

Community structure in networks

Introduction to Network Science

Carlos Castillo

Topic 19

Sources

- Barabási 2016 Chapter 9
- Networks, Crowds, and Markets Ch 3
- C. Castillo: Graph partitioning 2017

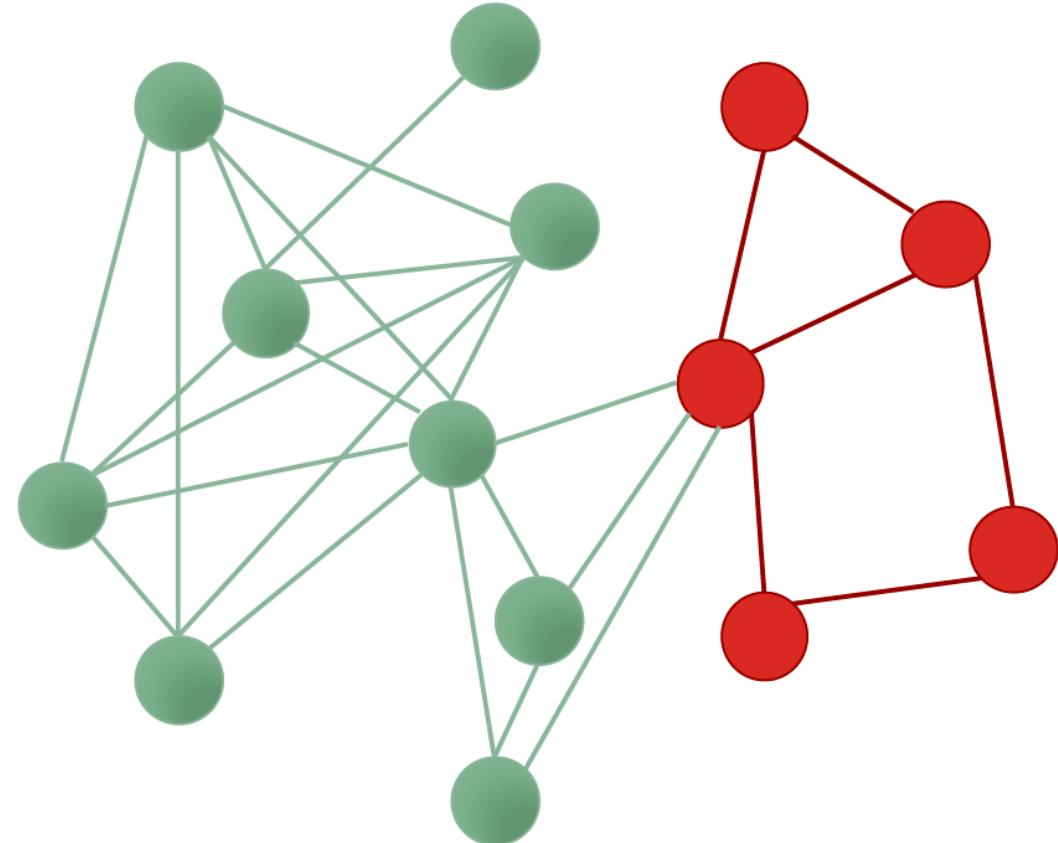
Typical community structures

- One dense sub-graph
 embedded somewhere within a larger graph
- Two groups (polarization)
 plus perhaps some ambiguous nodes
- Multiple communities

One dense sub-graph

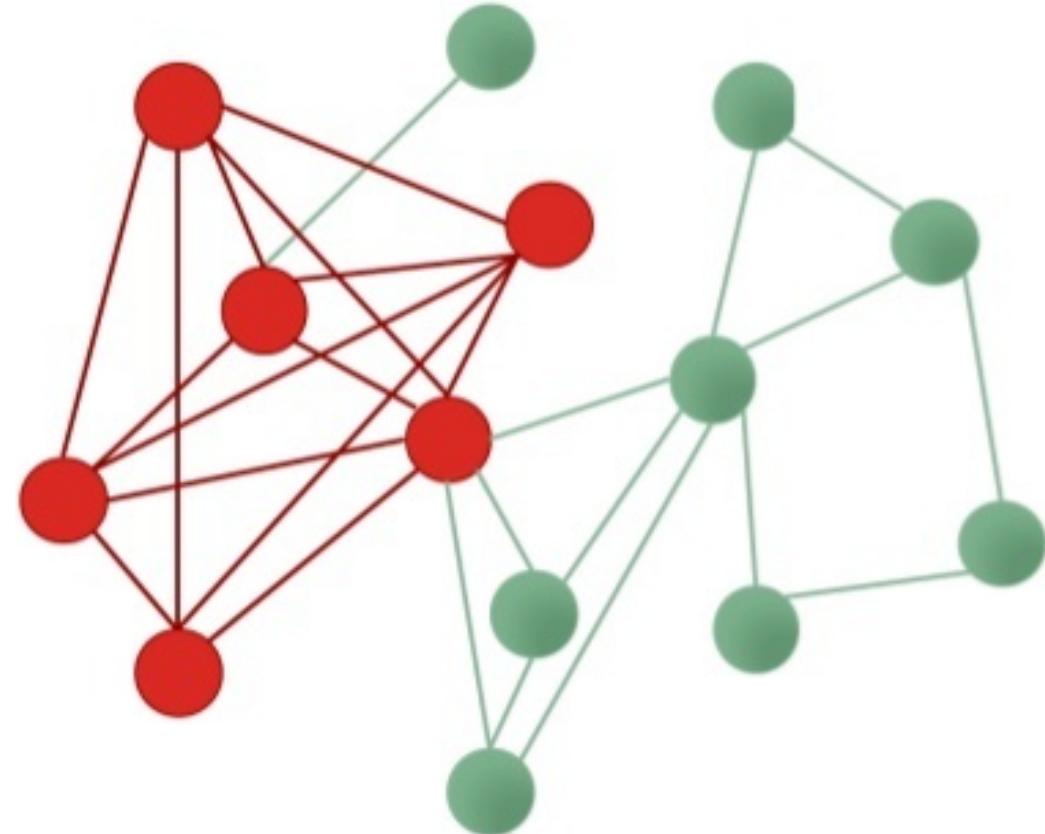
What is a sub-graph?

