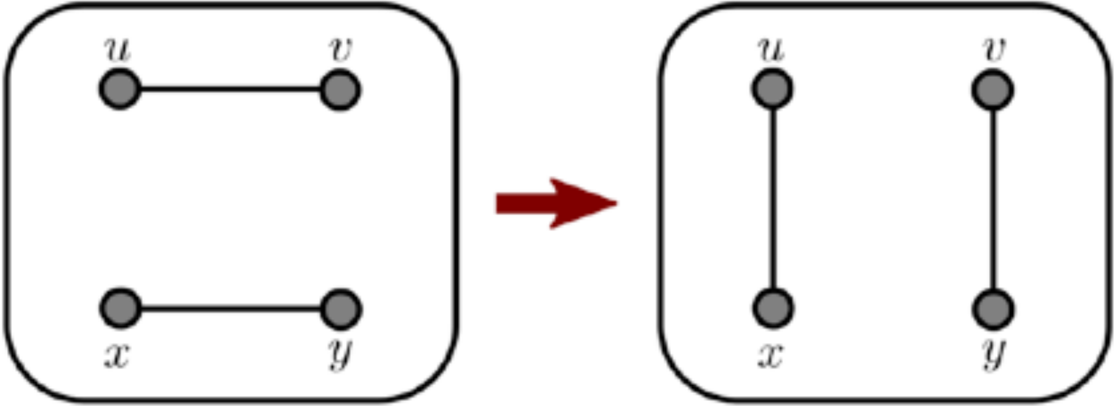
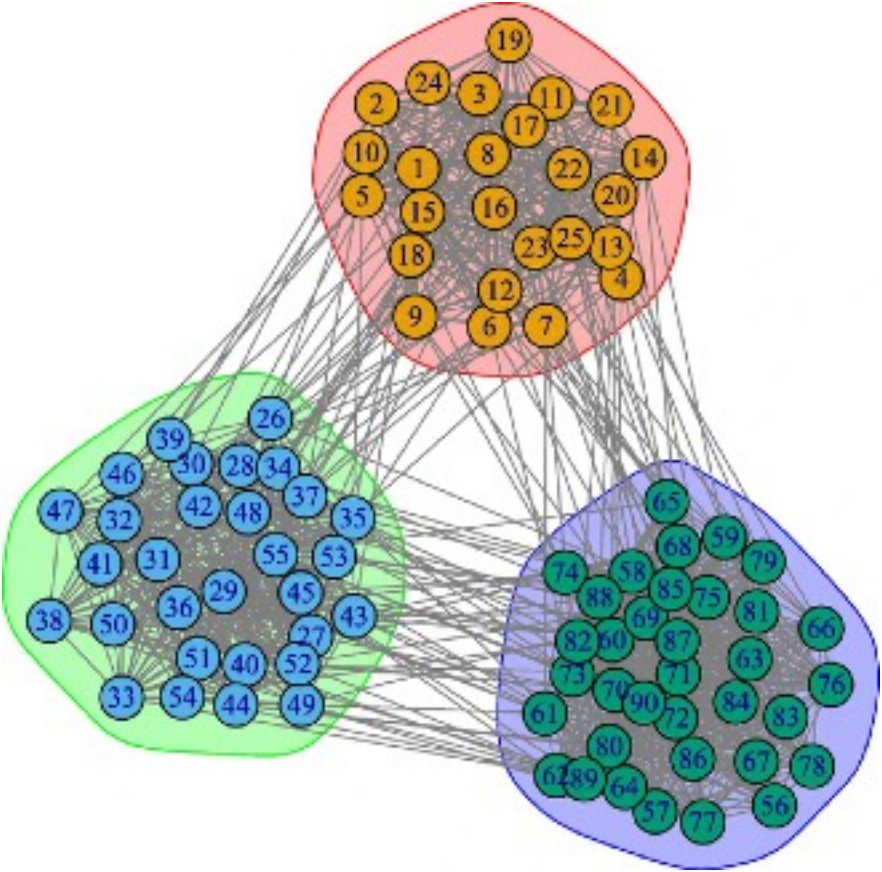
3

