

Introduction to Computational Social Science

Session 5: Network data and analysis

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Room B U103, Tue 14:00–18:00 (bi-weekly)

Today's session

Lecture

(**TODO?**)

- 1 Basic concepts
- 2 Data collection and storage
- 3 Network measures and models
- 4 Centrality and blockmodeling (**TODO?**) Network visualization techniques
- 5 Network dynamics
- 6 Applications in Political Science

Lab

(**TODO?**)

Before we begin

(**TODO?**) ChatGPT

Introduction & basic terms and concepts

Networks around us

(**TODO?**) Subway map

(**TODO?**) Friends

(**TODO?**) its alawys sunny mapped red string ting

(**TODO?**) Facebook

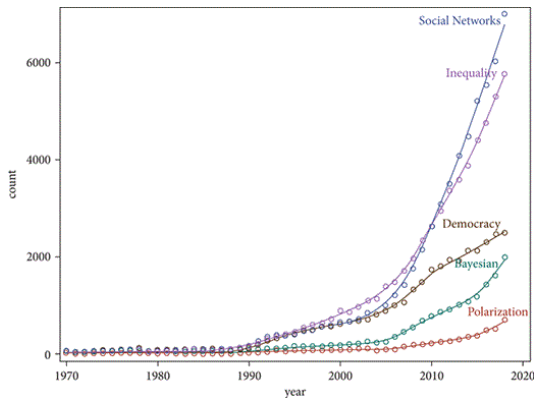
(**TODO?**)

- Networks have a long tradition in science, mostly in Physics and Biology

Introduction to networks in the Social Sciences

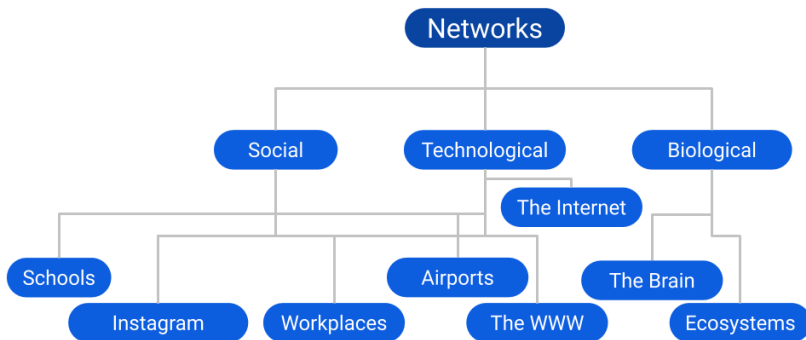
- Networks have a long tradition in science, mostly in Physics and Biology
- In the *Social Sciences*, we are often interested in *social* networks

Shy study networks?



Trend in articles on “Social Network*” topics among all papers indexed in Web of Science Social Science Citation Index, with other keywords for comparison. Source: Light & Moody (2021)

Example overview of types of networked systems



Source: Jilbert (n.d.)

Research questions and goals of network analysis

(**TODO?**) beginnngin of this

<https://www.youtube.com/watch?v=O-PF1PyQ8PA>

(**TODO?**) consequences of netowrks

(**TODO?**) prediction of netowkrs? (**TODO?**) is this a thing? borgetti
book ch 1

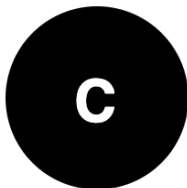
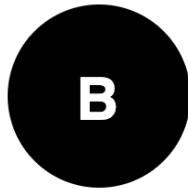
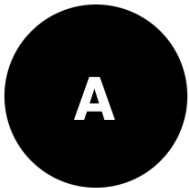
Social Science examples