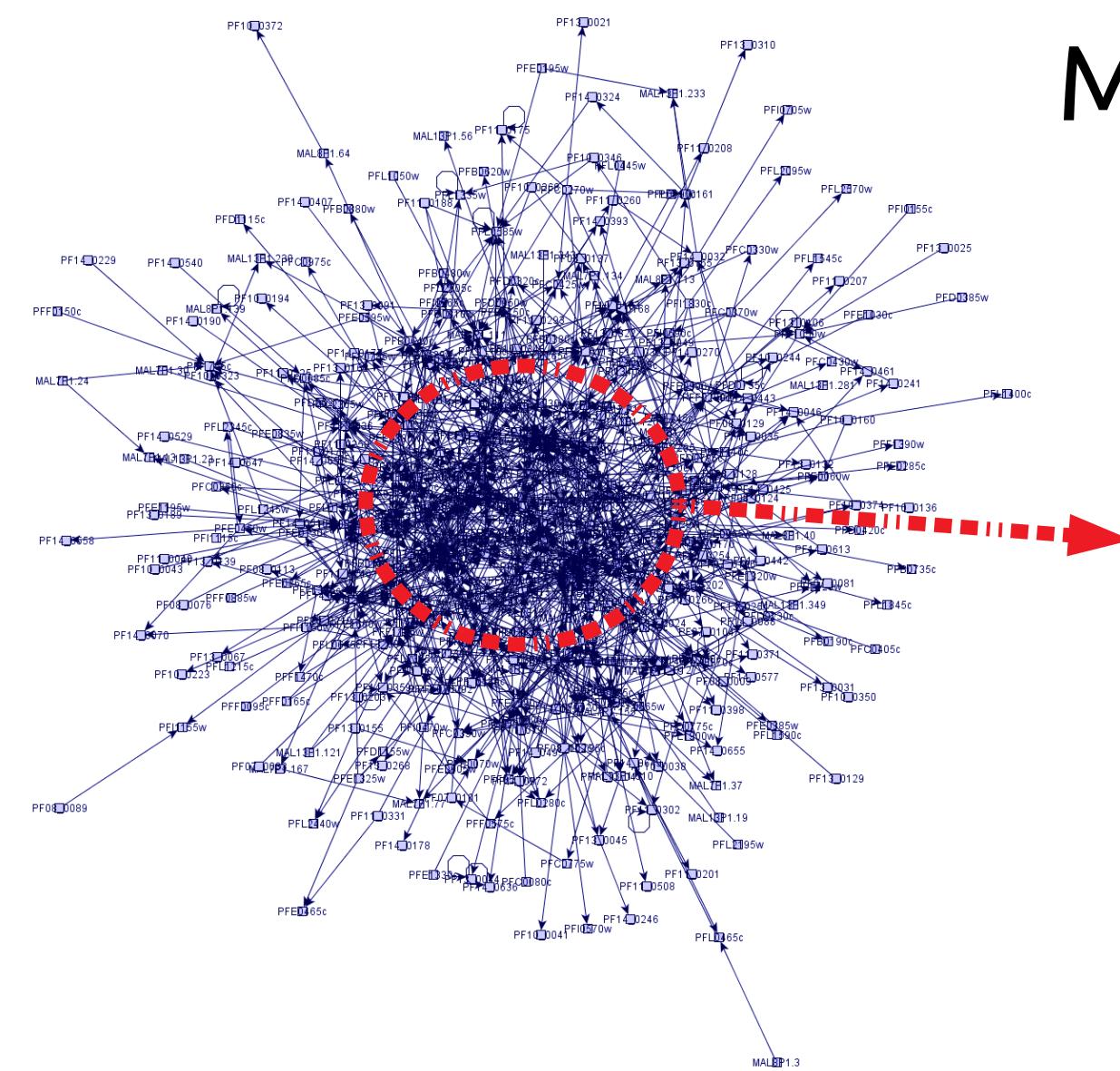
Subset of
nodes, and
edges among
those nodes



Densest sub-graph

Sub-graph
having the
maximum
density

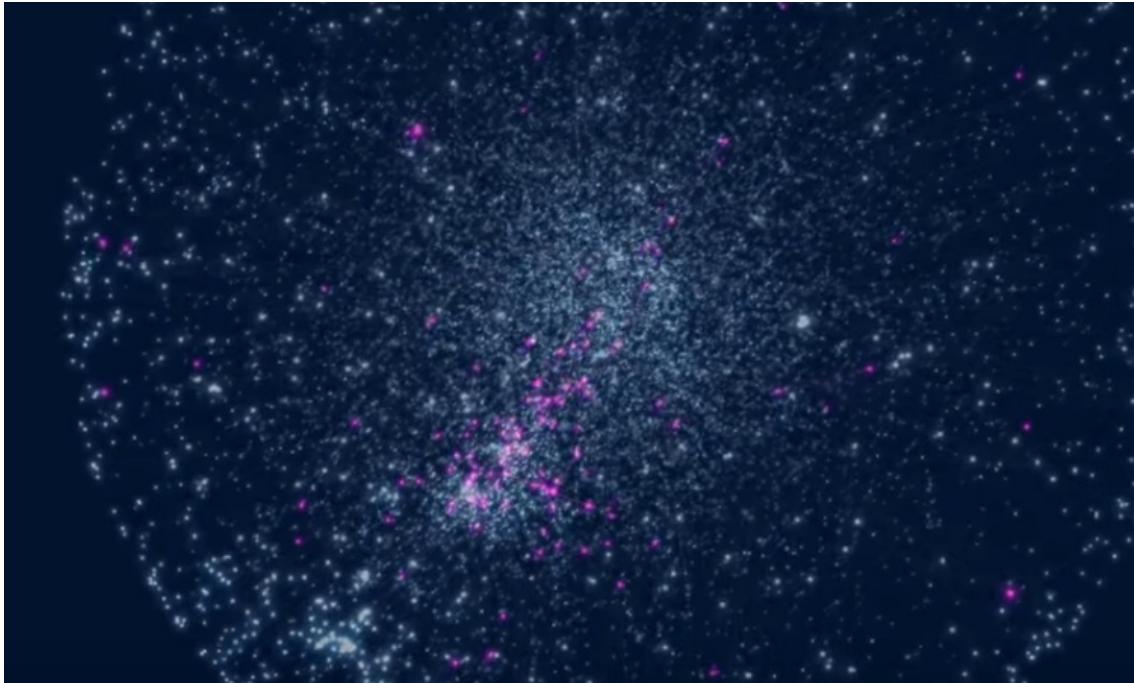




Many graphs look like “hairballs”

