MAX-PLANCK-INSTITUT
FÜR DEMOGRAFISCHE
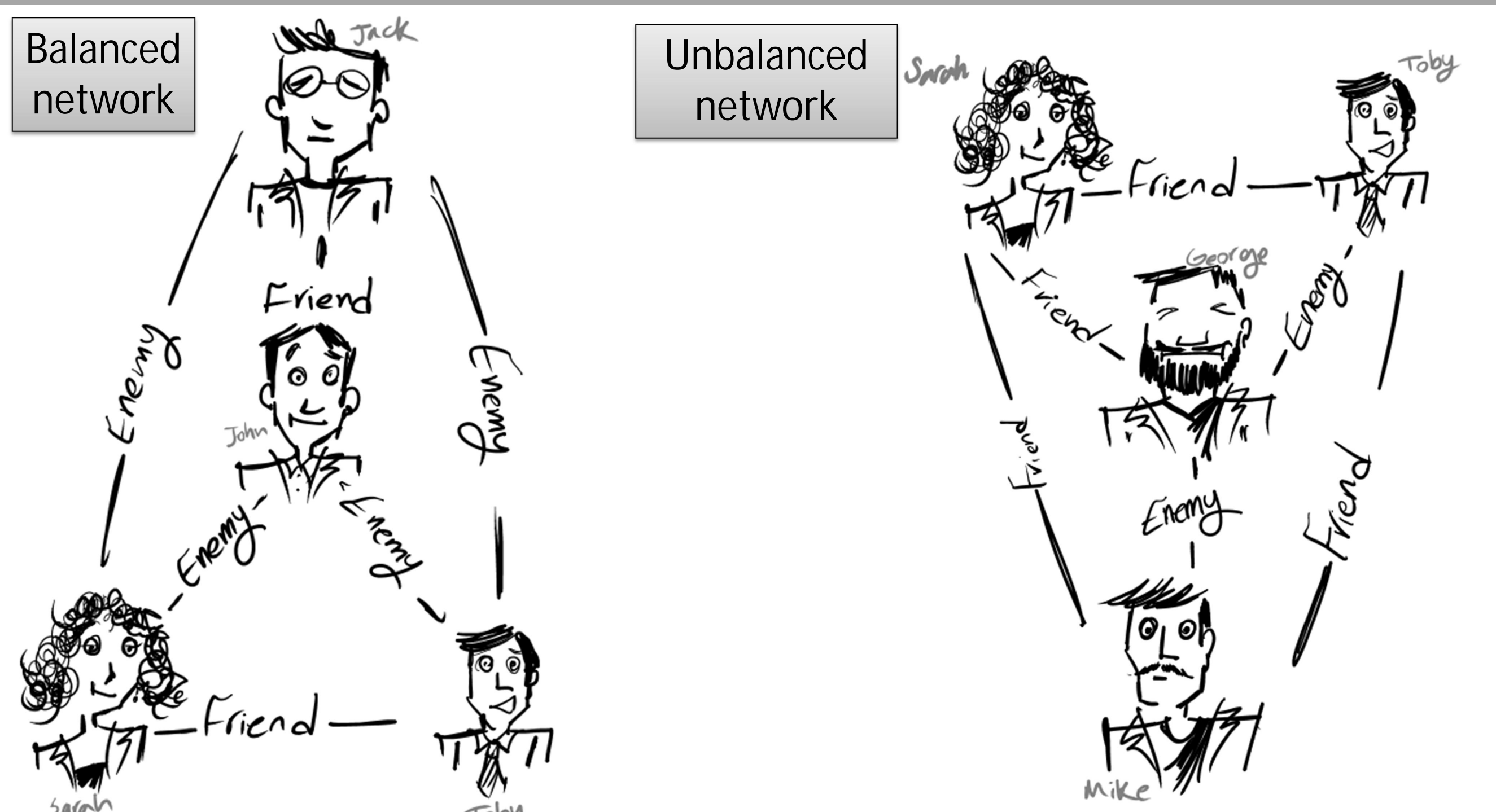FORSCHUNG

MAX PLANCK INSTITUTE
FOR DEMOGRAPHIC
RESEARCH

The Enemy of an Enemy is a Friend

Samin Aref, Laboratory of Digital and Computational Demography
aref@demogr.mpg.de

