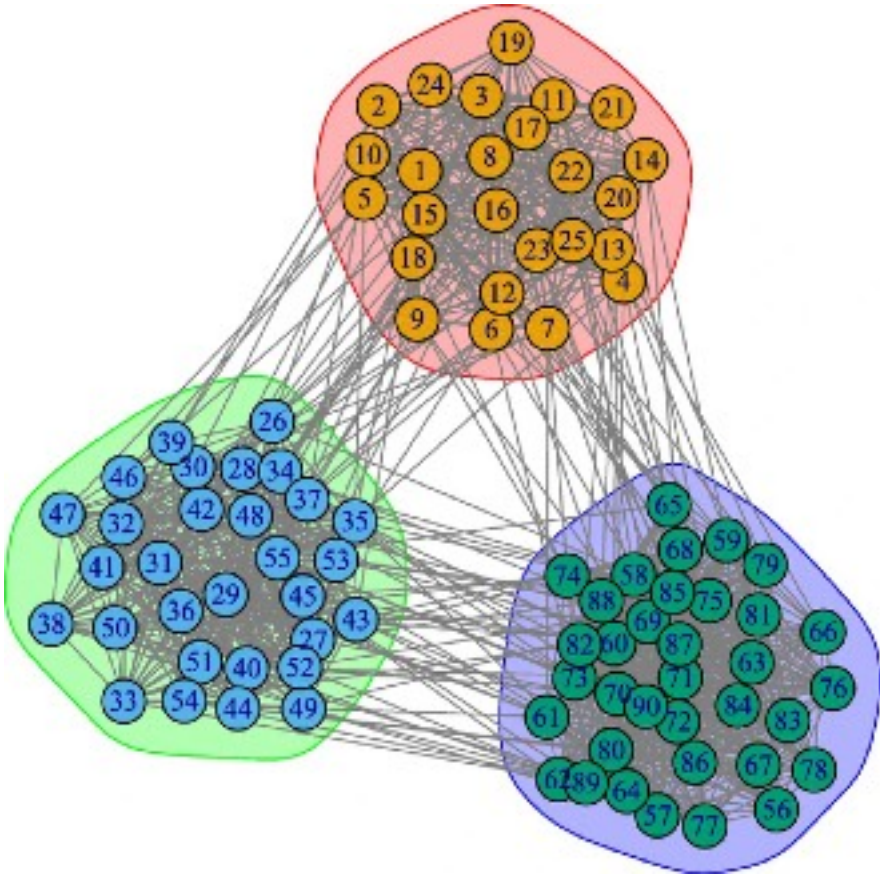


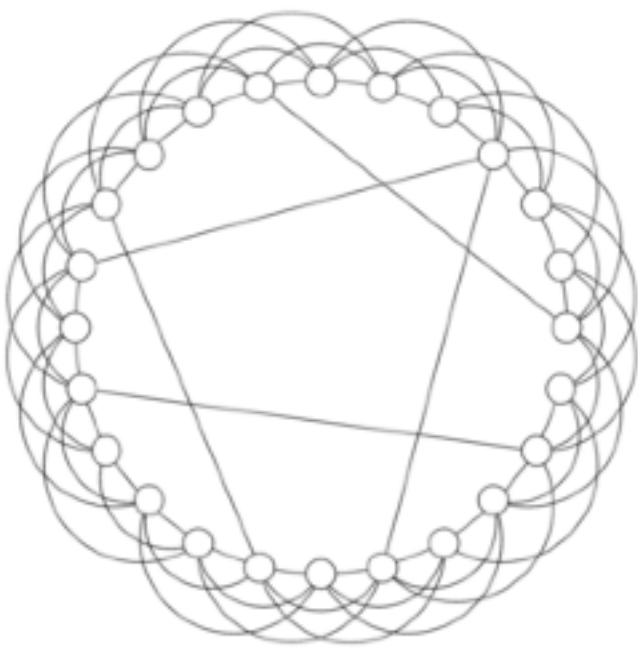
Network models

Some examples of equilibrium (fixed size) network models

$$(u, v), (x, y) \rightsquigarrow (u, x), (v, y)$$















8



# Configuration model (and variations)

- ▷ degree sequence/distribution [2]
- ▷ degree-degree correlations [3]
- ▷ k-core/onion decomposition [4]

