

Network Analysis:

The Hidden Structures behind the Webs We Weave

17-213 / 17-668

Exemplary Studies and Extensions

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2-min Quiz, on Canvas

Exemplary Studies

What are the uses?

In previous weeks, we explored specific quantitative measures, models, and methods for studying social phenomena through the lens of networks

- Homophily and degree assortativity
- Power and centrality
- Social groups
 - Cohesive subgroups
 - Structural equivalence
 - Affiliation networks

Let's look at effective uses of these methods and how the core insights of the methods can be adapted given the constraints of the study (e.g., data, population)

Examples: Power and Centrality

Network Position and Sexual Dysfunction

“Betweenness” of the spouse correlates with sexual dysfunction of older men
Masculinity norms expect autonomy and independence of men

Network Position and Sexual Dysfunction

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Masculinity norms expect autonomy and independence of men

Q: Which structure below poses a threat to masculinity from ego’s perspective?

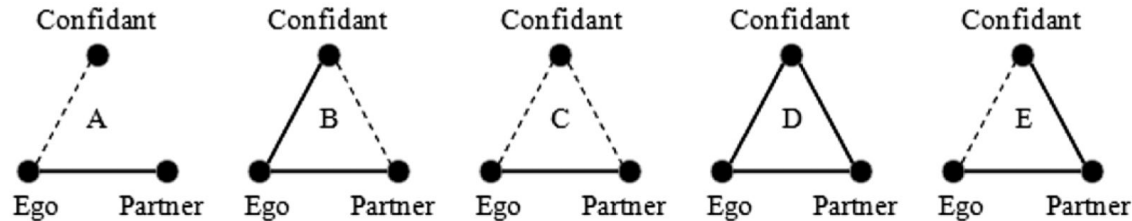
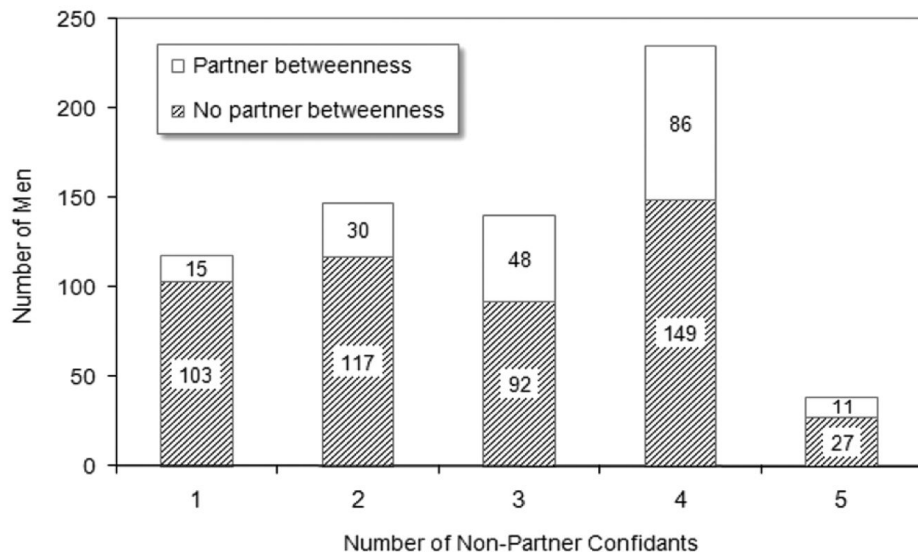


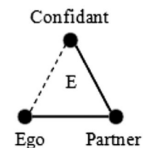
FIG. 1.—Five possible ego-partner-confidant triads, based on contact frequency. Solid lines represent frequent contact. Dashed lines represent (relatively) infrequent contact.

Network Position and Sexual Dysfunction



Data: National Social Life, Health, and Aging Project (2005~2006) Survey of 3K older adults in the U.S.