Sometimes, at the center these graphs may have an interesting dense sub-graph

Asthma-related genes



https://www.youtube.com/watch?v=VU_7FHAKMgA

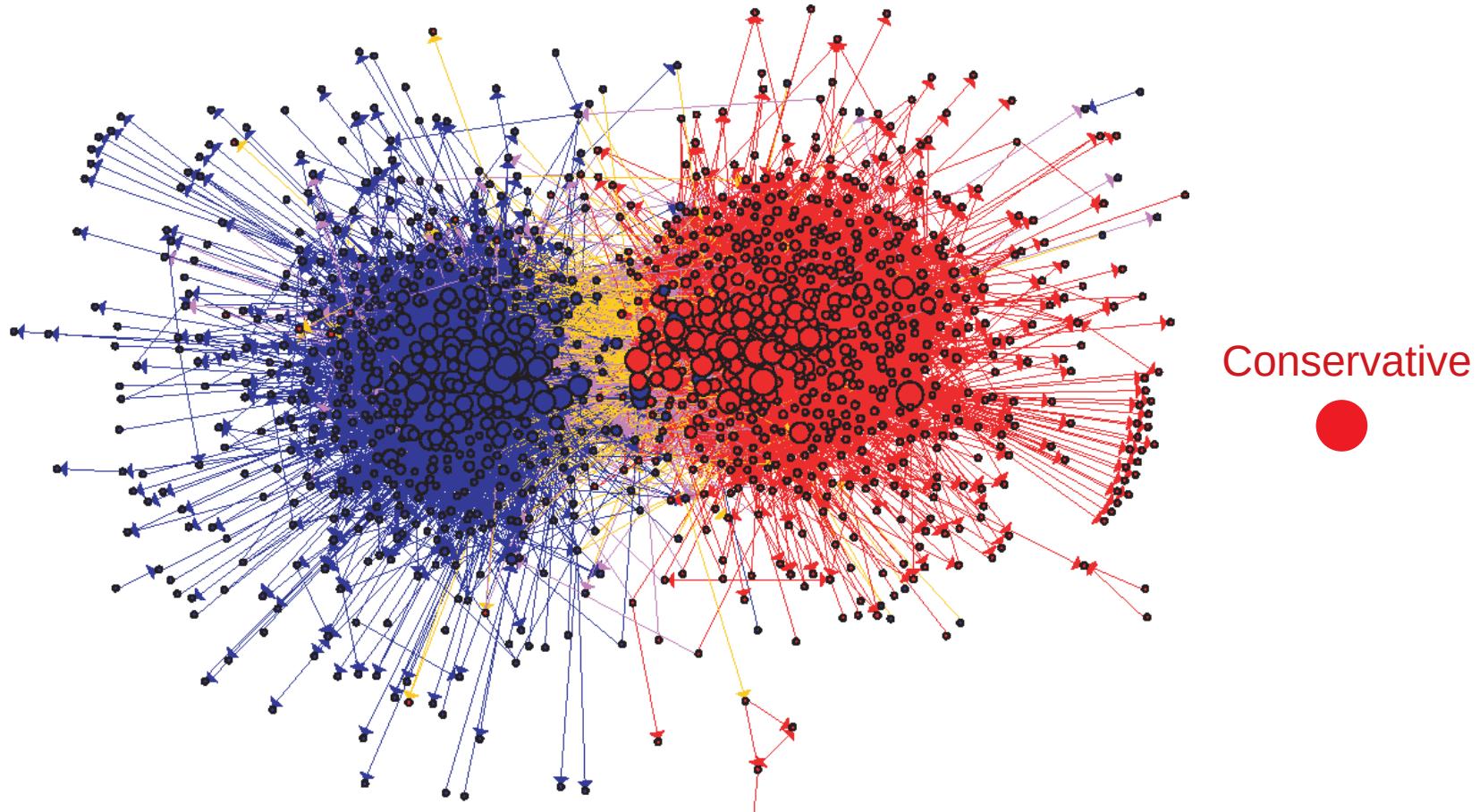
Two groups (polarization)

US Political Blogs (2004)