# Stochastic block models

▷ community structure/detection [5]

# Watts-Strogatz model

- ▷ small-world effect [7]

[1] Phys. Rev. E 80, 020901 (2009)

[2] SIAM Rev. 60, 315 (2018)

[3] Phys. Rev. Lett. 89, 208701 (2002)



[4] Phys. Rev. X 9, 011023 (2019)

[5] Soc. Networks 5, 109 (1983)

[6] Appl. Netw. Sci. 4, 122 (2019)

[7] *Nature* 393, 440 (1998)

[B]SIAM Rev. 45, 167 (2003)

# Why?

- ▷ Mathematical representation → **analytical** results and predictions.
- ▷ Identify the **mechanisms** behind a set of topological properties.
- ▷ **Disentangle** the effect of various topological properties (e.g. assortative mixing vs. clustering on the percolation threshold [1]).
- ▷ Identify significant patterns of connection in real networks (i.e. **null models**).
- ▷ Perform in silico controlled experiments (e.g. **simulation** of epidemic spreading).
- ▷ ...

# Network models

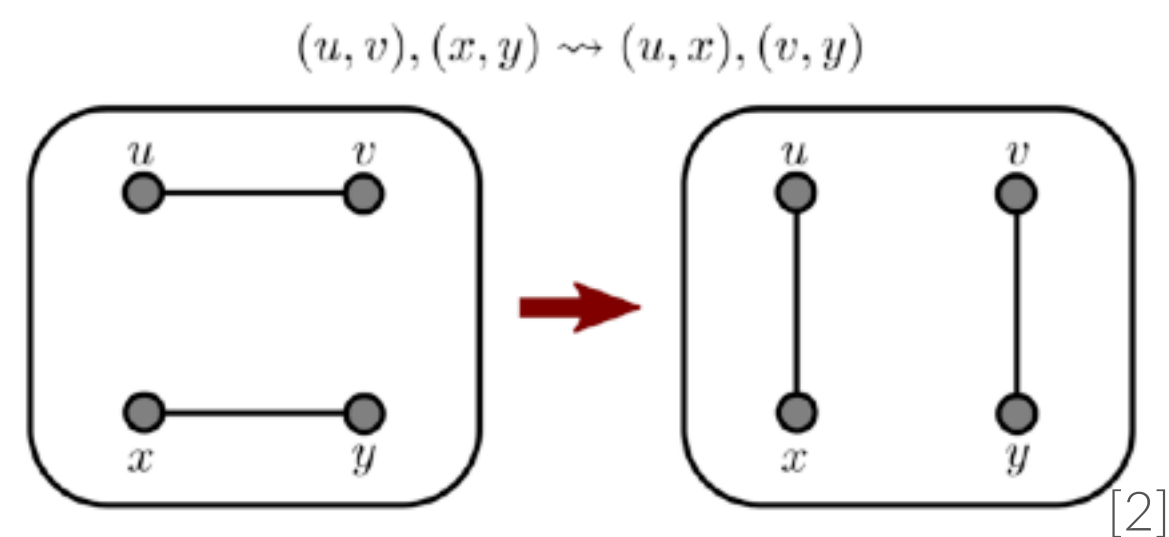
## Why?

- ▷ Mathematical representation → **analytical** results and predictions.
- ▷ Identify the **mechanisms** behind a set of topological properties.
- ▷ **Disentangle** the effect of various topological properties (e.g. assortative mixing vs. clustering on the percolation threshold [1]).
- ▷ Identify significant patterns of connection in real networks (i.e. **null models**).
- ▷ Perform in silico controlled experiments (e.g. **simulation** of epidemic spreading).
- ▷ ...