Balance in Signed Networks
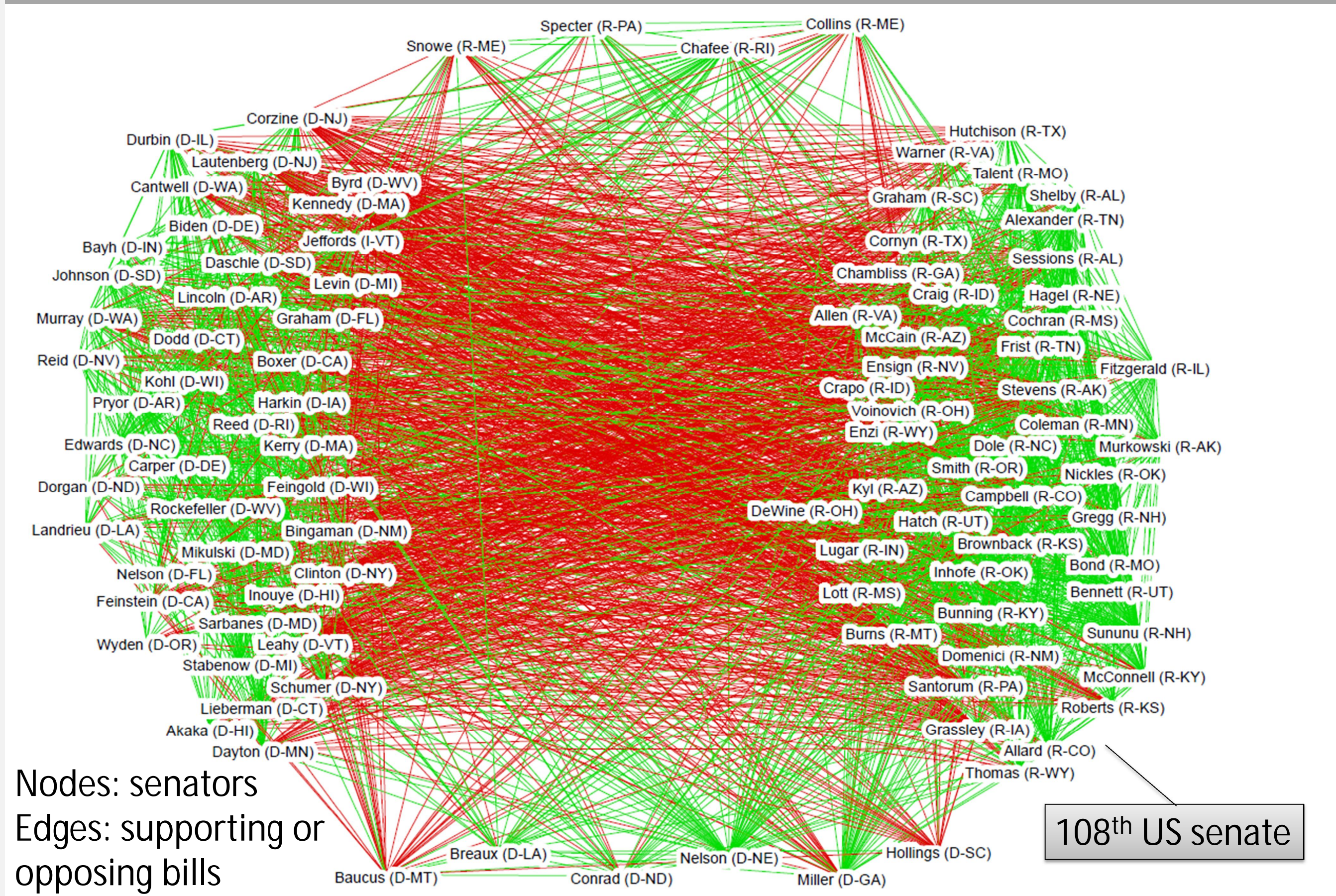
Balanced network

Unbalanced network

Unbalanced networks can be made balanced by removing the frustrated edges.