(**TODO?**) <https://www.youtube.com/watch?v=O-PF1PyQ8PA>

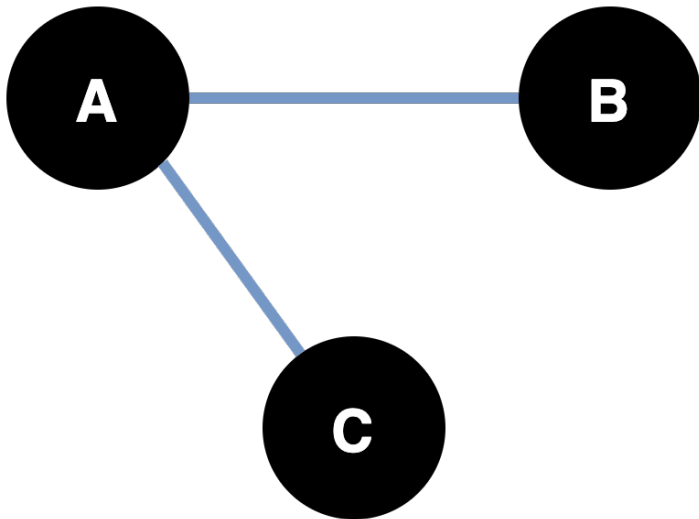
- Poole and degrees of separation

(**TODO?**) see examples in Borgatti et al p.1–2 end

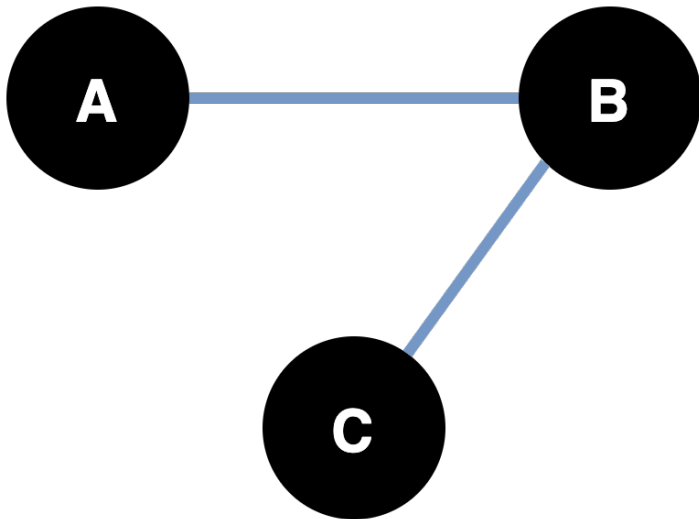
A simple network i



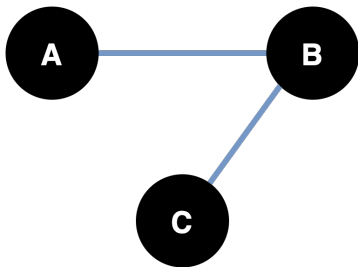
A simple network ii



A simple network iii

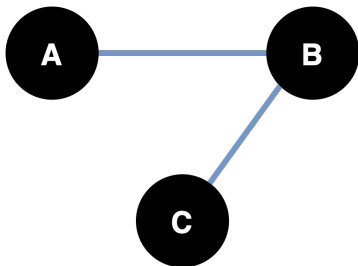


Nodes and edges



Nodes (also vertices) Entities or units in a network

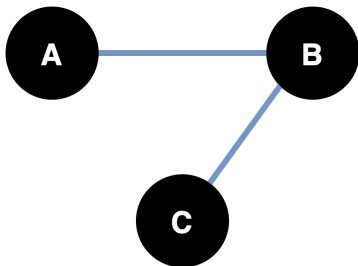
Nodes and edges



Nodes (also vertices) Entities or units in a network

Edges (also ties, links)
Connections between nodes

Nodes and edges

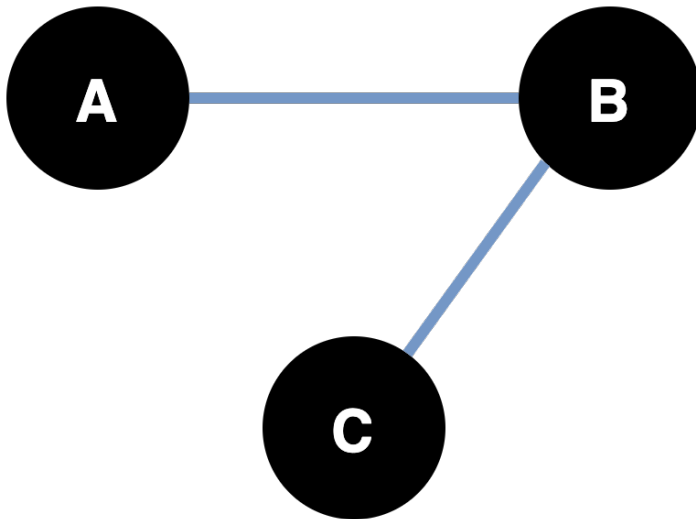


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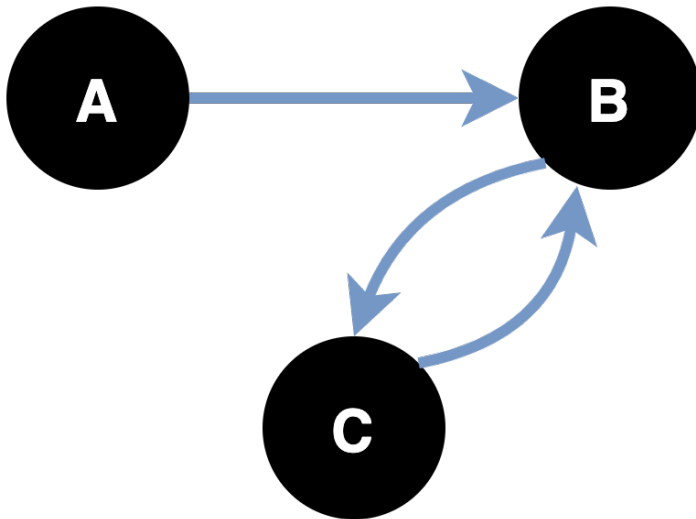
Edges (also ties, links)
Connections between nodes

→ **Network**

Undirected edges



Directed edges



Typology of relations between nodes

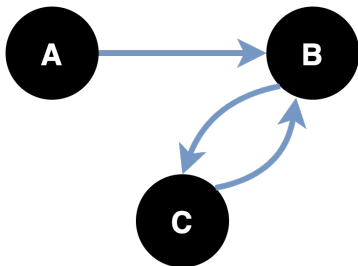
Similarities			Social Relations				Interactions	Flows
Location e.g., Same spatial and temporal space	Membership e.g., Same clubs Same events etc.	Attribute e.g., Same gender Same attitude etc.	Kinship e.g., Mother of Sibling of	Other role e.g., Friend of Boss of Student of Competitor of	Affective e.g., Likes Hates etc.	Cognitive e.g., Knows Knows about Sees as happy etc.	e.g., Sex with Talked to Advice to Helped Harmed etc.	e.g., Information Beliefs Personnel Resources etc.

A typology of ties studied in social network analysis by Borgatti et al. (2009)