Network models

Some examples of equilibrium (fixed size) network models

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

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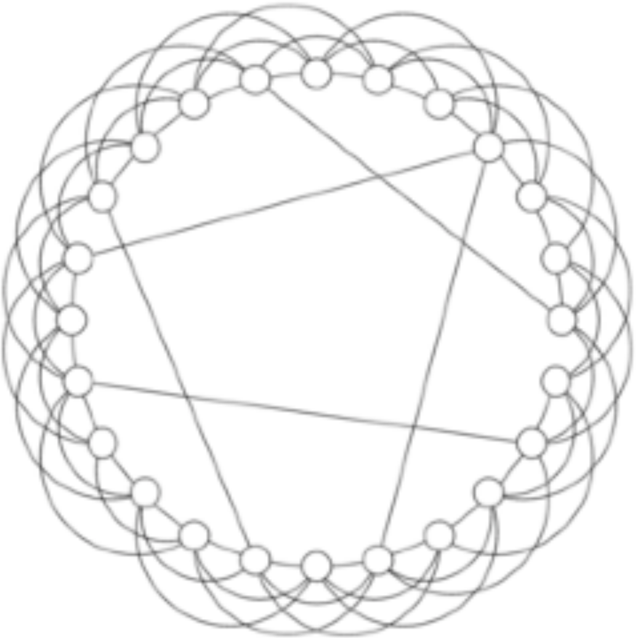

[2]

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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)

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 ?

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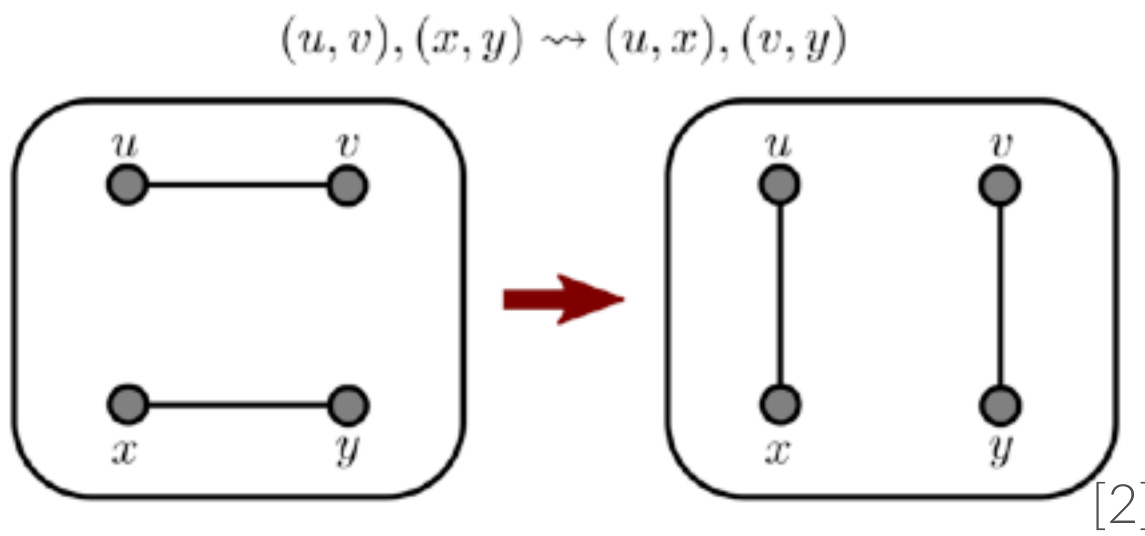
- ...