## Some examples of equilibrium (fixed size) network models

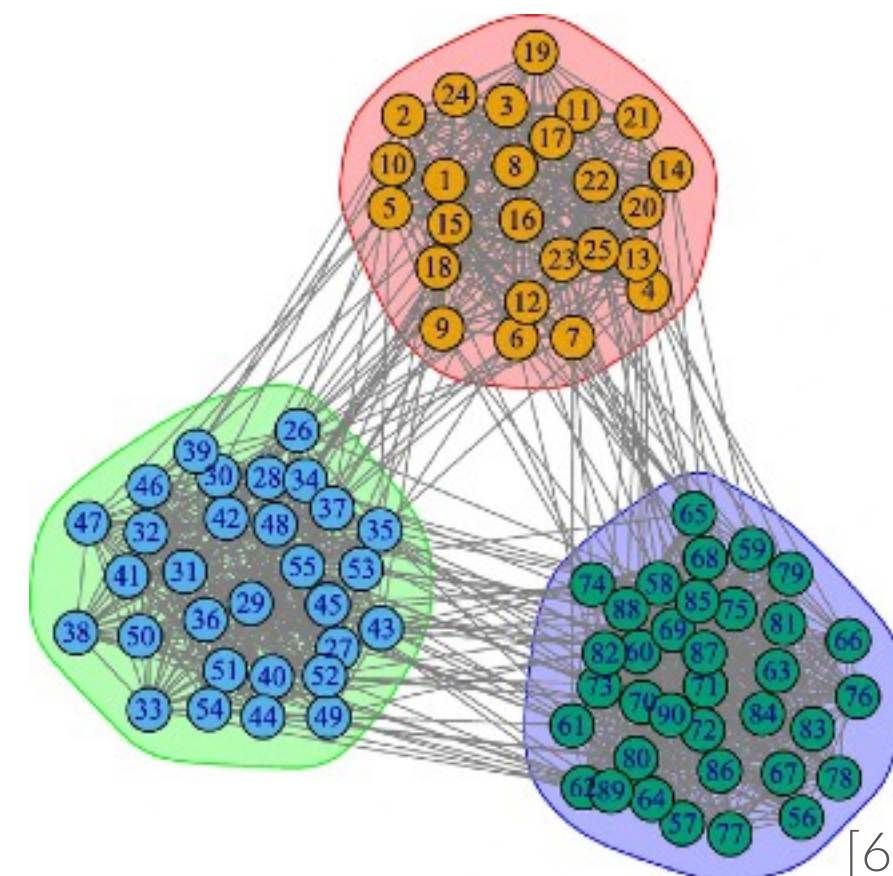
### Configuration model (and variations)

- ▷ degree sequence/distribution [2]
- ▷ degree-degree correlations [3]
- ▷ k-core/onion decomposition [4]



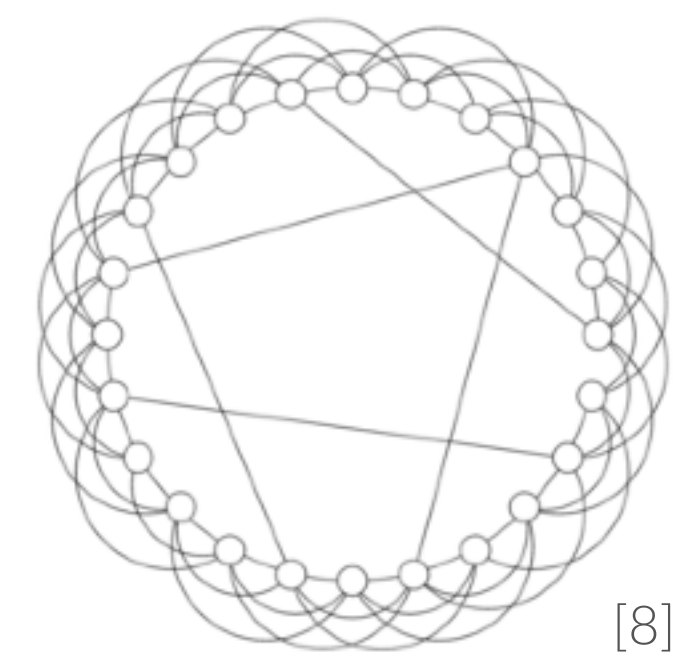
### Stochastic block models

- ▷ community structure/detection [5]