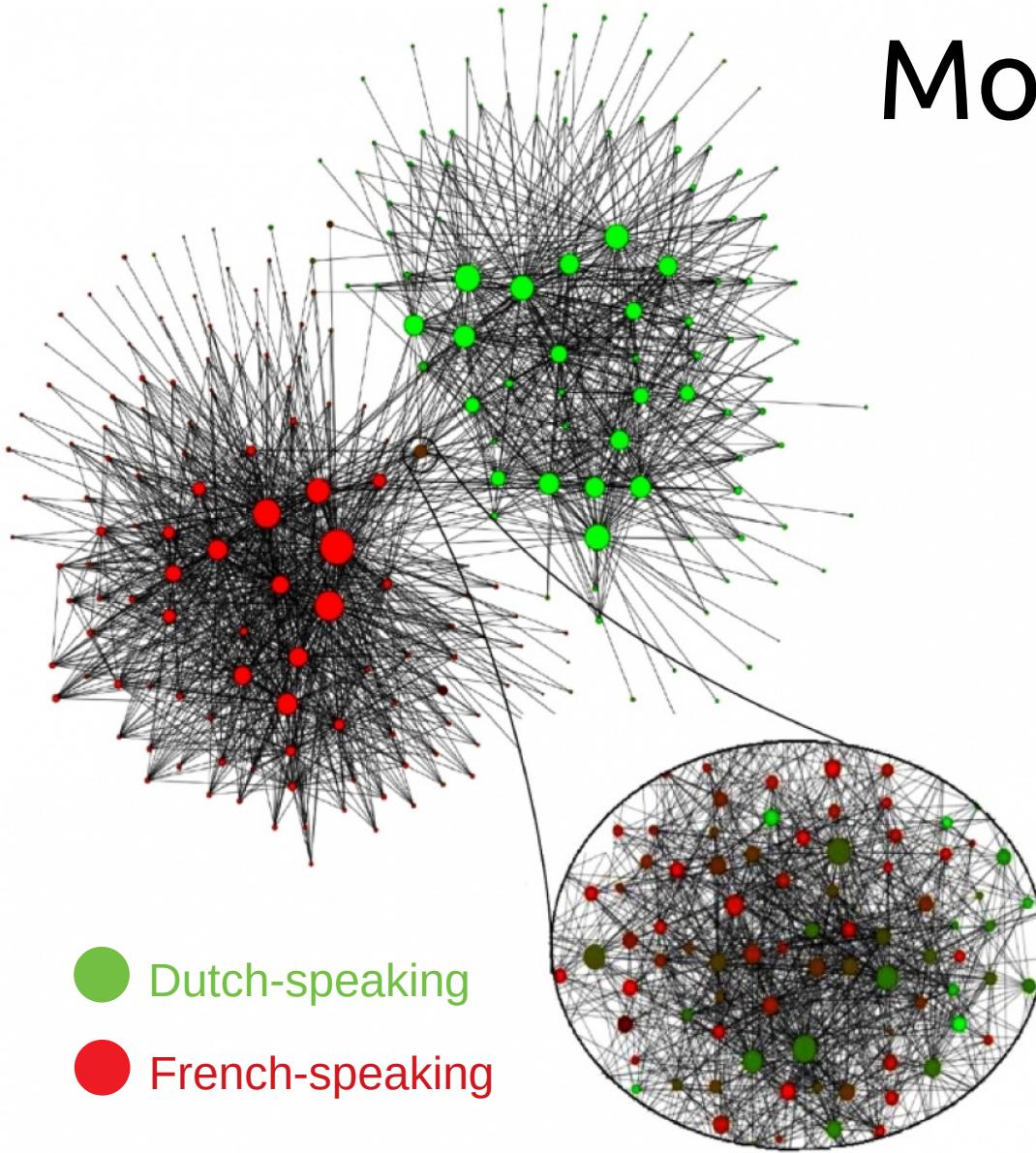
Liberal



Conservative



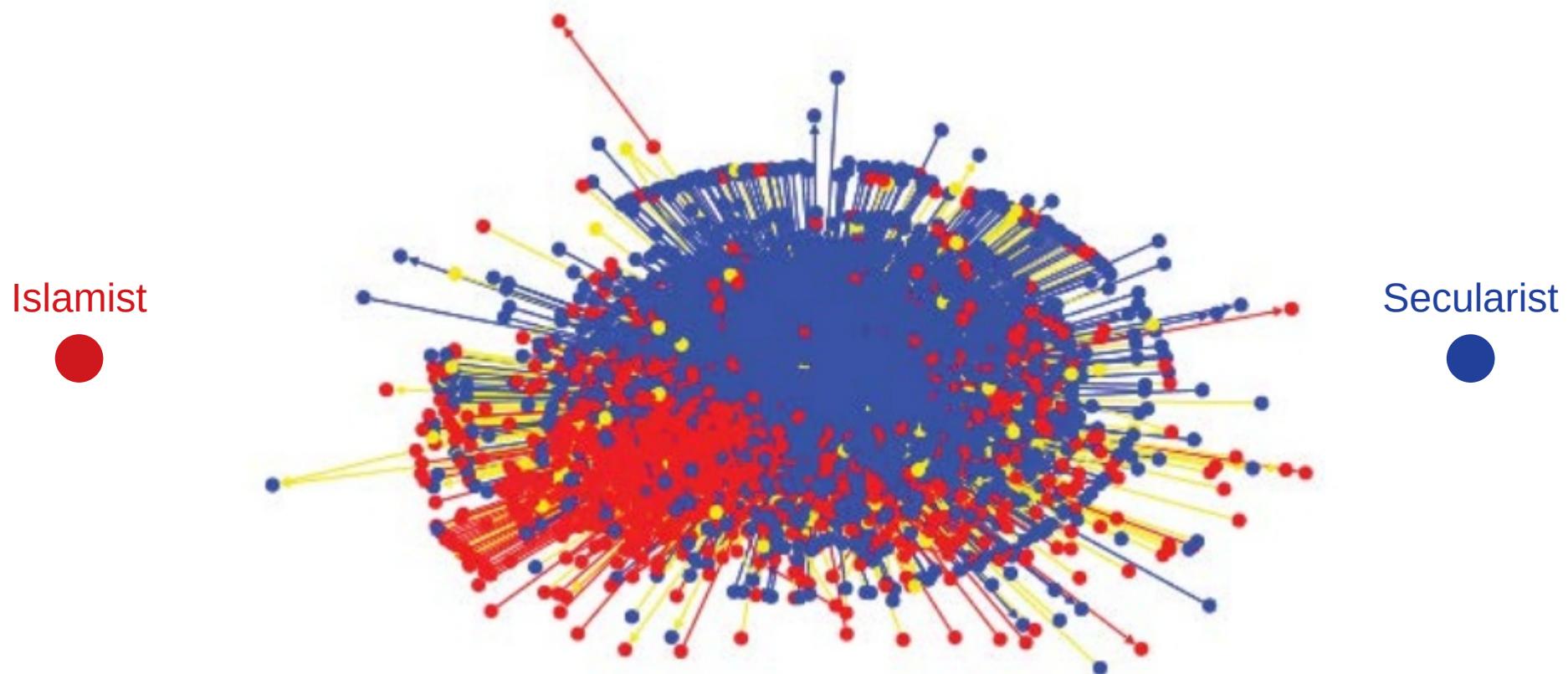
Mobile phone users in Belgium (2008)



Each node is a community of 100 mobile users or more that tend to call each other

V. D. Blondel, J.-L. Guillaume, R. Lambiotte, and E. Lefebvre. Fast unfolding of communities in large networks. *J. Stat. Mech.*, 2008.

Egyptian Twitter Users (2013)