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]



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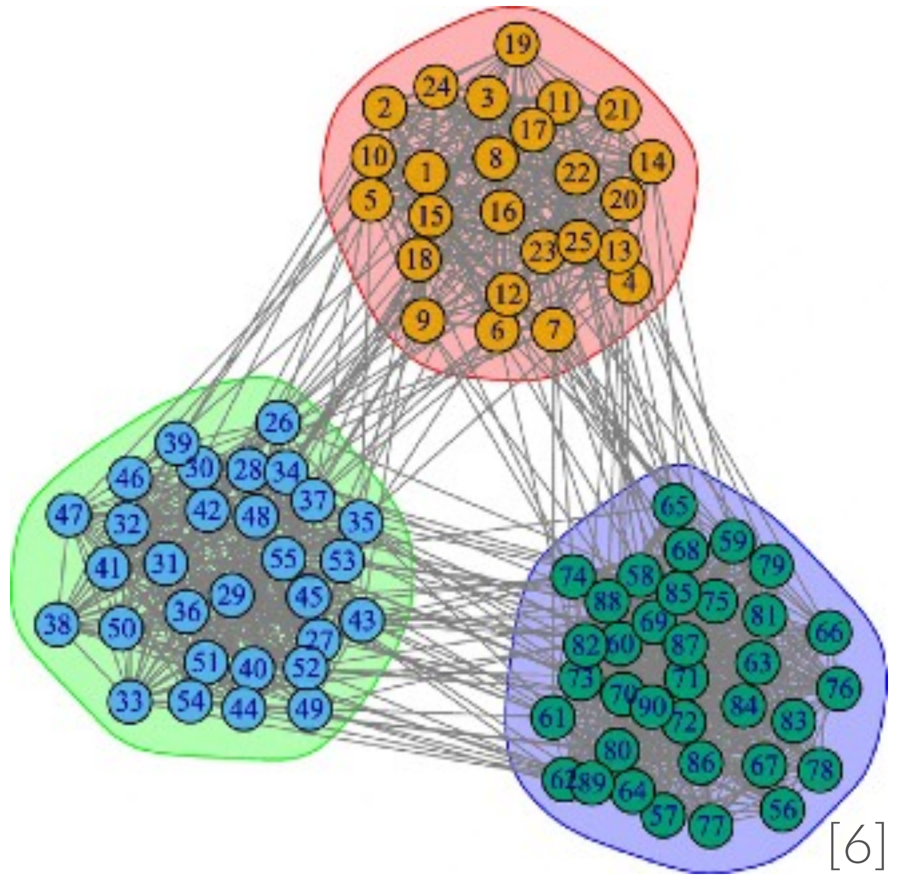
Stochastic block models

- community structure/detection [5]



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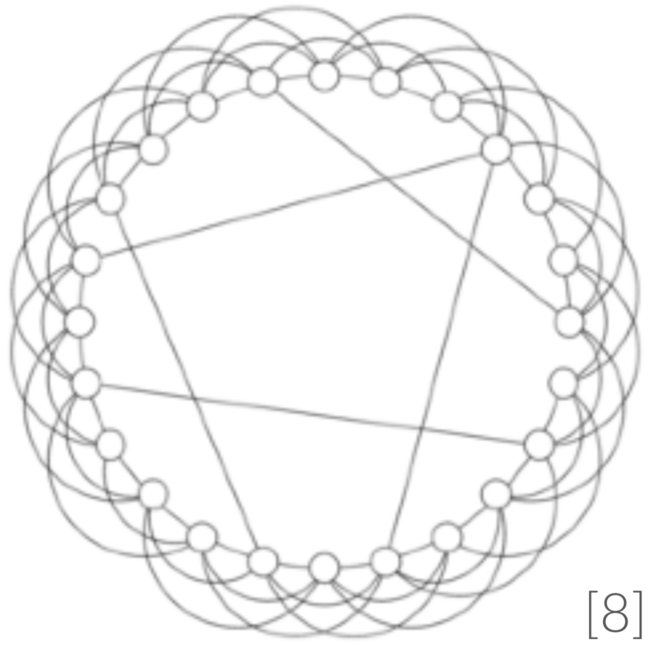

