# Social Networks in Social Science Research: Theory and Practice

Anna Sokolova, MSc

14.02.2024

# Our first session

1. Round of introductions
2. Course structure and principles
3. SNA: a brief history lesson
4. Vocabulary, main measurements, and principles of SNA
5. Next session

# About me

*2014 – 2018* BA in Sociology (Higher School of Economics, Moscow)

*2018 – 2020* MSc in Sociology and Social Research (Utrecht University, The Netherlands)

*since 2020* PhD candidate, researcher at the Chair in Sociological Methodology

*Research interests*: social networks, social capital, educational and economic inequality

*Methods*: SNA, agent-based modelling, lab experiments

# What about you?

# Course structure

(For full info, see the syllabus on ILIAS.)

- **Sessions 1-2**: Intro
- **Sessions 3-8**: Social networks in research
- **Sessions 9-10**: SNA methods and data
- **Sessions 11-12**: Hands-on tutorials in R

# Course requirements

**Studienleistung:**
Article presentation

- Presenting an article from the weekly readings (marked by * in the syllabus).
- Up to 15 minutes, in PowerPoint.
- Summarize main elements: research question, contribution, theory, data and methods, main results, conclusions, discussion.
- Own reflections: strong and weak elements, potential improvements, further directions.
- “Critique for the author”: how could the author improve their paper?
- “Critique for myself”: how would I have written this paper?
- “Critique for the audience”: how does this paper fit in the existing literature?

**Prüfungsleistung:**
Extended research proposal

- For details & structure, see *Final_paper_guide* on ILIAS.
- Own project idea within the SNA framework (theoretical or methodological).
- Make it realistic & doable.
- Use recent and relevant literature.
- State of the art is the ideal goal.
- Start thinking early!
- Consultations are encouraged.

# Course principles

For our sessions to be most productive...

- read the assigned papers;
- give thoughtful feedback to your peers;
- develop constructive criticism;
- apply own experience;
- express your thoughts;
- feel free to provide feedback to me.

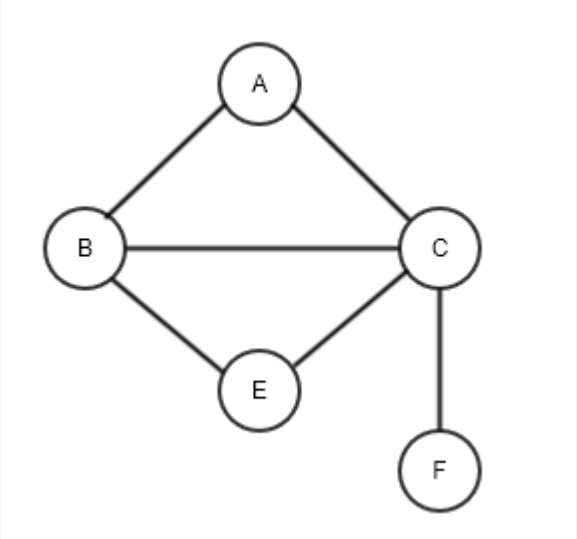

Questions?

# SNA: a history lesson

- *19-20th century:* G. Simmel, M. Weber, E. Durkheim recognize the importance of studying social relationships
- *from 1930-s:* analytical toolkit development; J. Moreno introduces sociograms, S. Milgram conducts “small world” experiment
- *from 1970-s:* theoretical heyday; J. Coleman, R. Burt, H. White, M. Granovetter, K. Carley, and many others
- *from 1990-s:* interdisciplinarity & methodological progress; A.-L. Barabási, N. Christakis, M. Jackson, D. J. Watts, and many others
- *from 2010-s:* wide popularity of SNA, many hubs and researchers, new sources of data (online networks, network experiments, longitudinal network studies, ...), new methods (ERGM, SAOM, etc.)

# Studying social networks

- Network theory is part of **graph theory**, a branch of mathematics.




Network as a graph

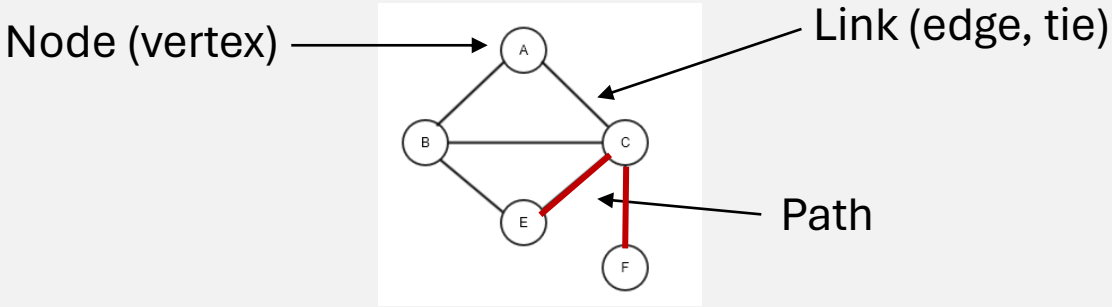
| | A | B | C | E | F |
|---|---|---|---|---|---|
| A | 0 | 1 | 1 | 0 | 0 |
| B | 1 | 0 | 1 | 1 | 0 |
| C | 1 | 1 | 0 | 1 | 1 |
| E | 0 | 1 | 1 | 0 | 0 |
| F | 0 | 0 | 1 | 0 | 0 |