One and two-mode networks

Text messaging among friends

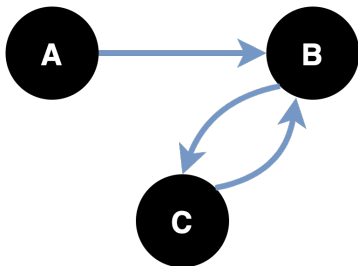
→ one-mode network



One and two-mode networks

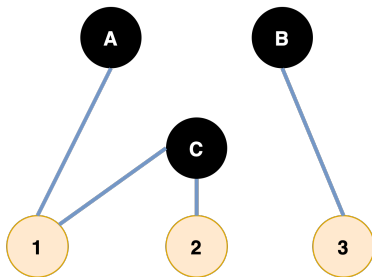
Text messaging among friends

→ one-mode network

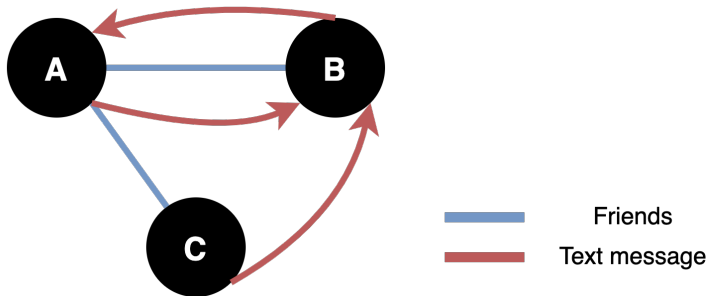


Hobbies among friends

→ two-mode network

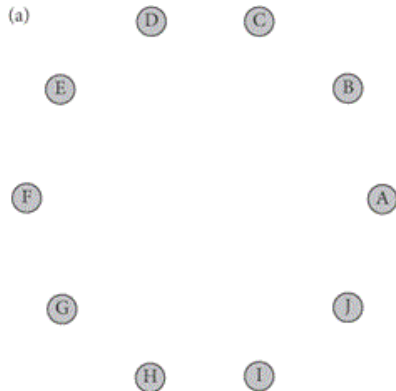


Multiplexity



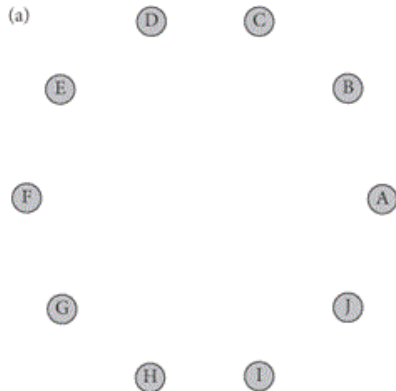
Unconnected and maximally connected networks

Unconnected network

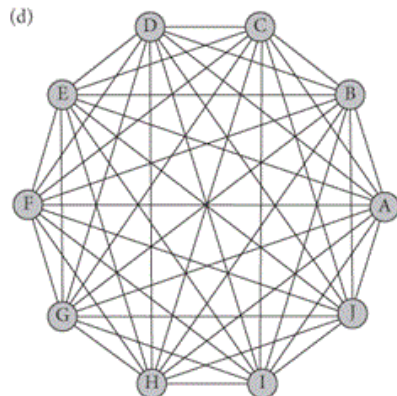


Unconnected and maximally connected networks

Unconnected network



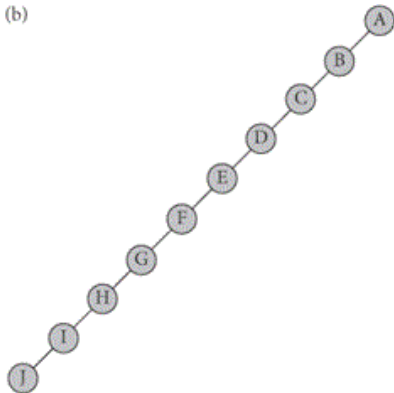
Maximally connected network



Chains and trees

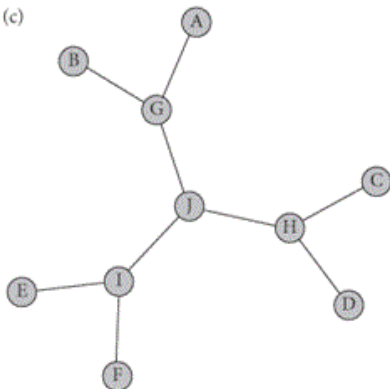
Chain

(b)