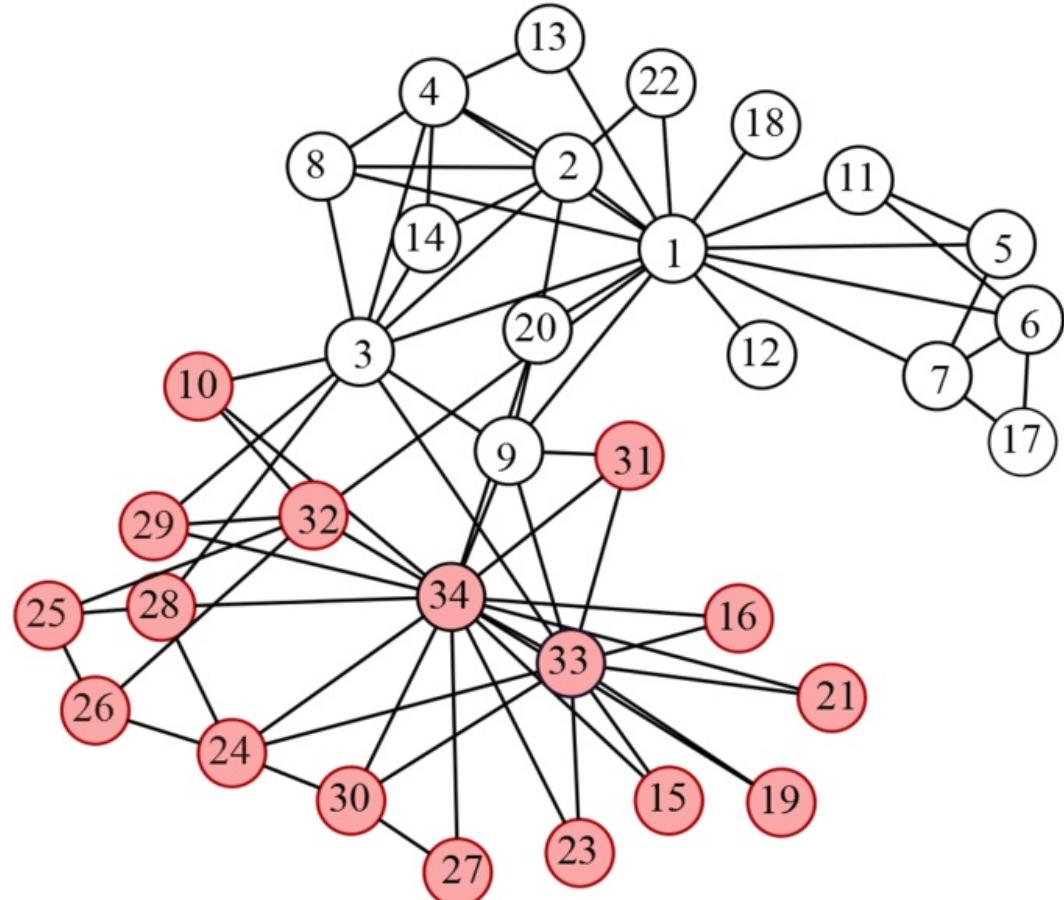
Political Books



Source:
Valdis Krebs
& The Economist

Wayne Zachary's PhD Thesis (1972)

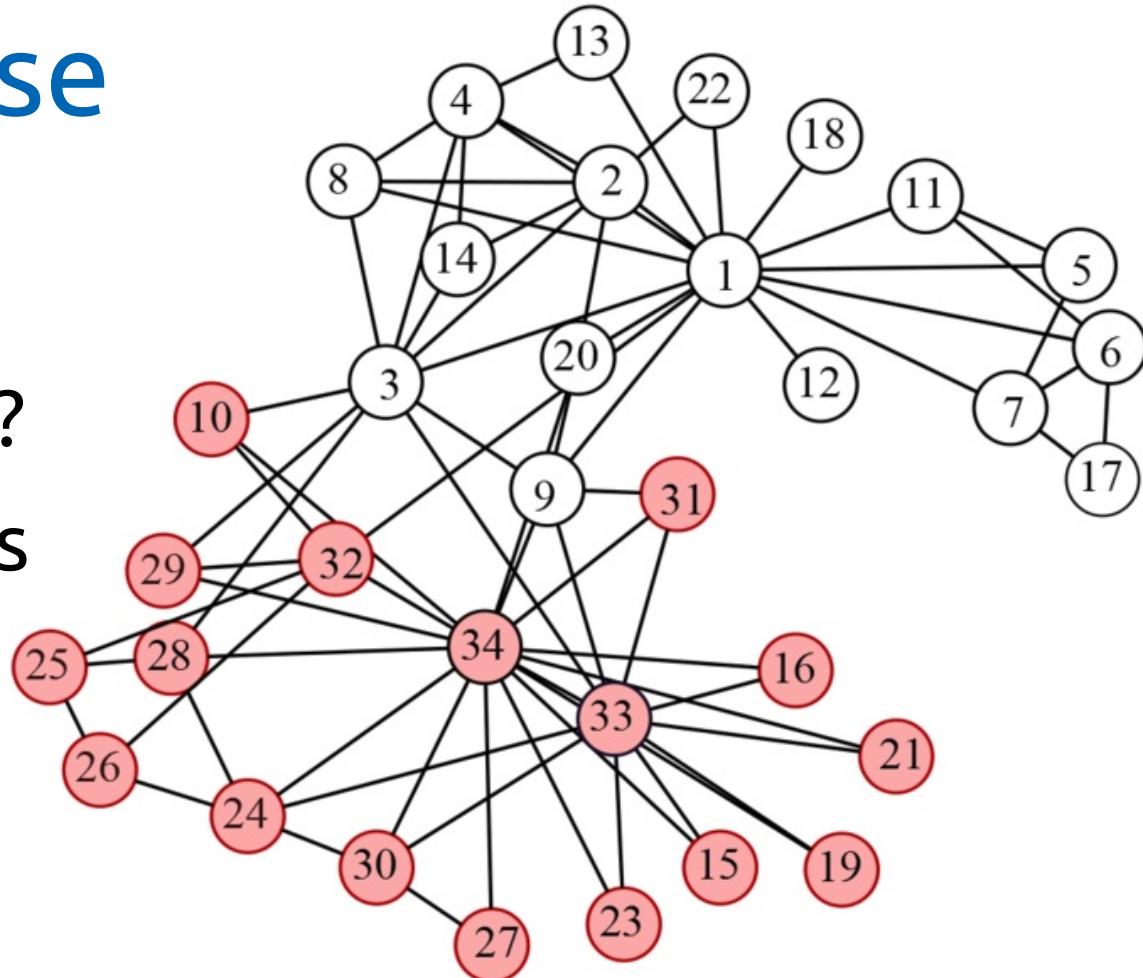
- Studied 34 members of a karate club
- Found 78 links between members who regularly interacted outside the club
- The club splitted in two during the study
- 1=sensei, 34=president



Simple exercise

- How many edges connect a white node to a red node?
- What if node 9 goes to the red component?

Answer in Nearpod Collaborate
<https://nearpod.com/student/>
Code to be given during class