Network as an adjacency matrix



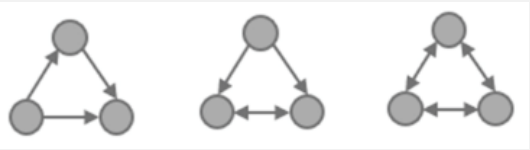
Pic source: https://www.oreilly.com/library/view/hands-on-data-structures/9781788995573/b7b11326-d032-420c-a8c0-aad6181a8f2c.xhtml

# SNA vocabulary



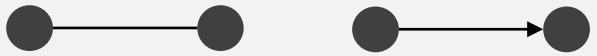

- A **graph** can be a...


dyad

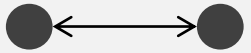

triad

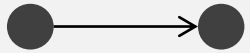

tetrad

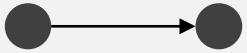
- A **tie** can be...

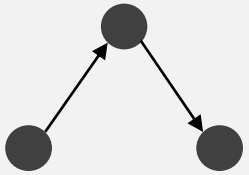

undirected


directed

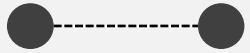

symmetrical


asymmetrical


direct


indirect


strong

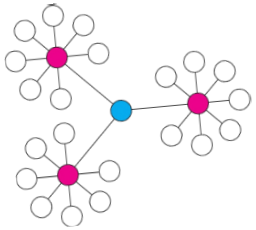

weak



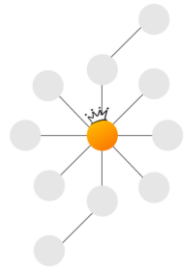
Pic source: https://appliednetsci.springeropen.com/articles/10.1007/s41109-021-00403-5

# SNA measurements: individual

- **Degree**: *n* of direct links a node has. For directed graphs, **in-degree** is *n* of incoming links, **out-degree** is the *n* of outcoming links.

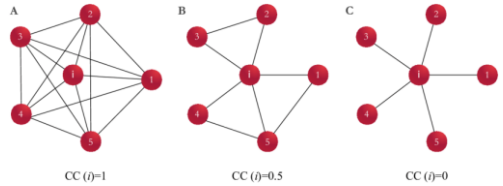


- **Betweenness Centrality**: Measures the extent to which a node lies on the shortest path between other nodes in the network.



- **Closeness Centrality**: Indicates how close a node is to all other nodes in the network, measured by the average length of the shortest path from the node to all others.

- **Eigenvector Centrality**: Reflects the influence of a node based not just on the number of connections but also on the centrality of those connections. A node connected to other highly connected nodes will have a high eigenvector centrality.



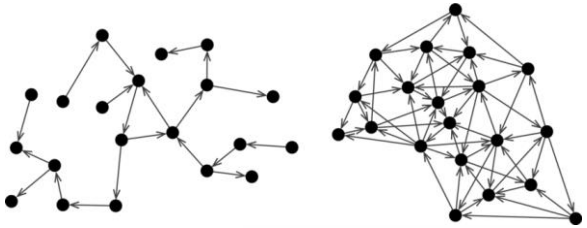

- **Local Clustering Coefficient**: Measures the degree to which a node's neighbors are connected to each other. This is an indicator of the clustering tendency around a particular node.



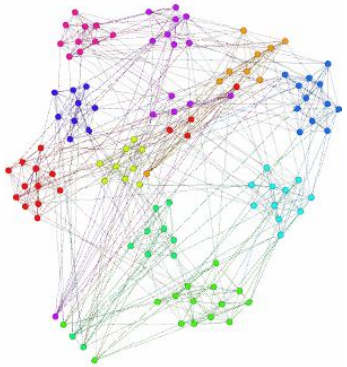
Pic sources: https://omicsforum.ca/t/what-are-the-differences-between-degree-and-betweenness-centrality/163, https://memgraph.com/blog/why-are-nodes-with-a-high-betweenness-centrality-score-high-maintenance, https://www.researchgate.net/figure/An-example-of-clustering-coefficient-Three-network-configurations-that-result-in_fig2_324745118

# SNA measurements: network-level

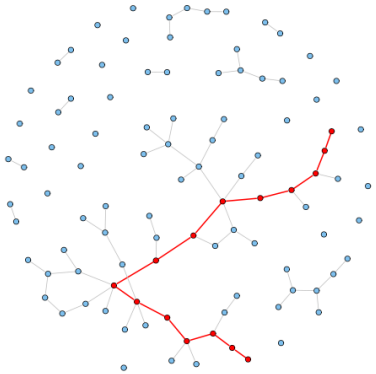
- **Density**: The ratio of actual connections in the network to all possible connections. High density → a highly interconnected network, low density → a sparse network.