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[1] Phys. Rev. E 80, 020901 (2009)
[2] SIAM Rev. 60, 315 (2018)
[3] Phys. Rev. Lett. 89, 208701 (2002)
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[6] Appl. Netw. Sci. 4, 122 (2019)
[7] Nature 393, 440 (1998)
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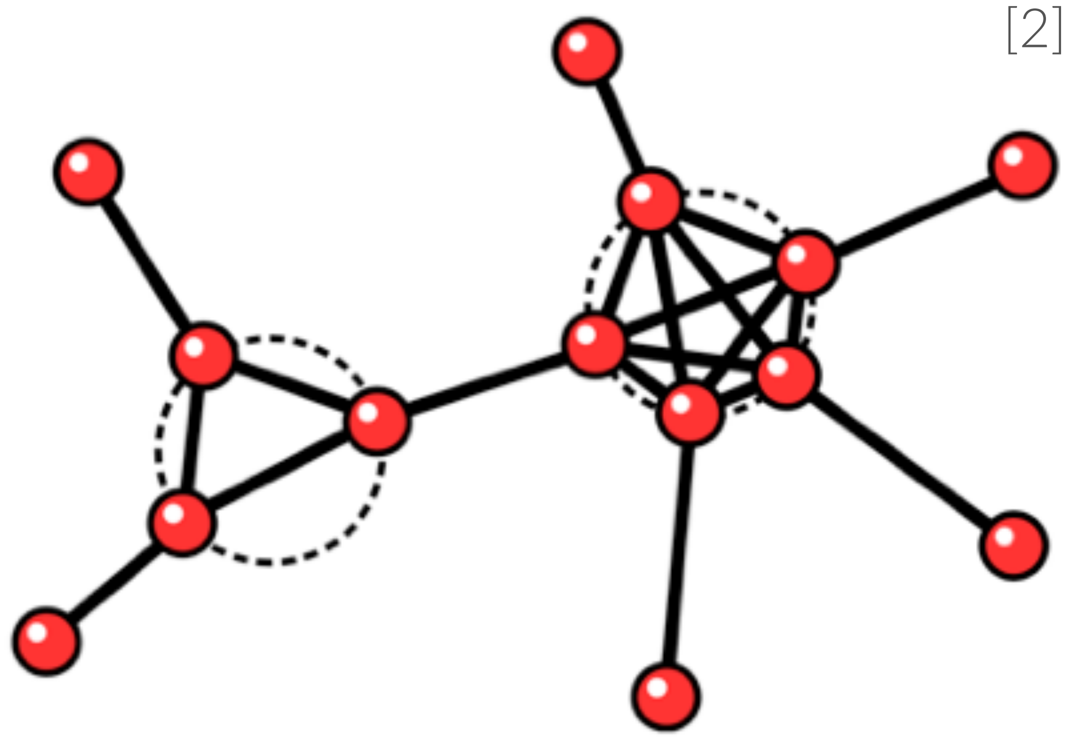
Modeling clustering