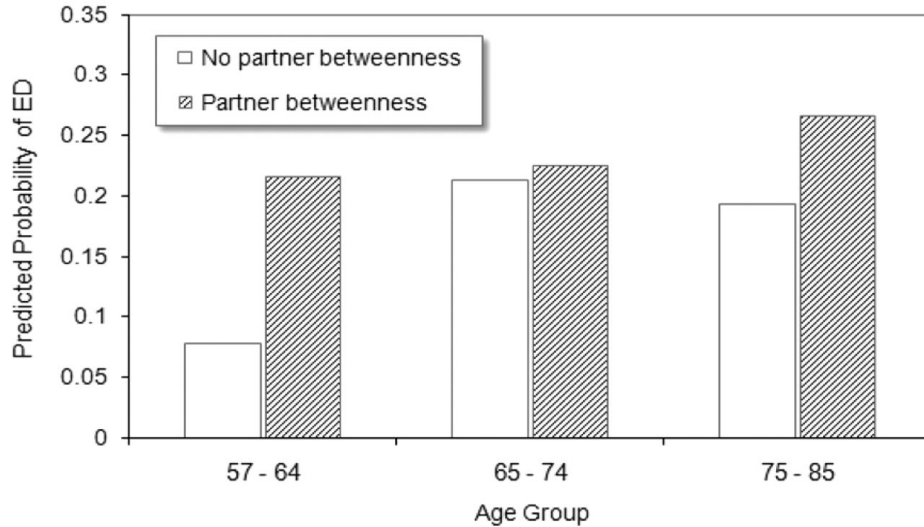
Partner betweenness:



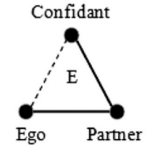
For older men, female spouses can become more central in the men's confidant network

- Their networks overlap at old age
- Men's deteriorating health facilitates more frequent contact between spouse and confidant

Network Position and Sexual Dysfunction



Partner betweenness:

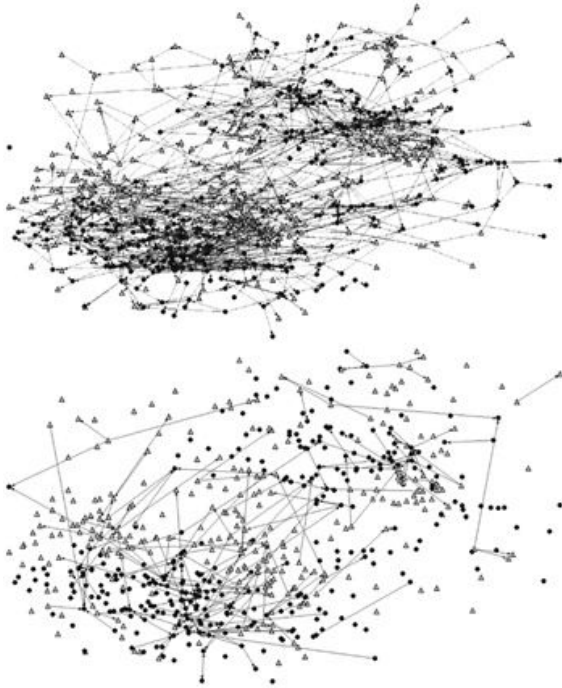


Probability of erectile dysfunction is significantly higher for men with partner betweenness

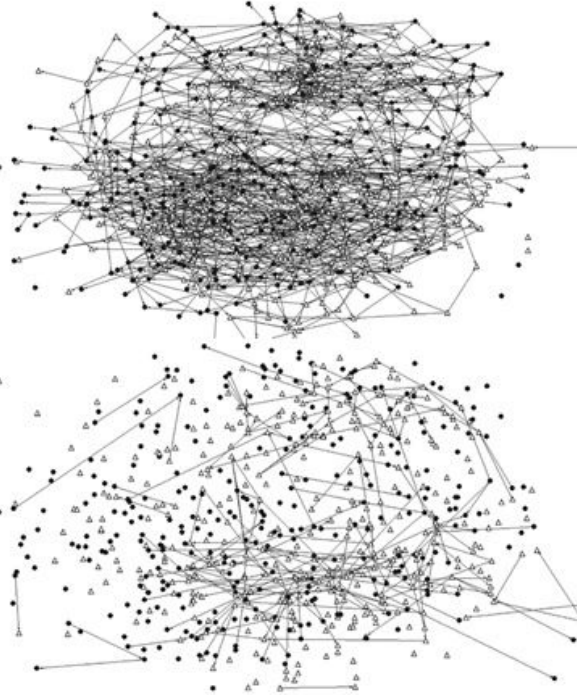
The study adapts the idea of betweenness centrality, given egocentric network data

Centrality and Aggression in High School

Washington: High Sex-Segregation



Jefferson: Low Sex-Segregation



Q: How is centrality in high school friendship networks related to aggression?