- **Global Clustering Coefficient**: Measures the degree of clustering in the entire network, showing how likely it is that nodes in the network cluster together. A high global clustering coefficient indicates community structure.



- **Average Path Length**: The average number of steps along the shortest paths for all possible pairs of network nodes. It offers insight into the efficiency of information or resource transfer in the network.

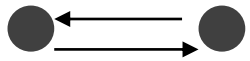
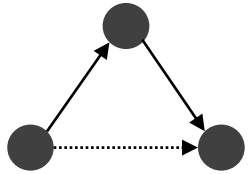


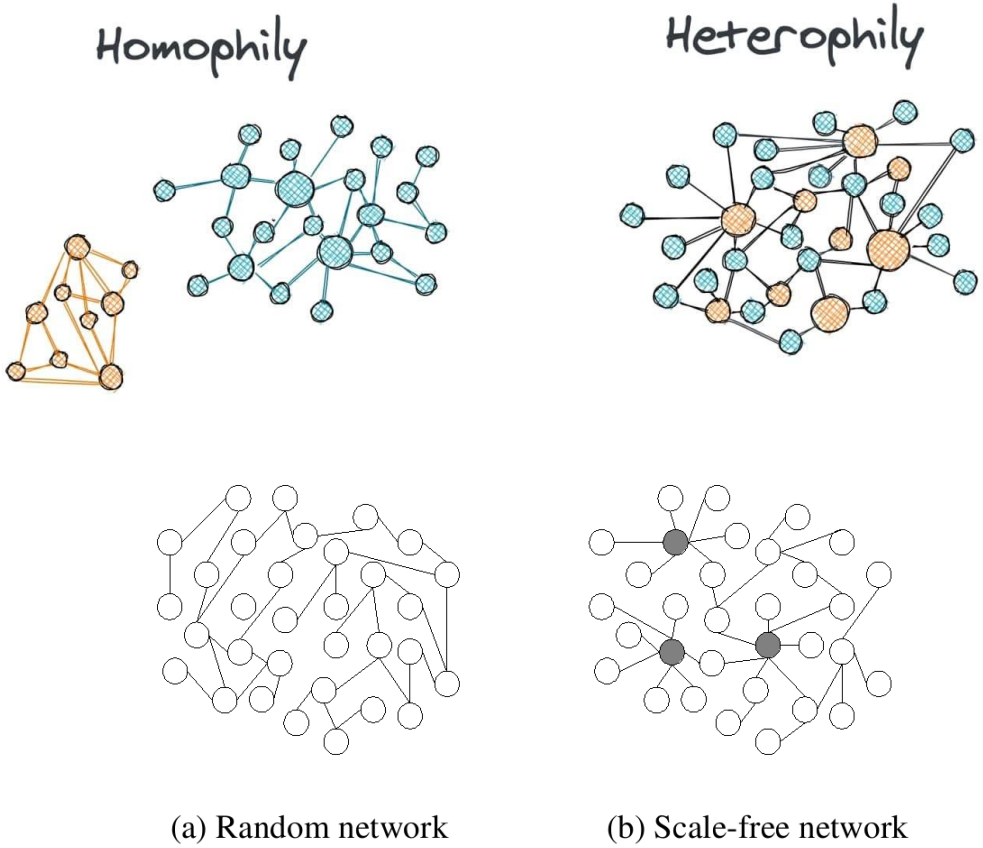
- **Diameter**: The longest shortest path between any two nodes in the network. It provides a sense of the "size" of the network in terms of path length and can indicate how far apart nodes can be within the network.



Pic sources: https://www.researchgate.net/figure/A-sparse-network-left-vs-a-dense-network-right_fig1_335869404, https://www.researchgate.net/figure/Clustering-the-American-College-football-network-by-applying-the-modularity-algorithm_fig2_271466069, https://www.sci.unich.it/~francesc/teaching/network/geodesic.html

# Social Network principles

- **Reciprocity** 
- **Transitivity** 
- **Homophily**: “birds of a feather flock together"
- **Scale-free networks**: a network whose degree distribution follows a power law (Pareto principle). There are few popular nodes, and many less connected nodes.






Pic sources: https://graphml.substack.com/p/gml-newsletter-homophily-heterophily, https://en.m.wikipedia.org/wiki/File:Scale-free_network_sample.png


Questions?

# Next session

- Obligatory reading:

Fuhse, J. A. (2020). Theories of social networks. The Oxford Handbook of Social Networks, 34-49.

- Article presentation:

*Vander Weele, T. J., & An, W. (2013). Social networks and causal inference. Handbook of causal analysis for social research, 353-374.

See you next week!