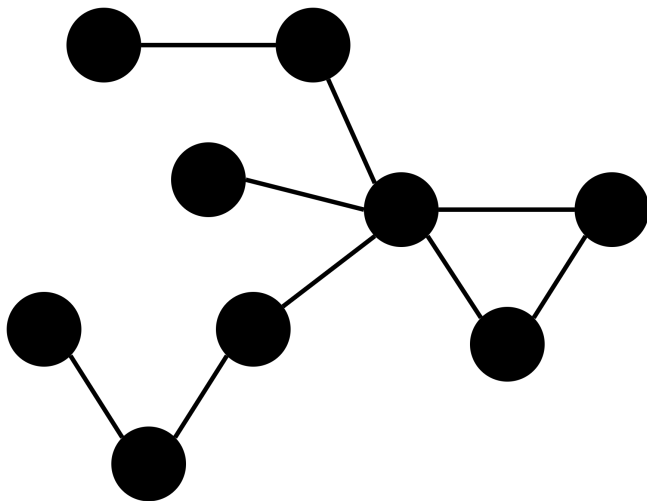


Tree

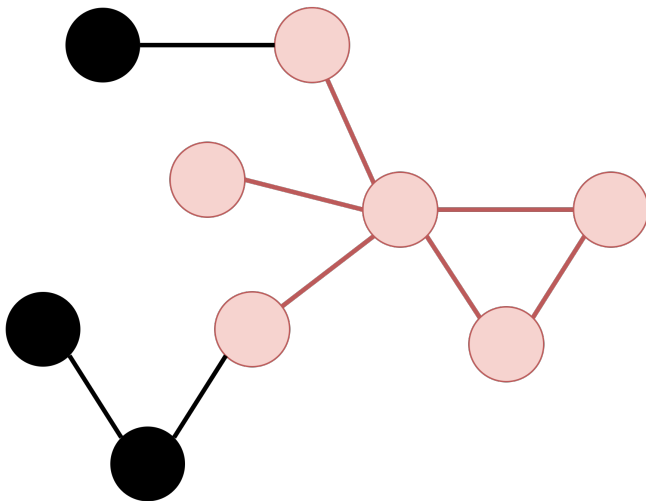
(c)