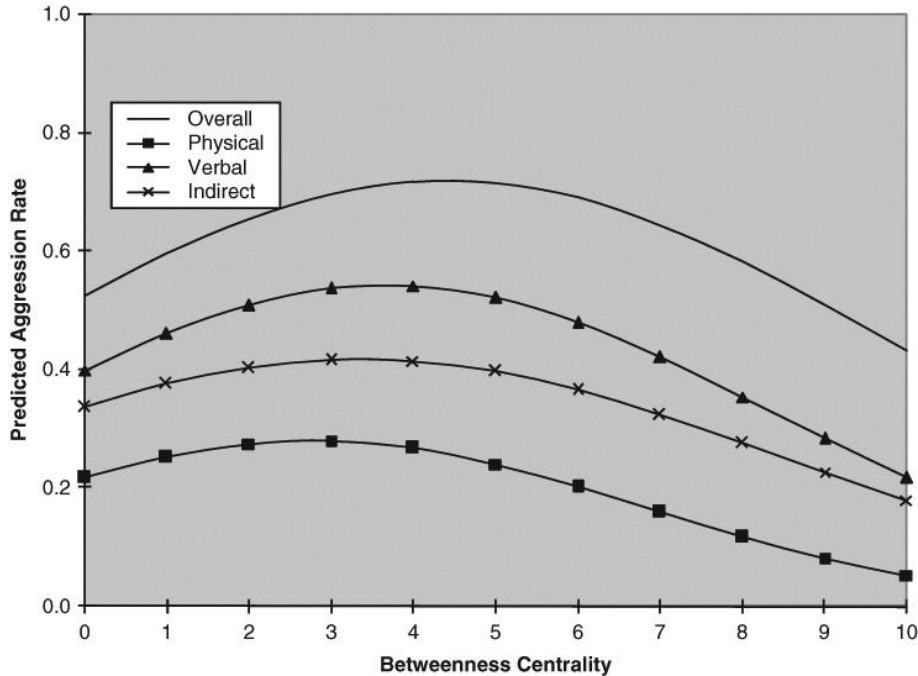
Positive relation?:

- Aggression as means of gaining status (centrality)

Negative relation?:

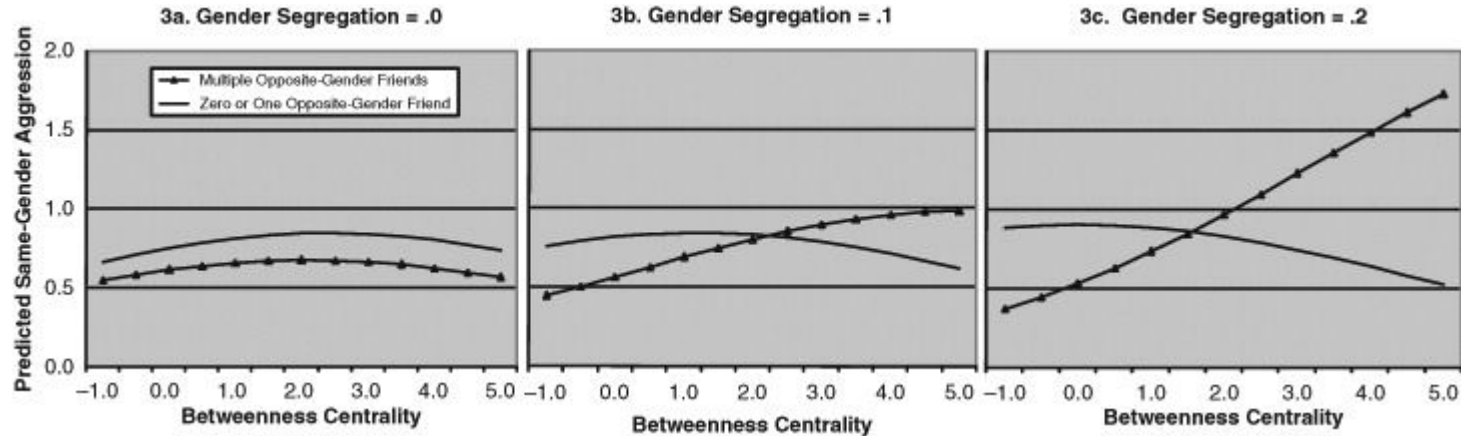
- Aggression as problematic behavior of the low status

Centrality and Aggression in High School



Q: Why does rate of aggression decline with higher centrality?