### Watts-Strogatz model

- ▷ small-world effect [7]



[1] Phys. Rev. E 80, 020901 (2009)

[2] SIAM Rev. 60, 315 (2018)

[3] Phys. Rev. Lett. 89, 208701 (2002)

[4] Phys. Rev. X 9, 011023 (2019)

[5] Soc. Networks 5, 109 (1983)

[6] Appl. Netw. Sci. 4, 122 (2019)

[7] Nature 393, 440 (1998)

[8] SIAM Rev. 45, 167 (2003)

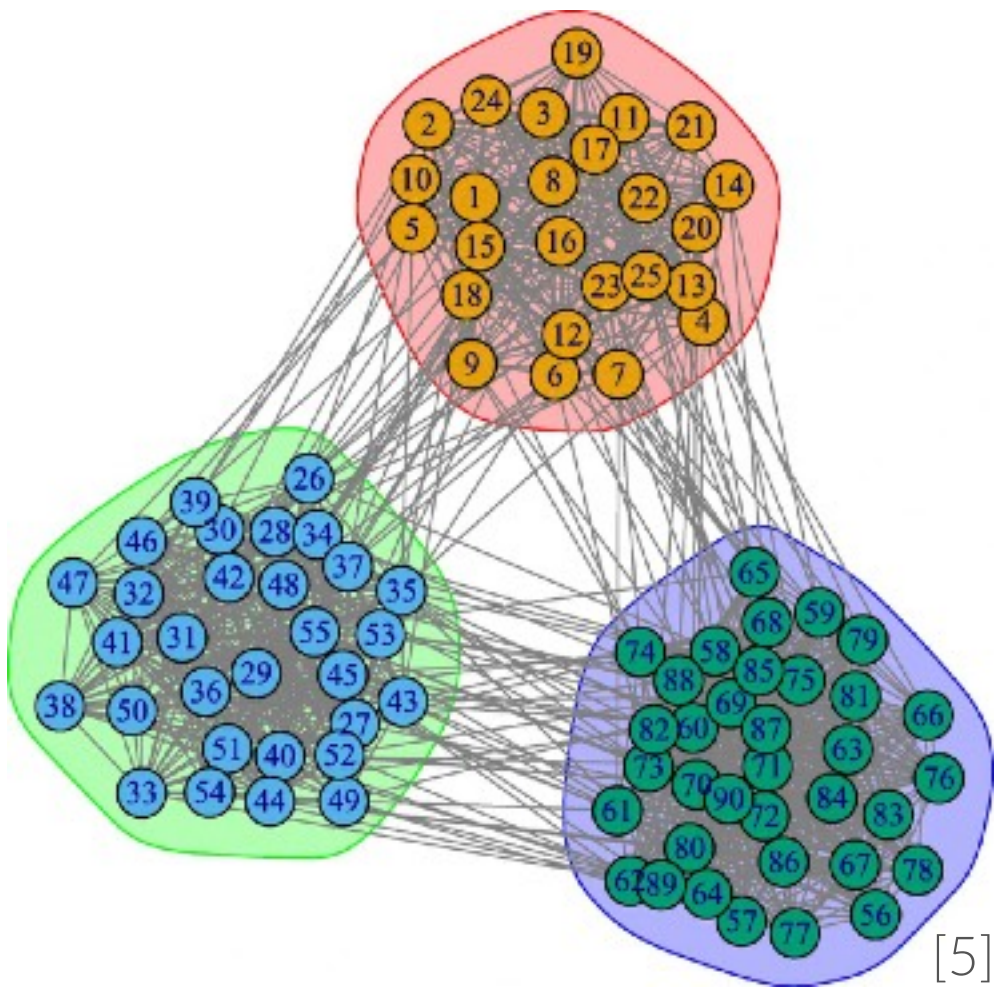
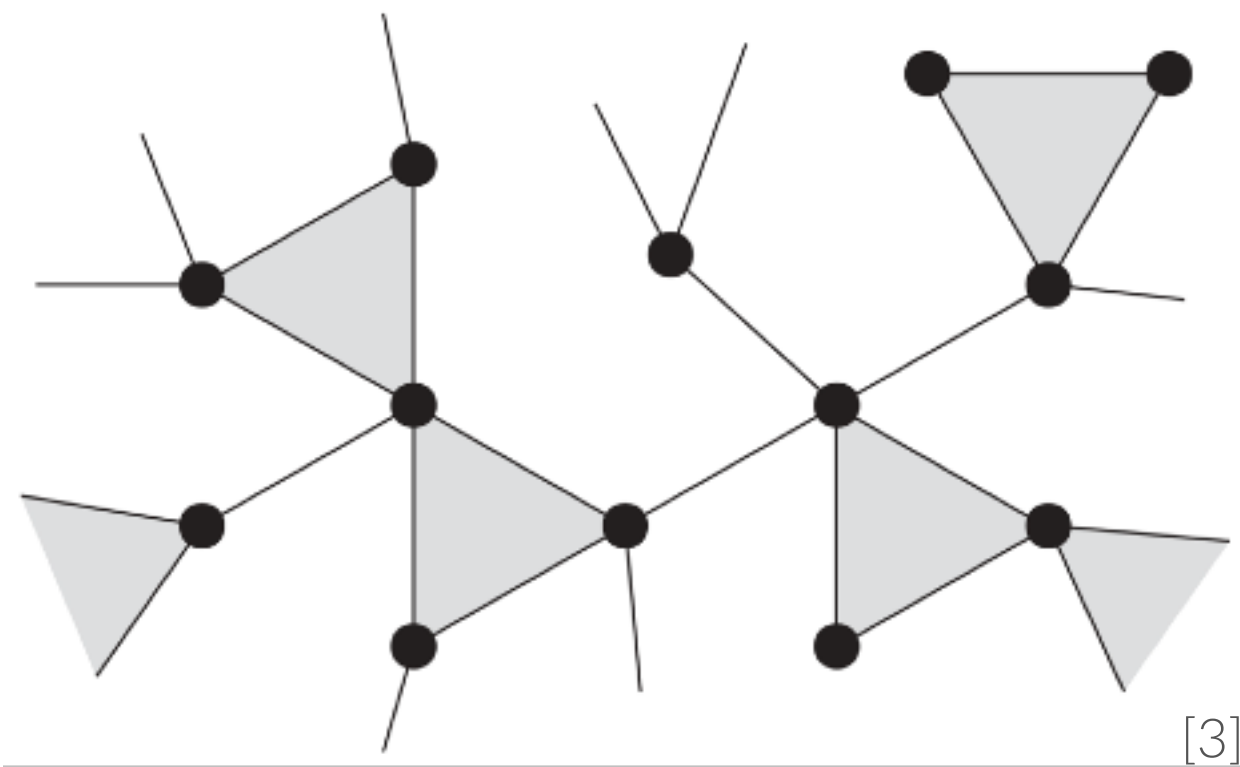
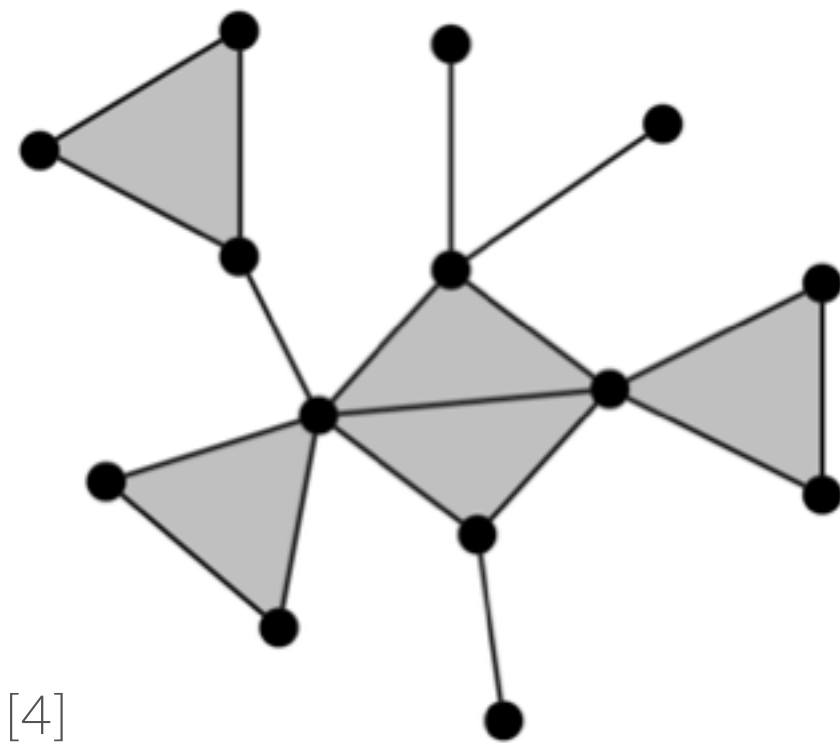
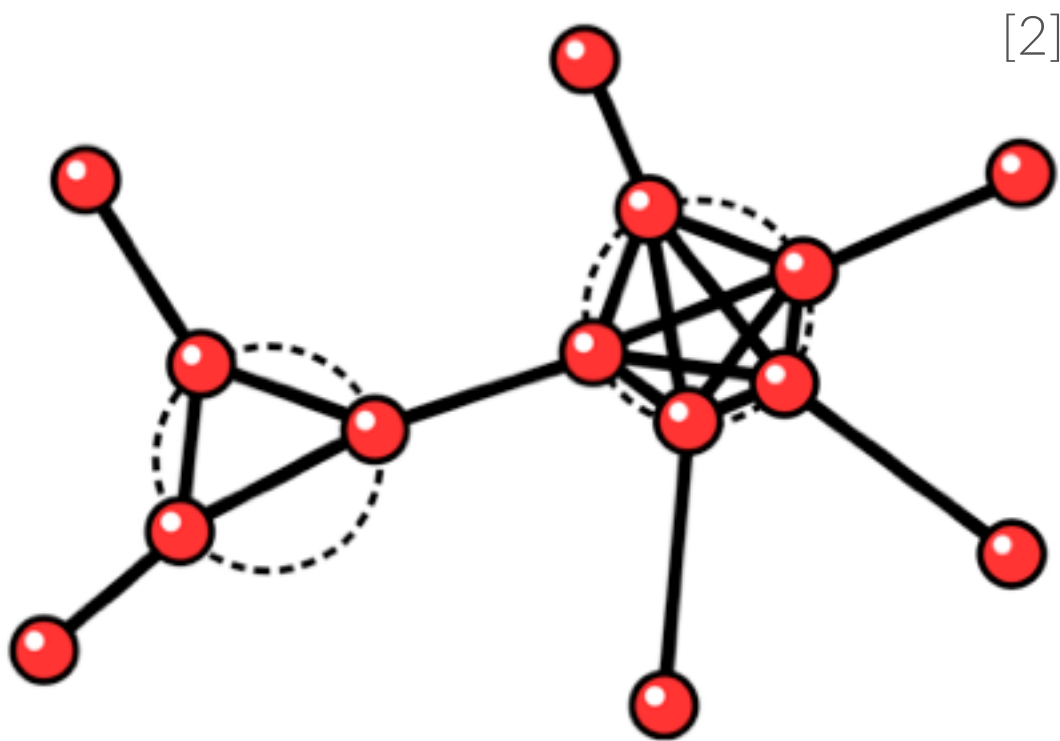