Frustrated edges:
- positive edges with different endpoint colours
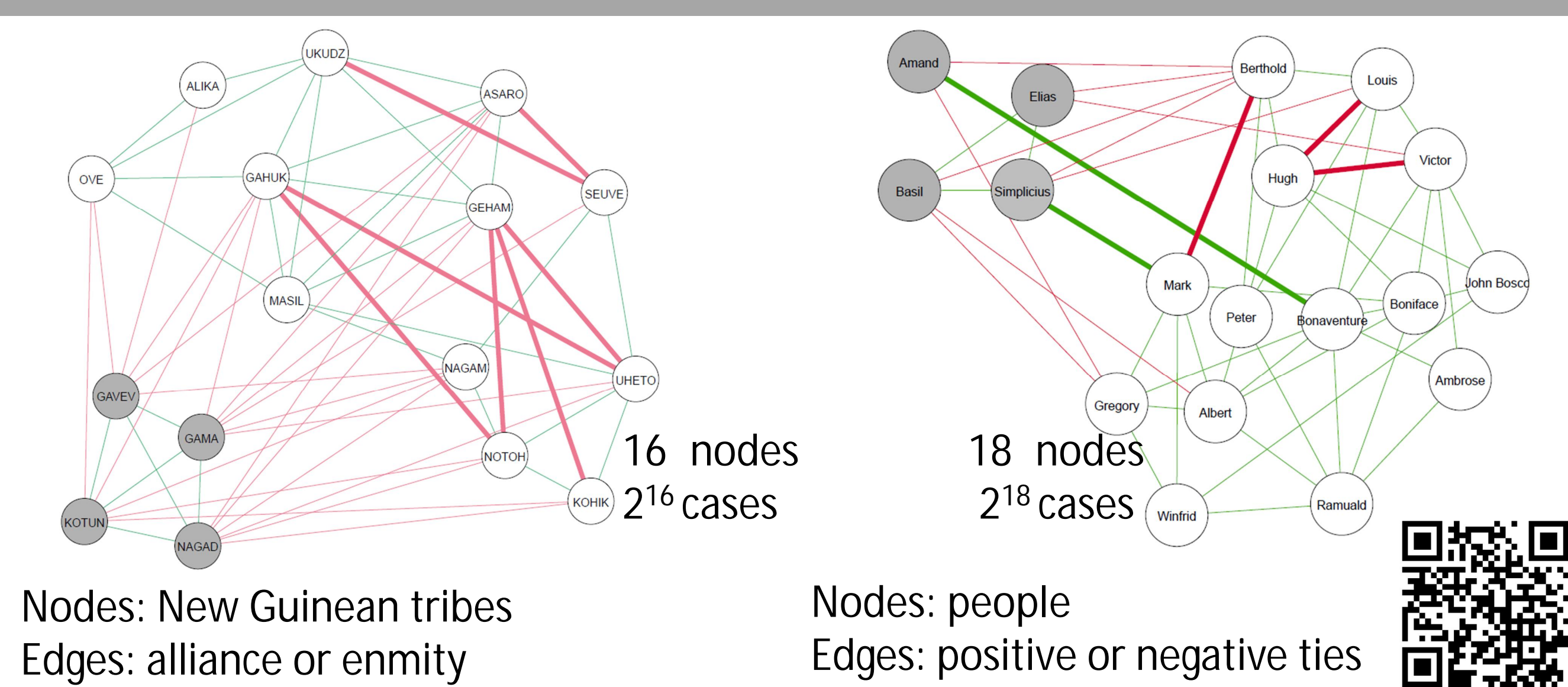- negative edges with the same endpoint colours

Social Networks

16 nodes
2^{16} cases

18 nodes
2^{18} cases

Nodes: New Guinean tribes
Edges: alliance or enmity

Nodes: people
Edges: positive or negative ties

Biological Networks

Nodes: biological molecules
Edges: activation or inhibition relations

EGFR protein

2^{329} cases

White blood cell (macrophage)