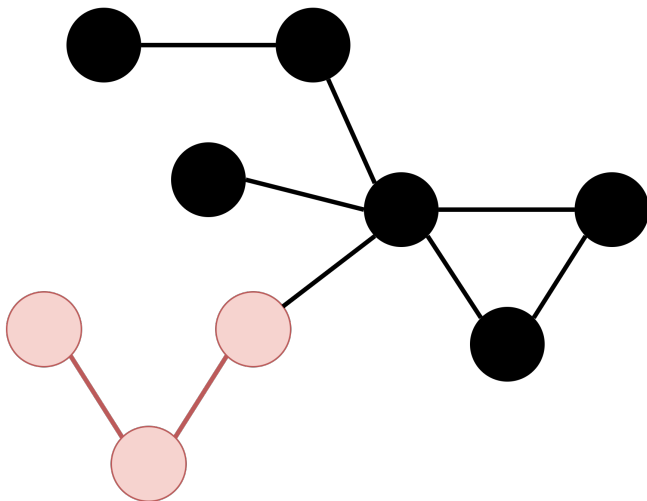
Levels of analysis: network



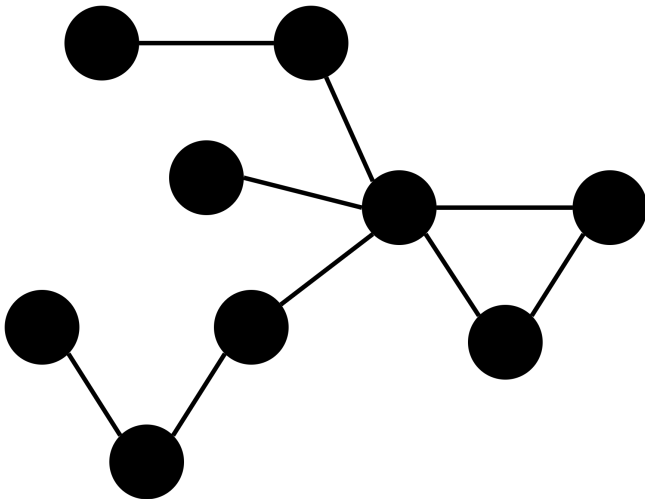
Levels of analysis: subgroup



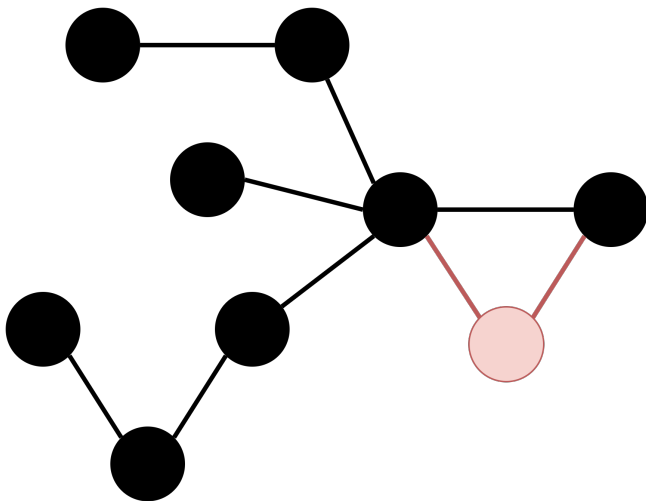
Levels of analysis: triad



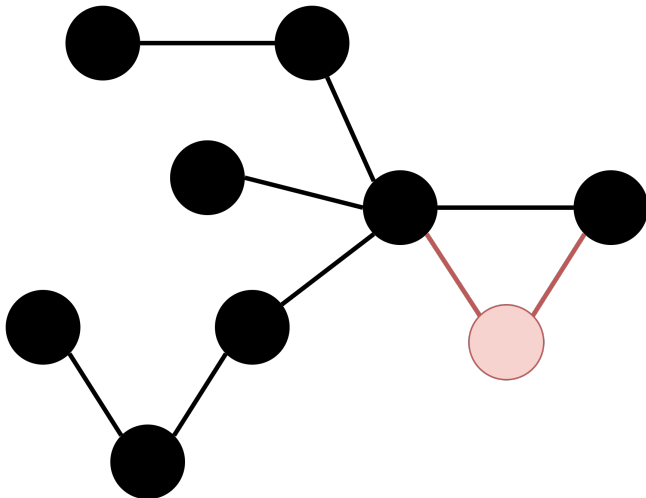
Levels of analysis: dyad



Levels of analysis: ego



Levels of analysis: ego and alter



(Fodor) ... how the ...

(**TODO?**) where to put

(**TODO?**) borgetti

Transmission

Adaption

binding

exclusion

centrality → more later

Social Network Theory and measurement

(**TODO?**) necessary?

(**TODO?**) https://bookdown.org/omarlizardo/_main/1-3-the-two-faces-of-social-network-analysis.html#the-two-faces-of-social-network-analysis

(**TODO?**) differentiate between the

(**TODO?**) Borgetti et al

(**TODO?**) Borgetti et al Fig. 3

Network data collection and storage

What do we want to know? (Light & Moody, 2021)

Ties (Borgatti et al., 2009)

- social relationships (e.g. friendship, kinship)
- interactions (e.g. sending and receiving messages, sharing resources)
- flows (spread of, e.g. ideas, diseases) → between nodes connected by relation or interaction ties

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Scope

- Local networks (convenience samples)
- Complete / global networks

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Scope

- Local networks (convenience samples)
- Complete / global networks

Complete networks are often unobtainable → *Sampling*

- Respondent-driven sampling → gain insights in network of hidden populations
- Network scale-up method → estimate the size hidden populations

Boundary specification problem *“In social networks boundaries can often logically extend to every human on the planet.”* (Light & Moody, 2021)

→ Researchers need to specify the boundaries of the network they want to analyze

How can we collect network data? (**adams_strategies_2021?**)

Collection via

Primary sources

- Survey / Interviews

Secondary sources

- Information on individuals (e.g. archival sources)

Hybrid sources

- Sensor data / digital trace data / metadata

Name generators

- Example: “*Who do you contact if you get stuck with your work?*”