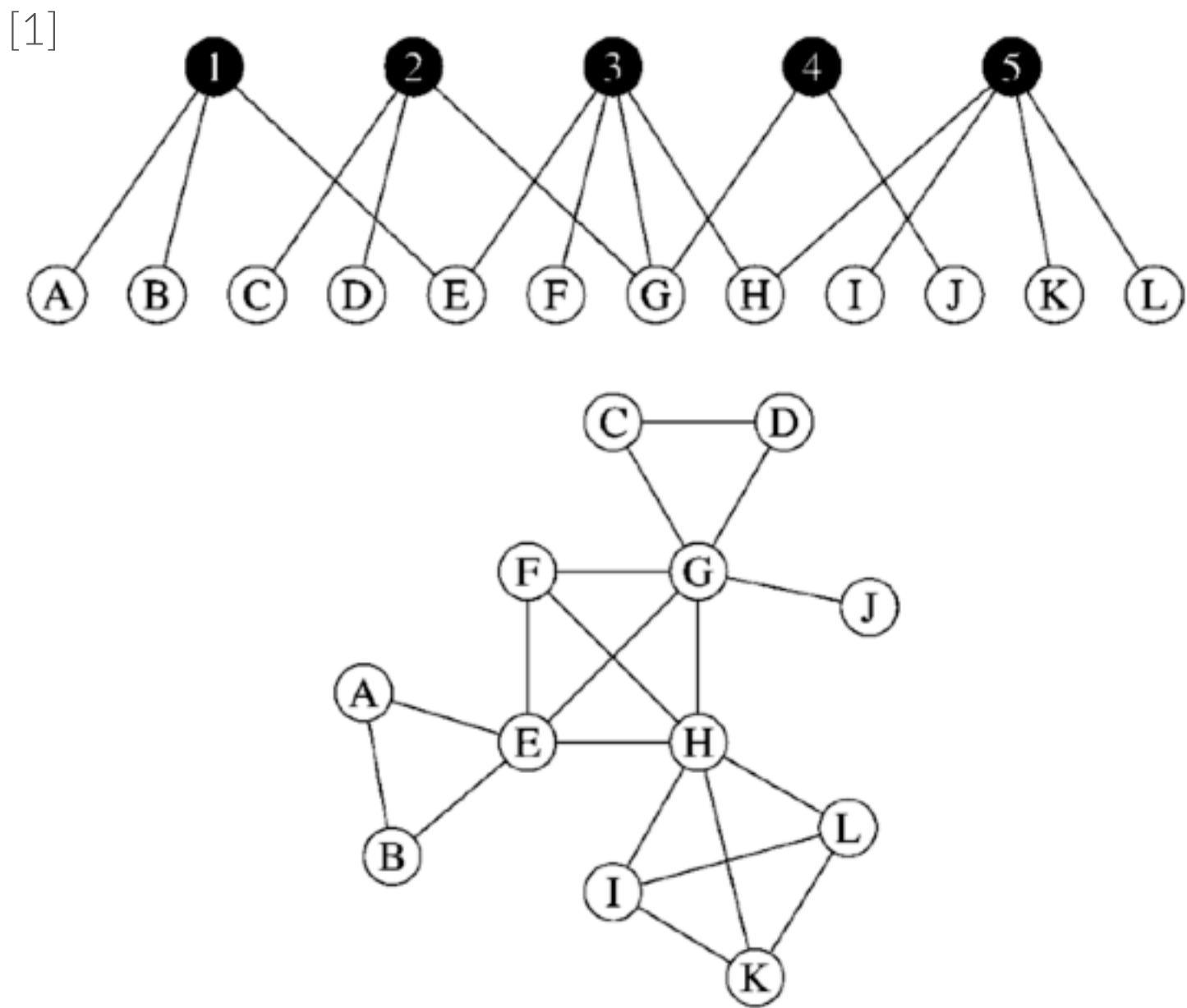


# Modeling clustering

Trickier because clustering consists in **three-node interactions** while our mathematical tools rely on **pairwise interactions** either explicitly or implicitly.

Most models therefore assume

- ▷ an **underlying tree-like** structure
- ▷ that the networks are **dense**



[1] Phys. Rev. E 68, 026121 (2003)  
[2] Phys. Rev. E 80, 036107 (2009)  
[3] Phys. Rev. Lett. 103, 058701 (2009)  
[4] Phys. Rev. E 82, 066118 (2010)  
[5] Appl. Netw. Sci. 4, 122 (2019)