E.coli bacterium

Baker's yeast

Political Networks

Nodes: senators
Edges: supporting or opposing bills

108th US senate
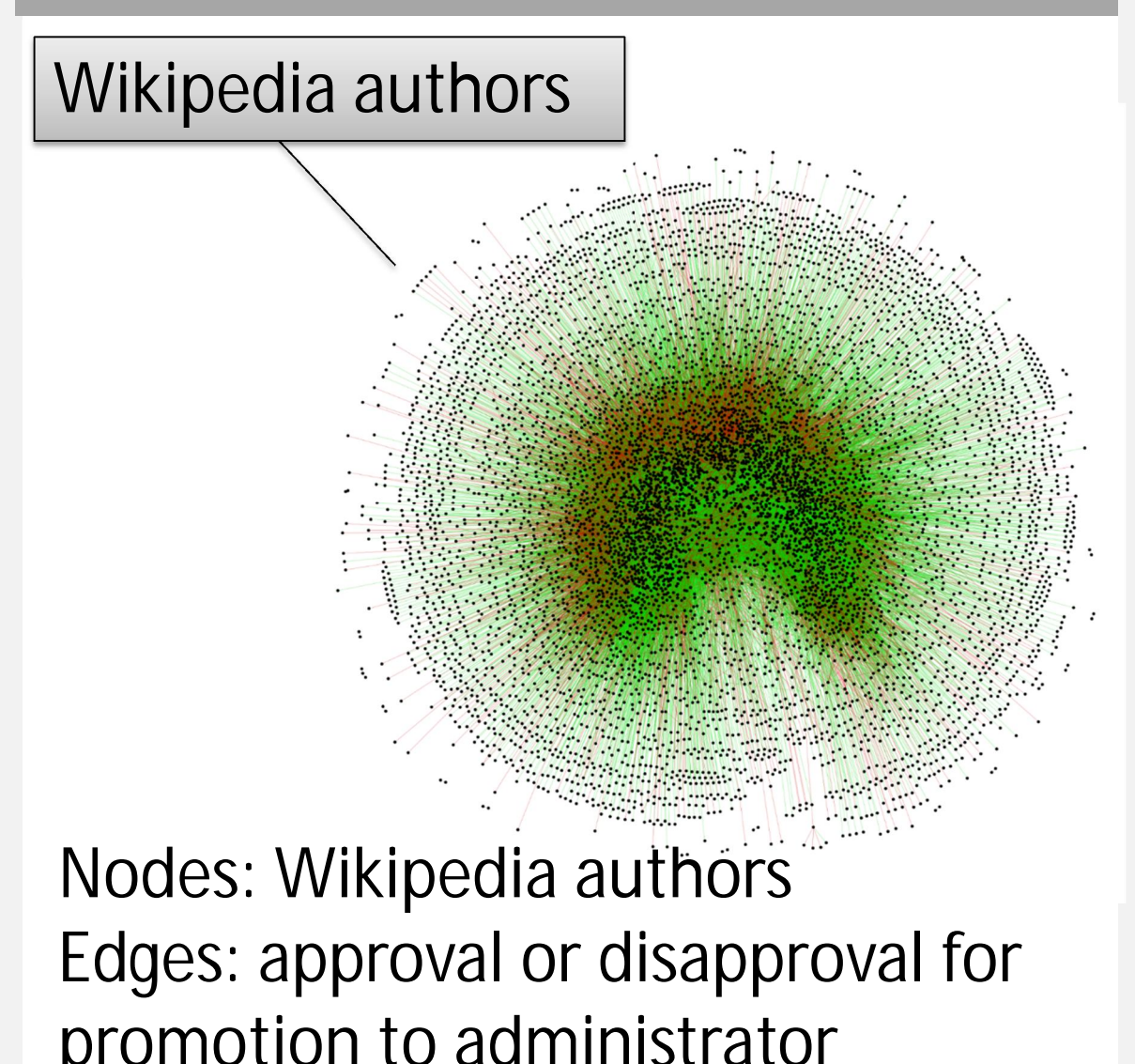

Ising Models (Physics)
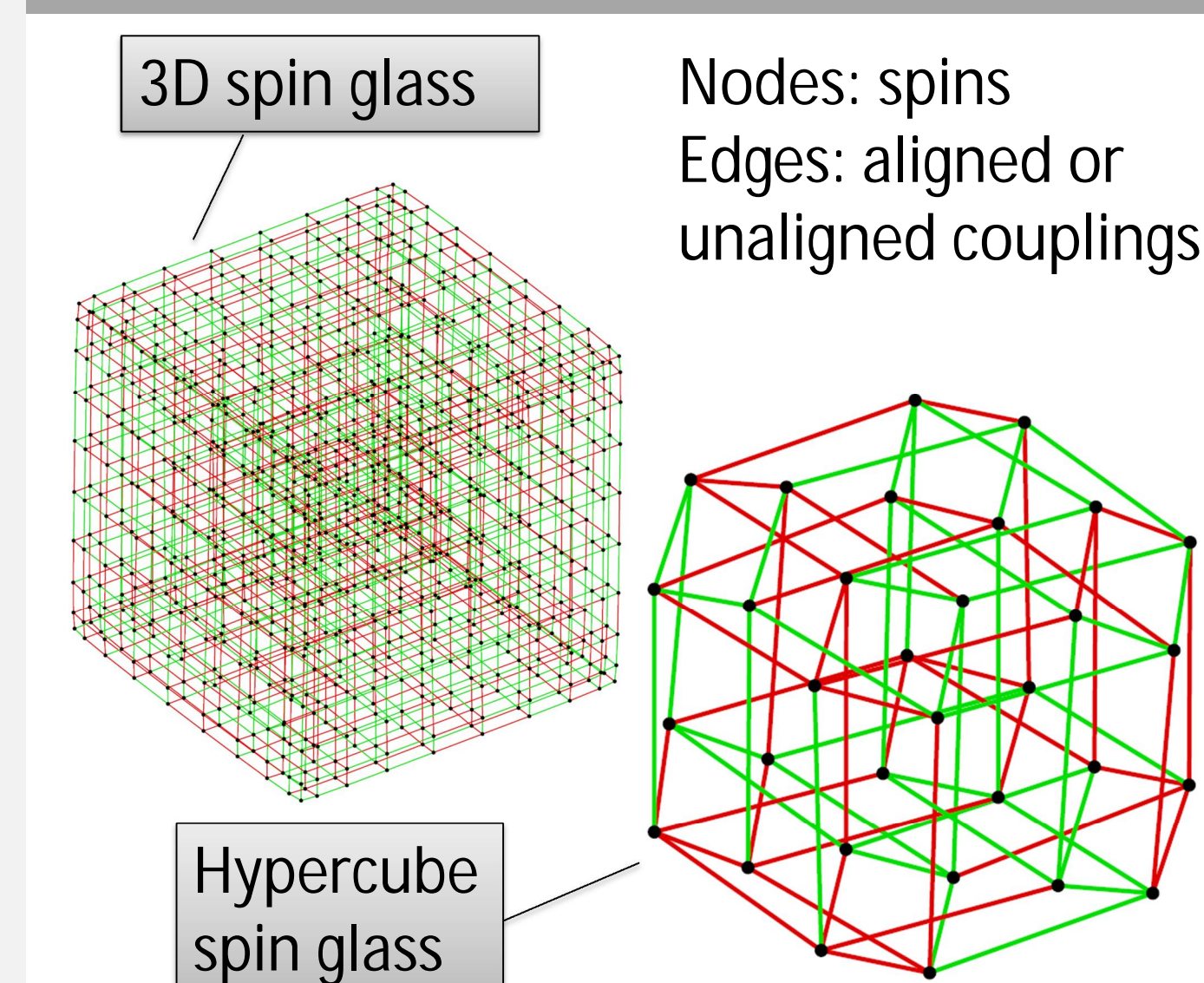
3D spin glass

Nodes: spins