Multiple communities

Science

Links connect two topics

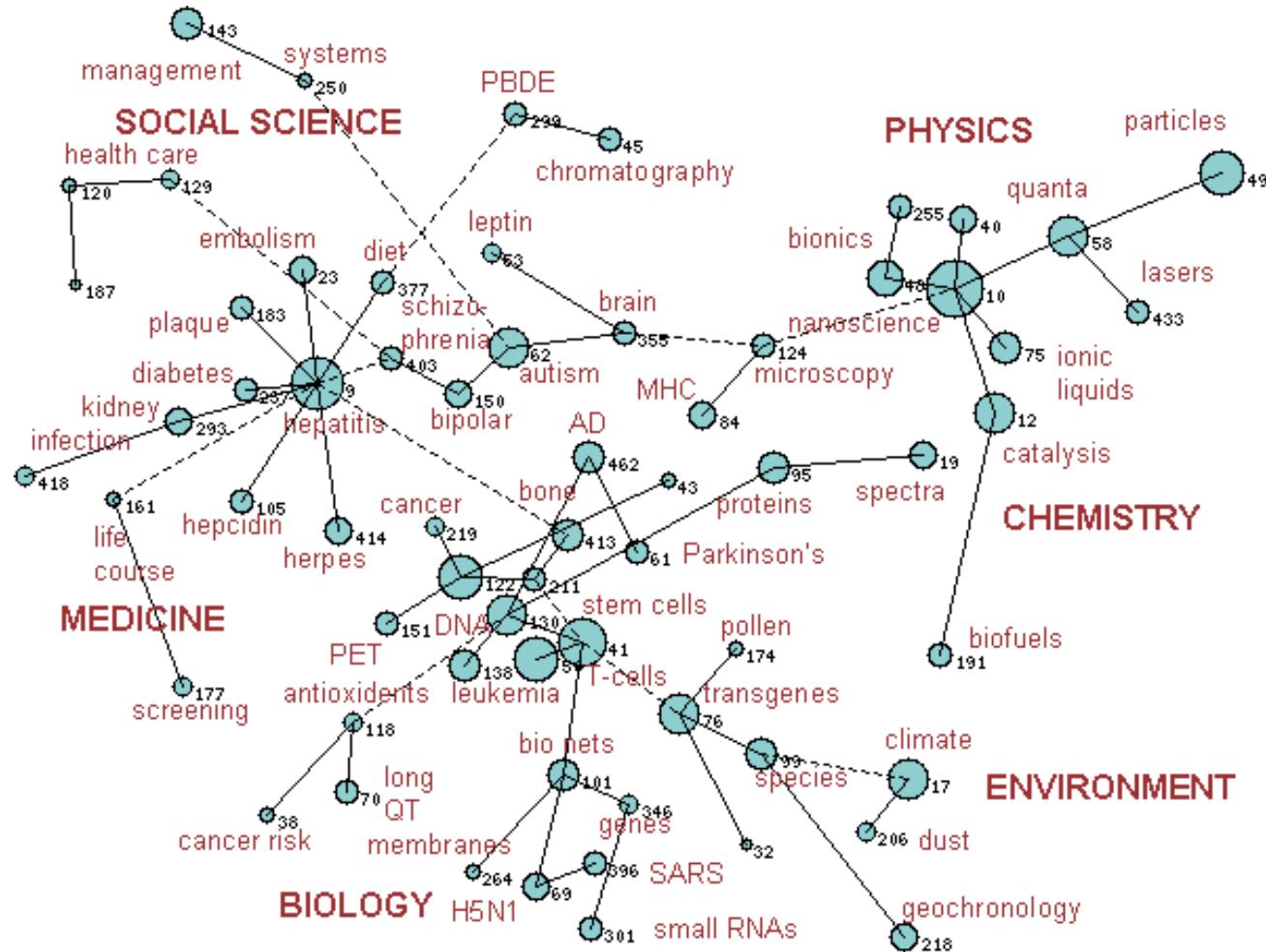
T1, T2,

if there is a paper A that

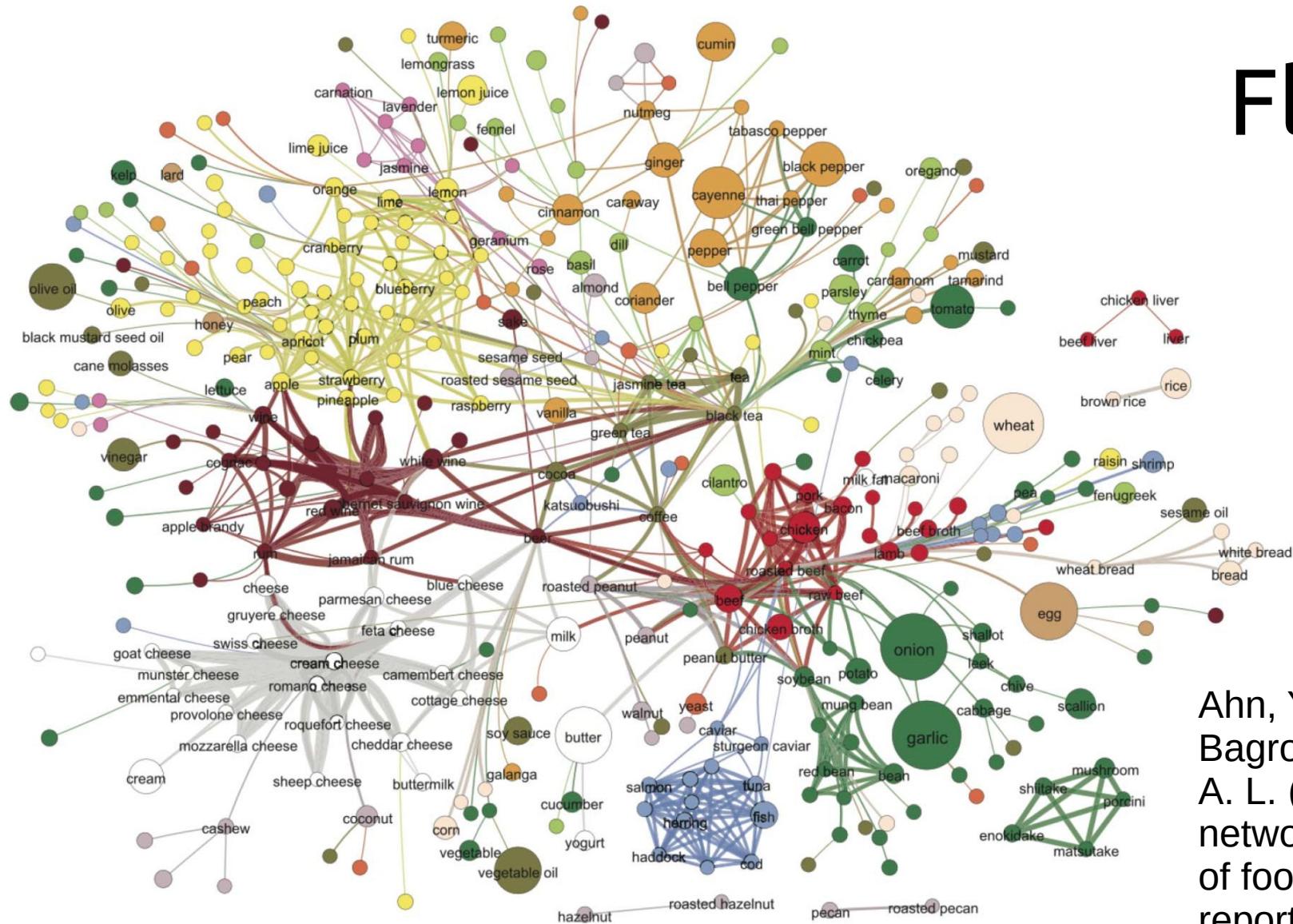
cites:

a paper B in T1 and

a paper C in T2.