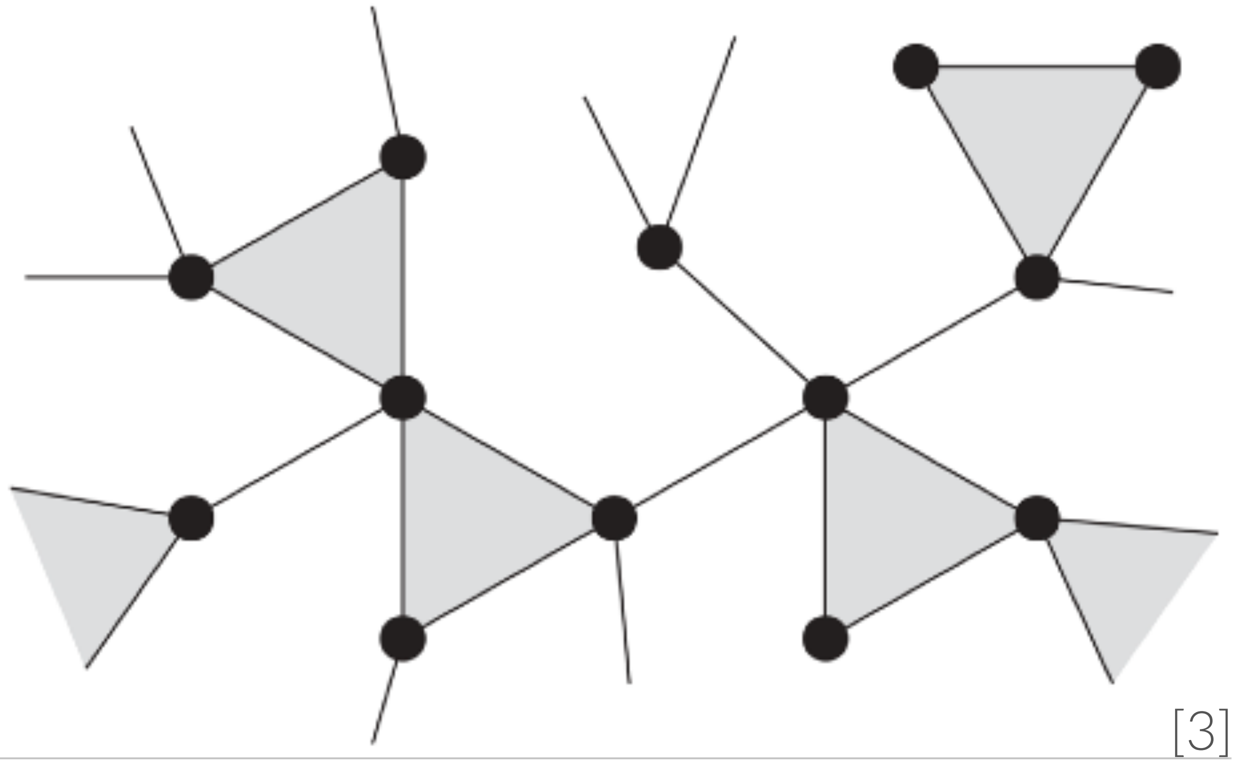
Trickier because clustering consists in three-node interactions while our mathematical tools rely on pairwise interactions either explicitly or implicitly.

Most models therefore assume

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

[2]