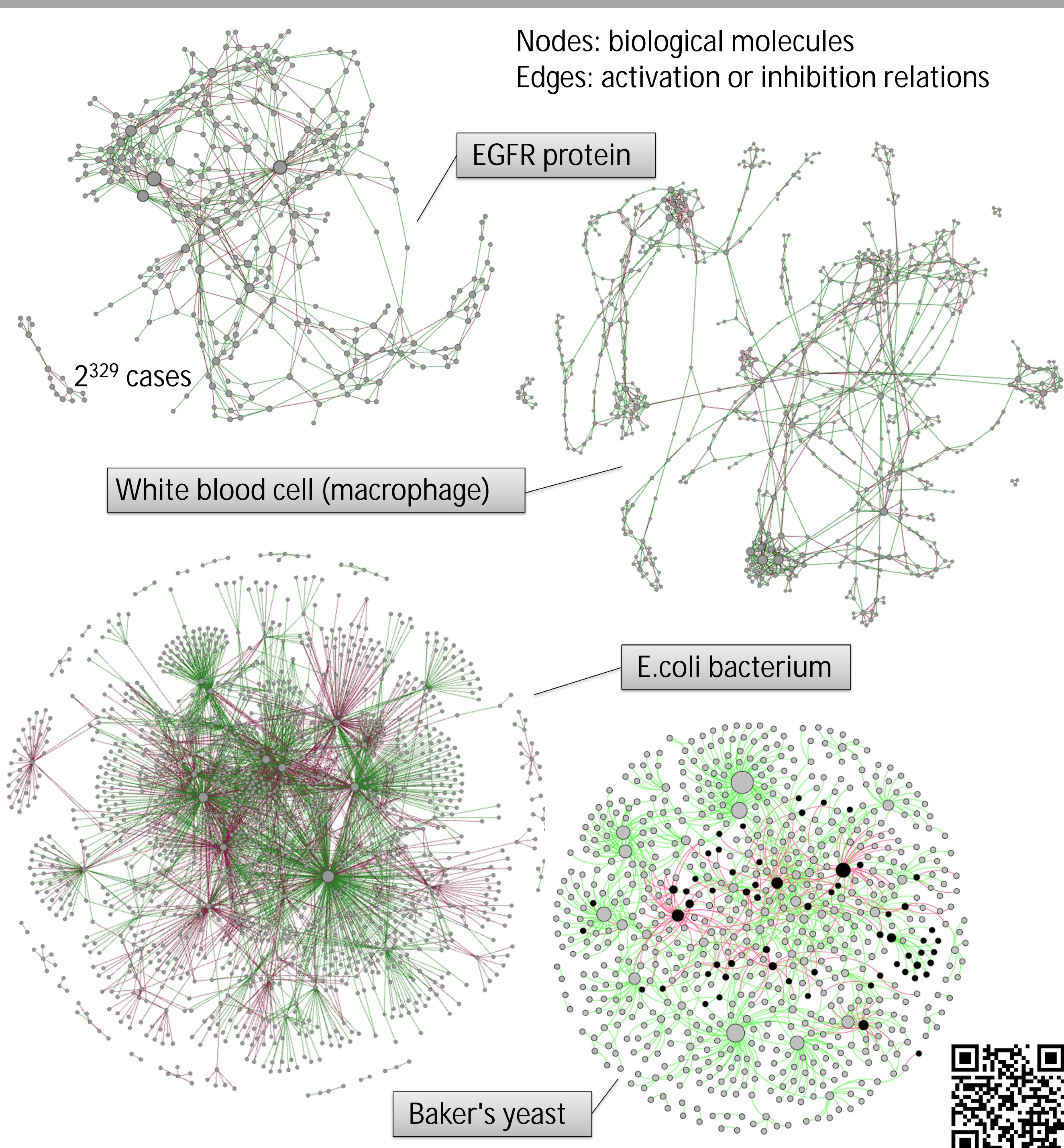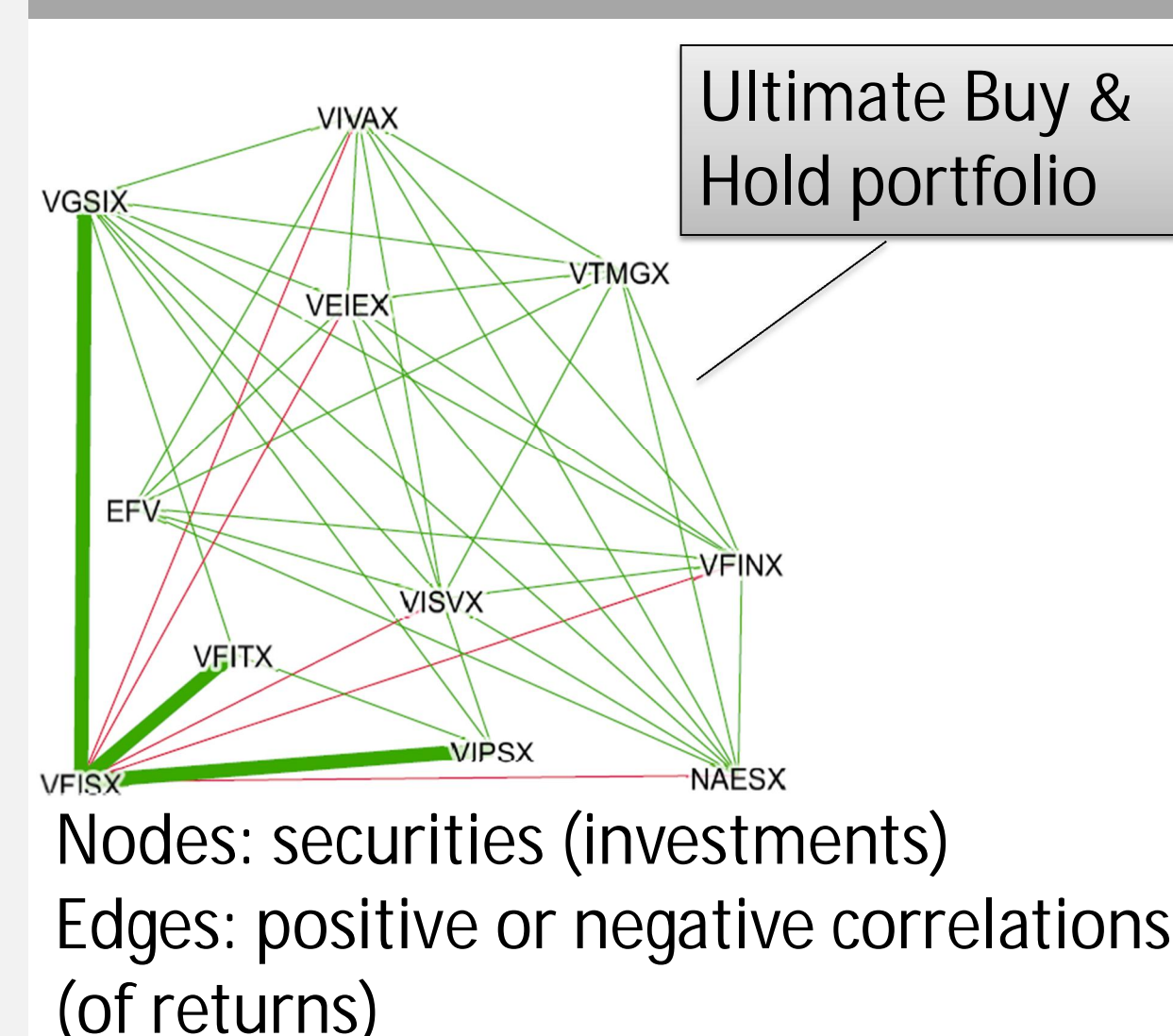Edges: aligned or unaligned couplings