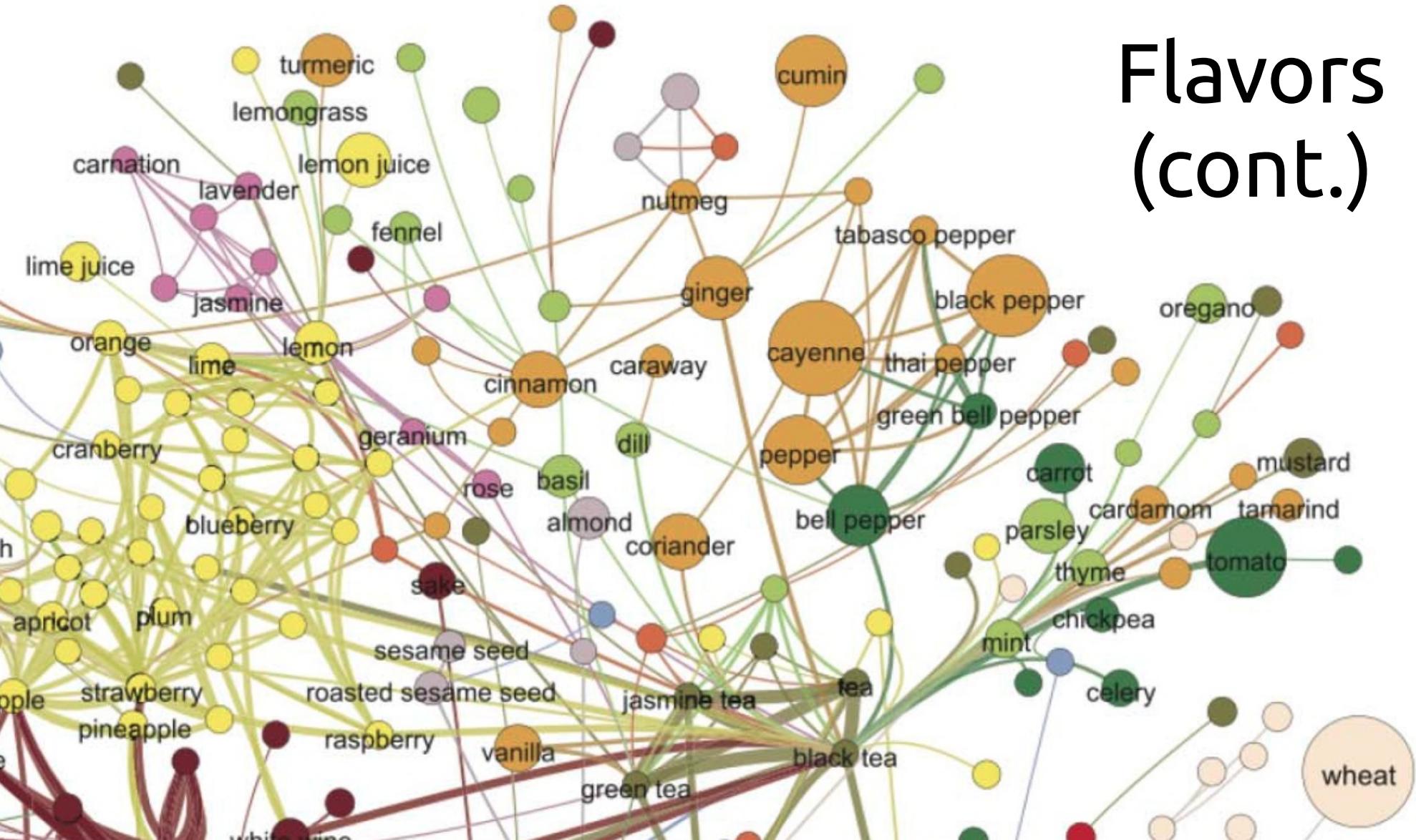


Flavors

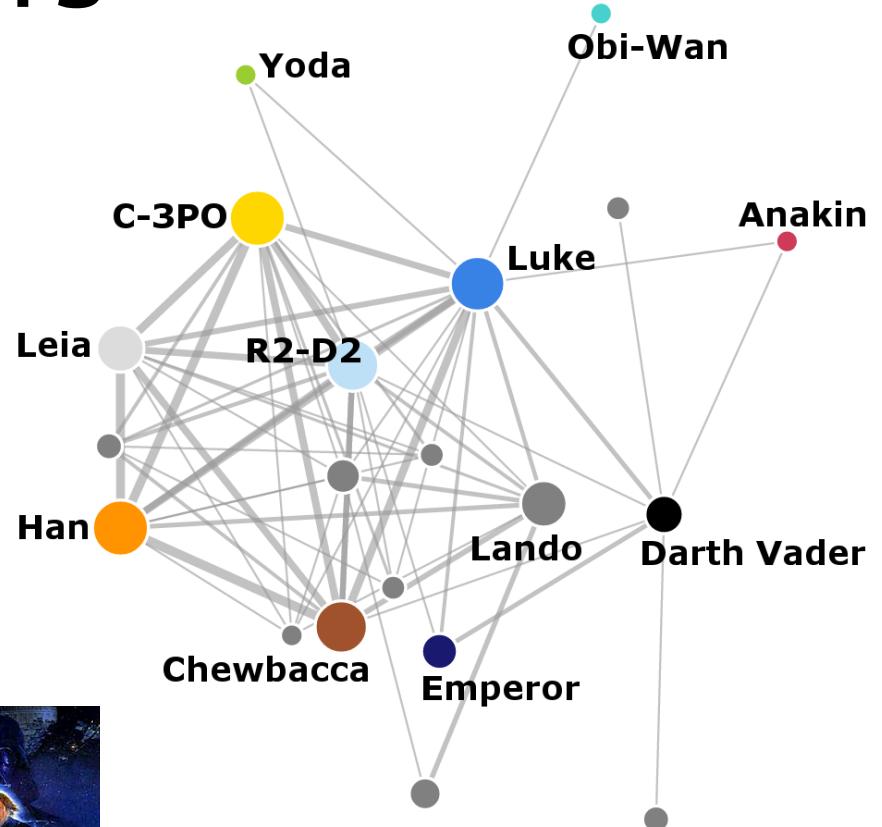
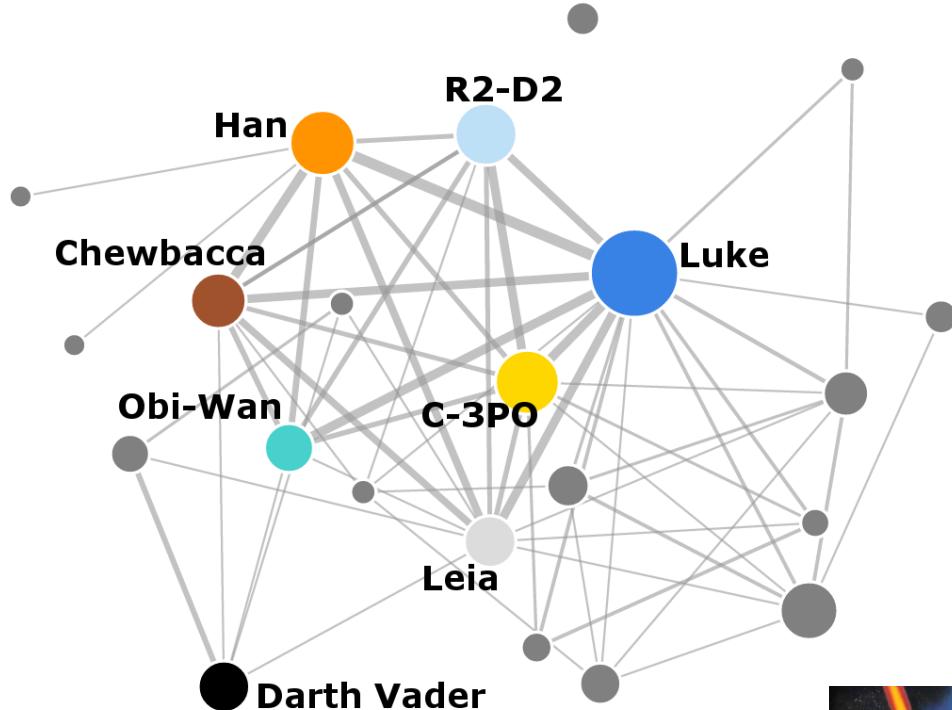