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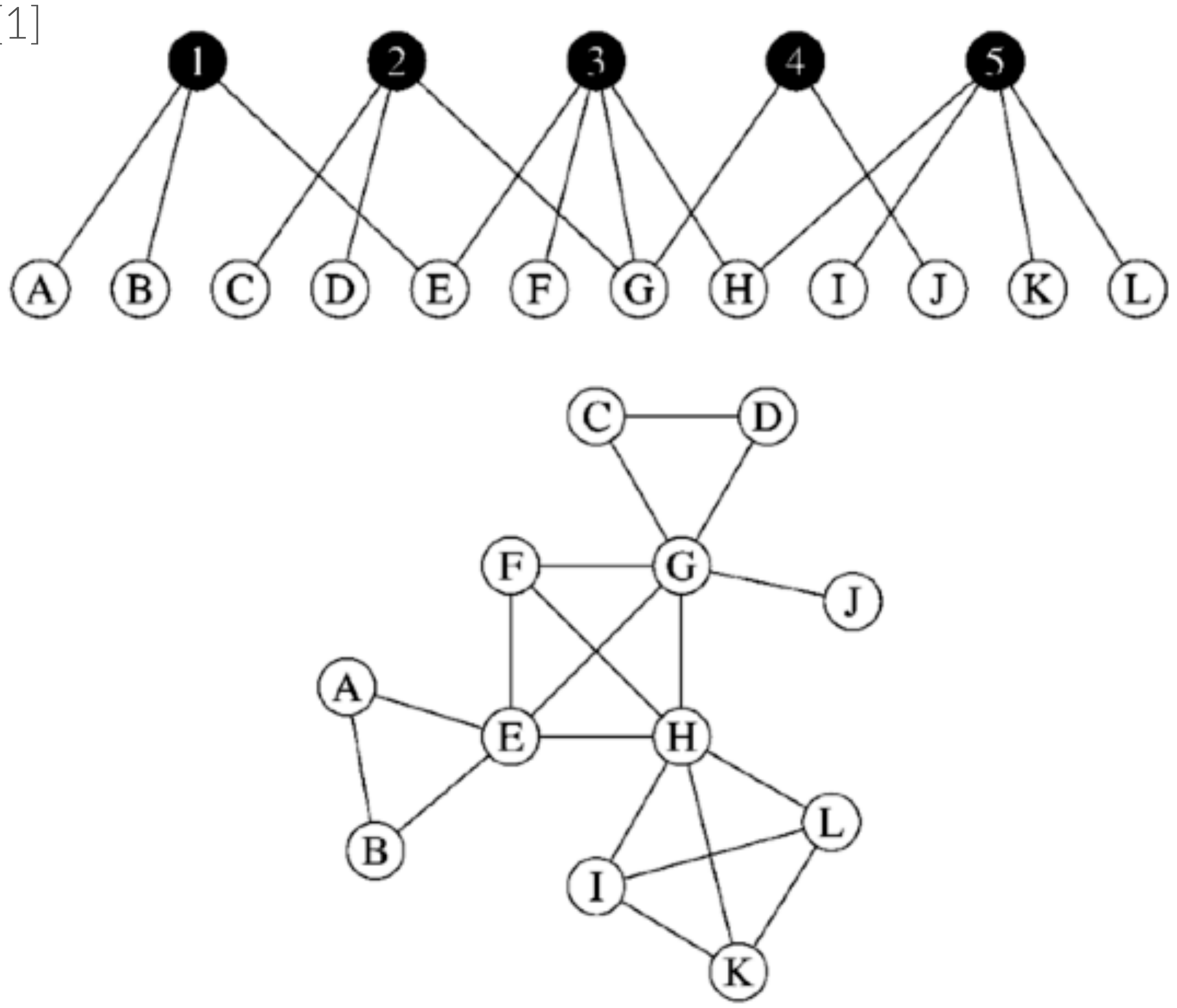
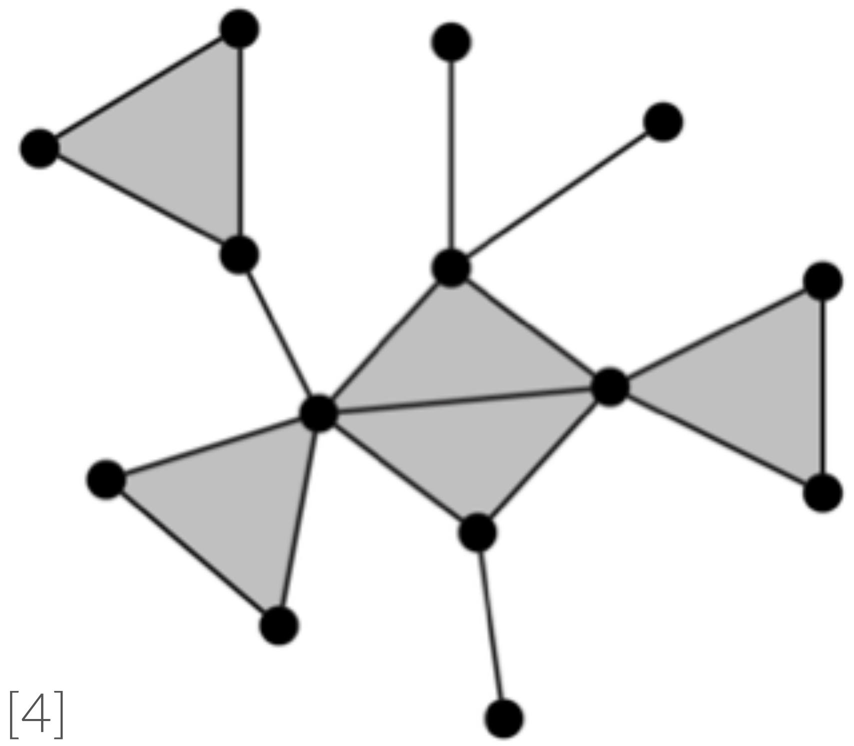