Hypercube spin glass

Large-scale Social Networks

Wikipedia authors

Nodes: Wikipedia authors
Edges: approval or disapproval for promotion to administrator
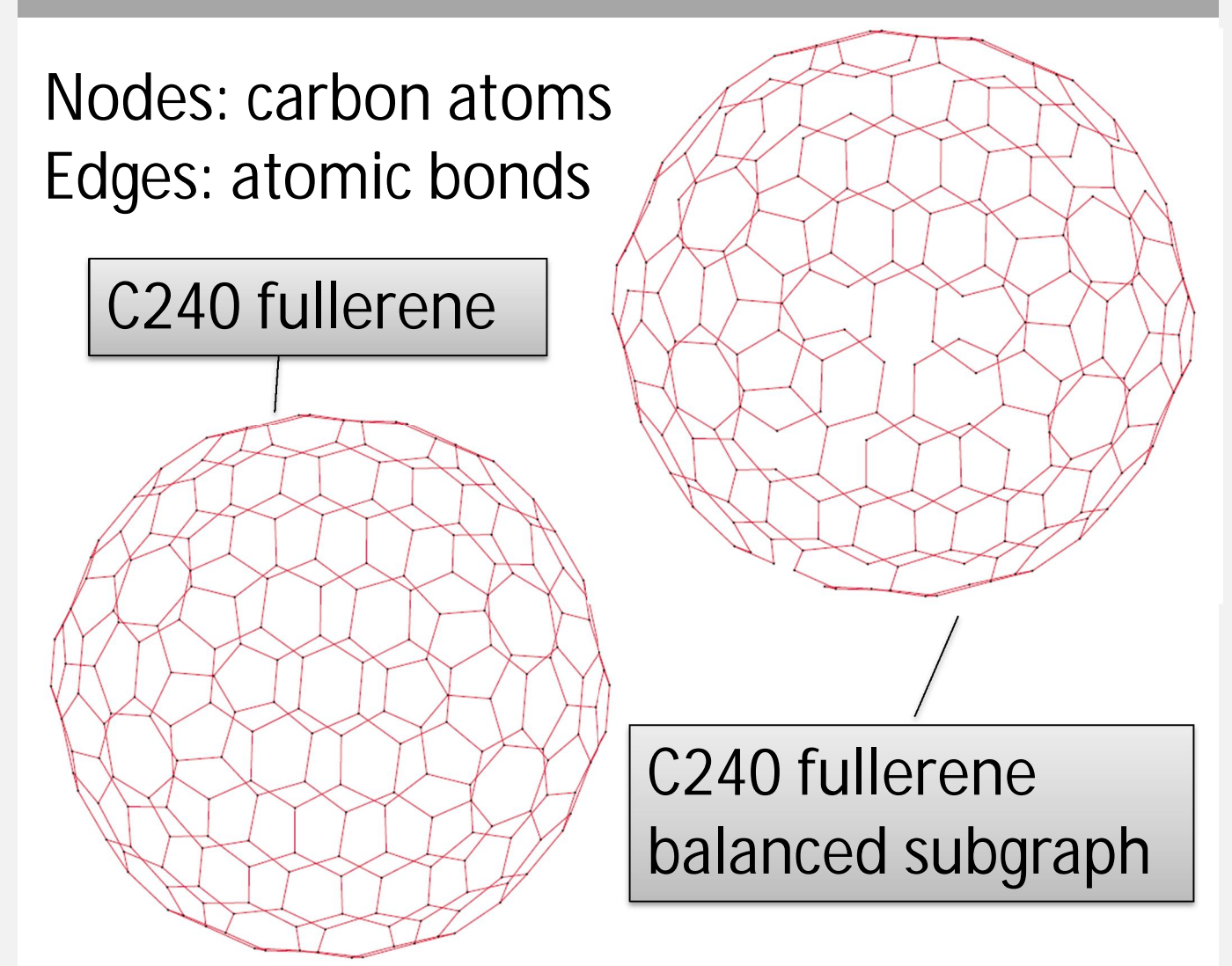