Ahn, Y. Y., Ahnert, S. E., Bagrow, J. P., & Barabási, A. L. (2011). Flavor network and the principles of food pairing. *Scientific reports*, 1, 196.

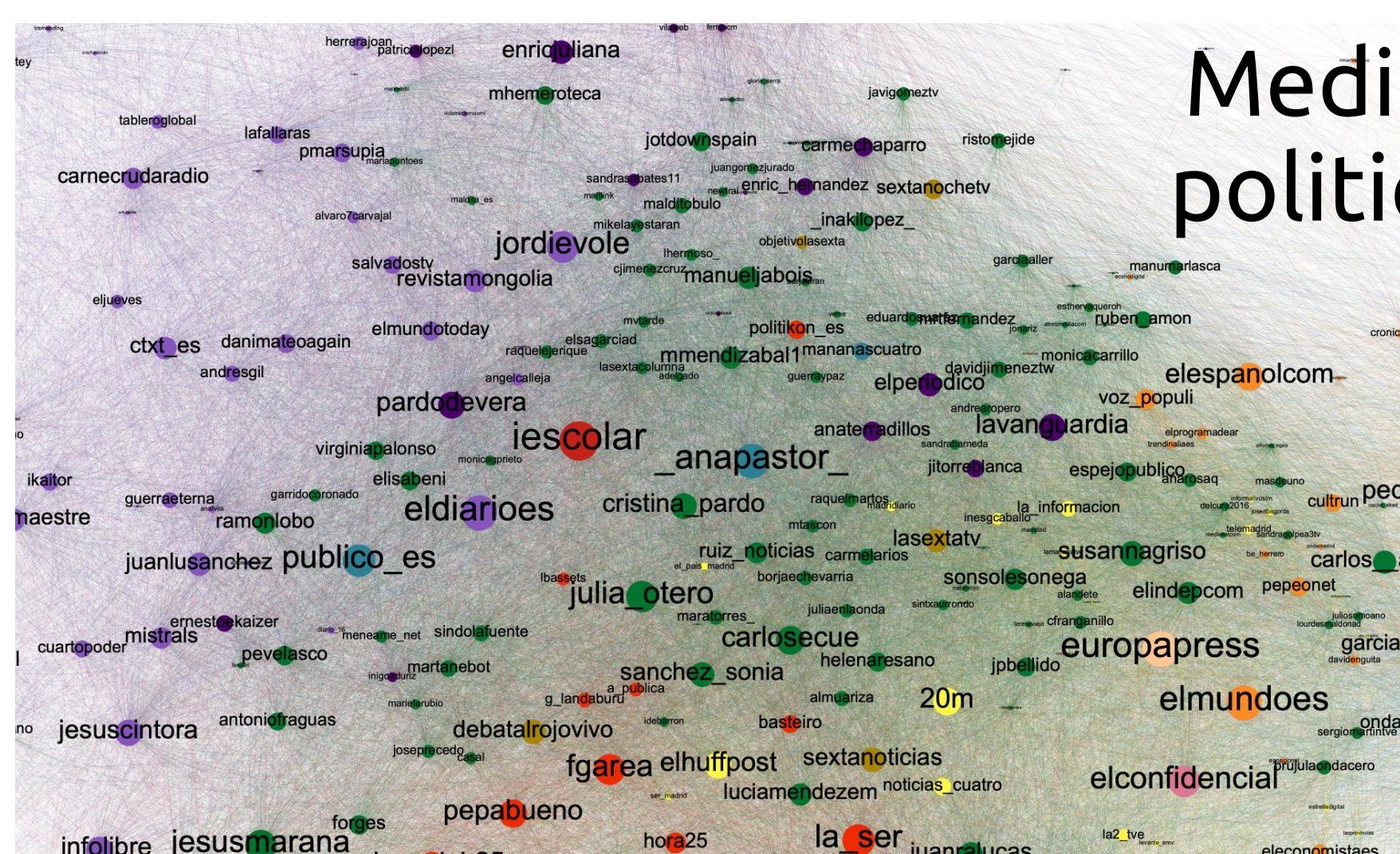
Flavors (cont.)



Star Wars



Media and politicians?



<https://twitter.com/jbo/status/1120444347772821504/photo/1>

Summary

Things remember

- Many networks have community structure
- Sometimes it's:
 - One dense sub-graph
 - Two communities (polarization)
 - Multiple communities