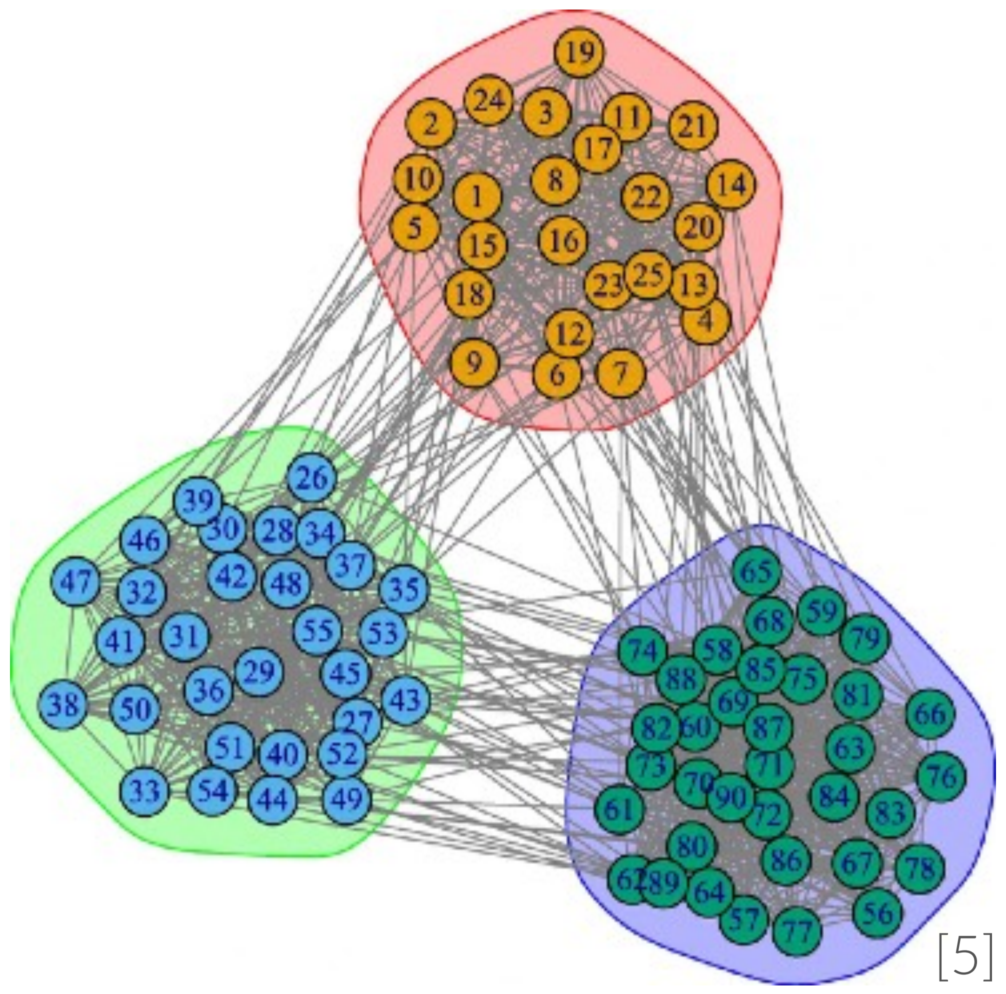




[4]



[5]

[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)