Financial Networks

Ultimate Buy & Hold portfolio

Nodes: securities (investments)
Edges: positive or negative correlations (of returns)
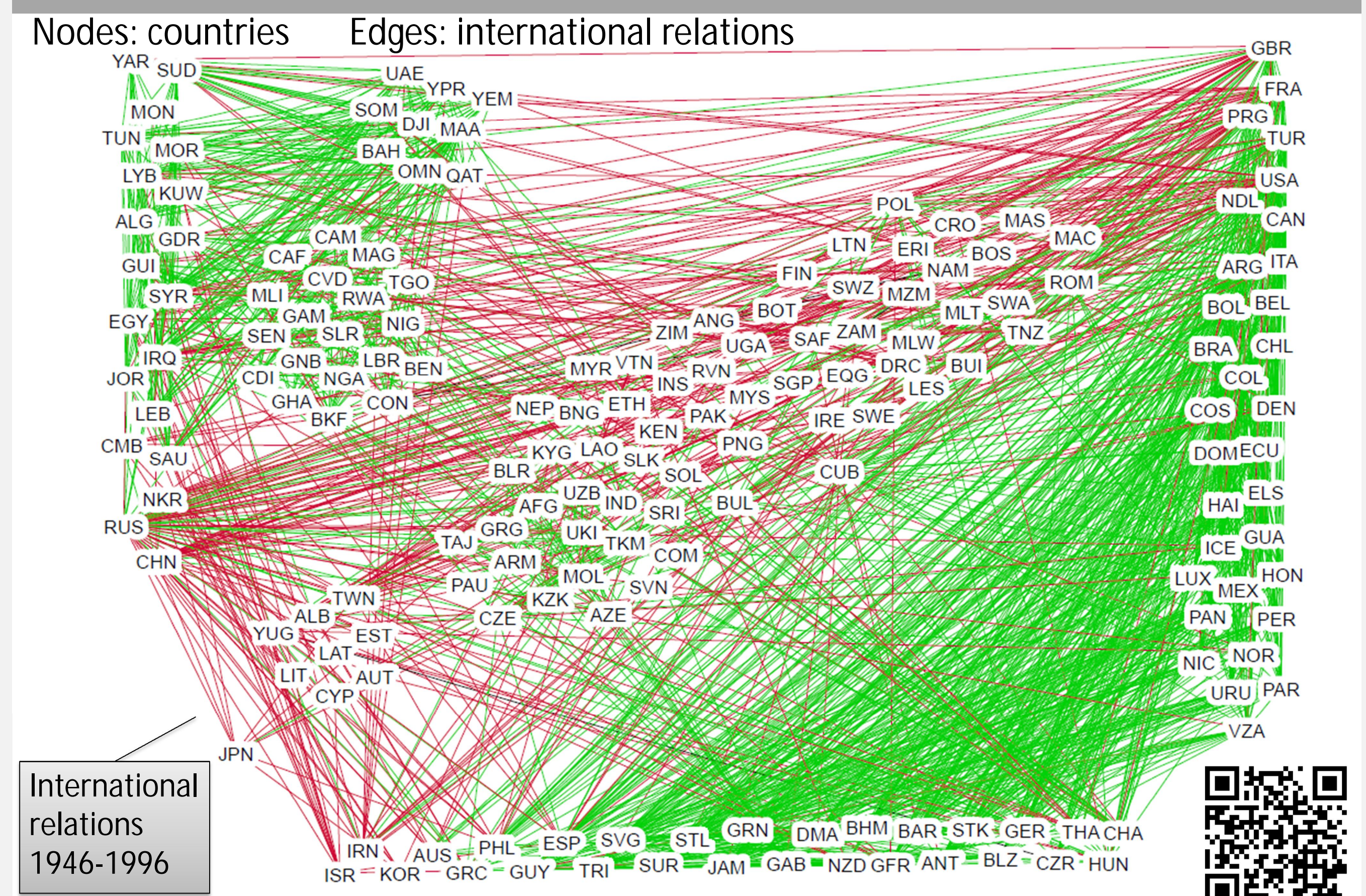

Fullerenes (Chemistry)

Nodes: carbon atoms
Edges: atomic bonds

C240 fullerene

C240 fullerene balanced subgraph

International Relations Networks

Nodes: countries   Edges: international relations

International relations 1946-1996