Name generators

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- General Social Survey: *“From time to time, most people discuss important matters with other people. Looking back over the last six months, who are the people with whom you discussed matters important to you?”* → can be used to identify alters of an ego

Name generators

- Example: *“Who do you contact if you get stuck with your work?”*
- General Social Survey: *“From time to time, most people discuss important matters with other people. Looking back over the last six months, who are the people with whom you discussed matters important to you?”* → can be used to identify alters of an ego

→ The exact name generator is determined by the research question

Name interpreters

Determine

- attributes of the nominated alters
- details of the relationship
- strength or frequency of relationship

Information on networks from

- Monitoring of behavior (e.g. sensor data, app use log)
- Digital trace data (e.g. interaction on social media)
- Metadata (e.g. who cites whom, who follows whom)

Data collection

- Anonymity / Confidentiality → Problem: anonymized data can be used to deduct identities
- Informed consent
- Active consent / opt-out in population studies

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Analysis

- Network visualization can reveal identities
- Balance between benefit and harm (e.g. infectious disease tracing)
- Network analysis use in business and management to assess performance

How to store network data?

How to store network data?

Adjacency matrices

Undirected

(a)



Undirected, binary

	a	b	c	d	e
a		1			
b	1		1		
c		1		1	1
d			1		1
e			1	1	

How to store network data?

Adjacency matrices

Undirected

(a)



Undirected, binary

	a	b	c	d	e
a		1			
b	1		1		
c		1		1	1
d			1		1
e			1	1	

Directed

(a)



Undirected, binary

	a	b	c	d	e
a		1			
b	1		1		
c		1		1	1
d			1		1
e			1	1	

Source (both): Light & Moody (2021)

(**TODO?**) potentially extend after labn / praxctice?

(**TODO?**) adjacency img fig 2.1 from

<https://academic-oup-com.emedien.ub.uni-muenchen.de/edited-volume/34294/chapter/290739653> (**TODO?**)

(**TODO?**) borgetto book evtl?

(**TOOD?**) matrices and graphs (**TOOD?**) what we have used so far
pgrpahs,

Network measures and models

(**TODO?**) for each measure give operationalization and examples why they might be useful

(**TODO?**) graphs (**OTOD?**) graphs have mathematical properties

(**TODOOpen?**) and closed networks borgetti - Open - Closed

(**TOOD?**) While social relationships differ from interactions conceptually, they also differ in the approaches taken for their analyses—for example, between models that focus on more stable relationships (e.g., exponential random graph models or stochastic actor-based models) versus those that focus on the sequential structural patterns among more momentary interactions (e.g., relational event models).

(**TODO?**)

<https://academic-oup-com.emedien.ub.uni-muenchen.de/edited-volume/34294/chapter/290739653#342494672>

(**TODO?**) <https://en.wikipedia.org/wiki/Blockmodeling>

(**TODO?**) Borgatti et al fig. 2

(**TODO?**)

Distance

(**TODO?**)

Other models and features

(**TODO?**) stuff we do not consider e.g. over time etc

(**TOOD?**) consider theory together with measurement?

Network visualization techniques

Why do we visualize networks?

(**TODO?**) <https://www.youtube.com/watch?v=lnLW6ITFY3M>
beginning

Limits of visualization

(**TODO?**)

Network dynamics

(**TODO?**) dynamic networks?

Networks, Political Science and CSS

Where does computation come in?

(**TODO?**) <https://academic-oup-com.emedien.ub.uni-muenchen.de/edited-volume/34294/chapter/290739997>

Next session (TODO?)

Lab

References

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network Analysis in the Social Sciences. *Science*, 323(5916), 892–895.

<https://doi.org/10.1126/science.1165821>

Jilbert, O. L. and I. (n.d.). *Social Networks: An Introduction*.

Light, R., & Moody, J. (2021). Introduction. In R. Light & J. Moody (Eds.), *The Oxford Handbook of Social Networks* (p. 0). Oxford University Press.

<https://doi.org/10.1093/oxfordhb/9780190251765.013.1>

Appendix i