Centrality and Aggression in High School



Aggression increases with centrality in gender-segregated schools for students who have multiple opposite gender friends (3c).

Q: How do you make sense of this finding?

Examples: Structural Equivalence

Social Contagion: Cohesion vs. Structural Equivalence

Prominent sociologist James Coleman published a study on the diffusion of a new antibiotic medical innovation among 150 physicians in Illinois in the 1960s

High uncertainty and high risk of adopting new medicine

Cohesion: Coleman argued that physician adoption occurred through **discussions and advice giving** with trusted strong ties due to the high uncertainty and risk

Social Contagion: Cohesion vs. Structural Equivalence

20 years later, Ron Burt reanalyzed the same physician adoption data from the 1960s

Structural equivalence: Burt argued that it is the similarity in structural positions that drove adoption:

*“..the trigger to ego's adoption is **adoption by the people with whom he jointly occupies a position in the social structure**, the people who could **replace** him in his role relations if he were removed from the social structure. It is here where feelings of **envy, relative deprivation, and advantage** are felt...*

Once the occupants of his status begin adopting, ego is expected to follow suit rapidly in order to avoid the embarrassment of being the last to espouse a belief or practice that has become a recognized feature of occupying his status”

Social Contagion: Cohesion vs. Structural Equivalence

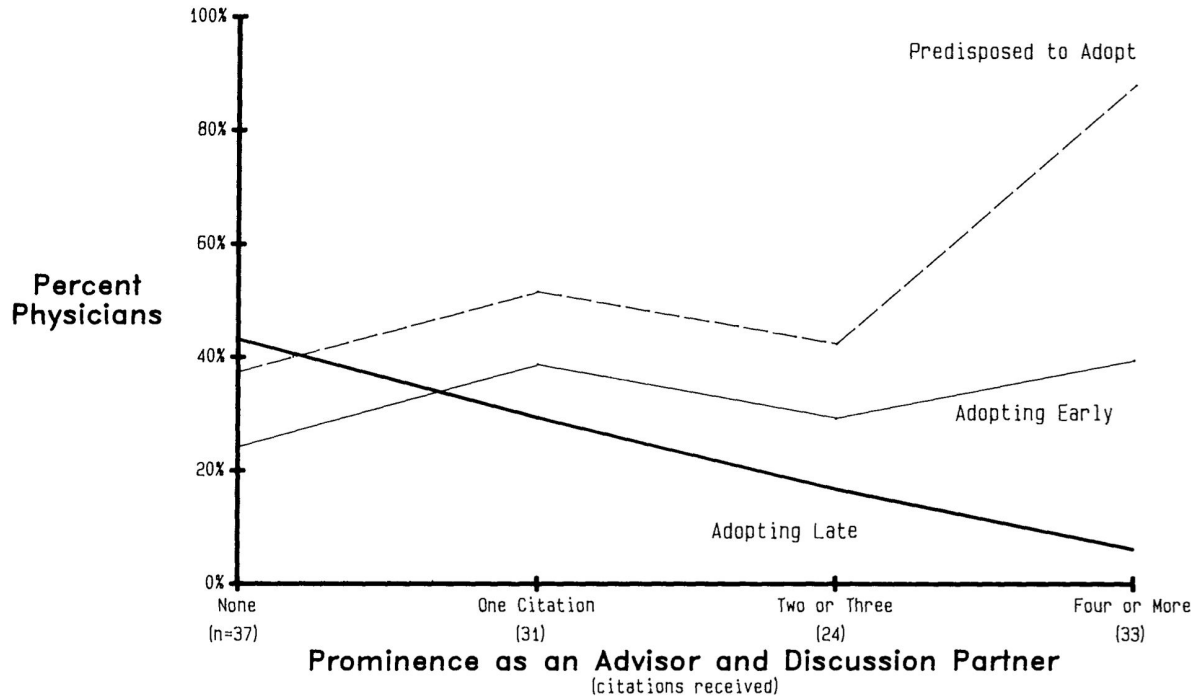


FIG. 6.—Adoption across levels of prominence

Social Contagion: Cohesion vs. Structural Equivalence

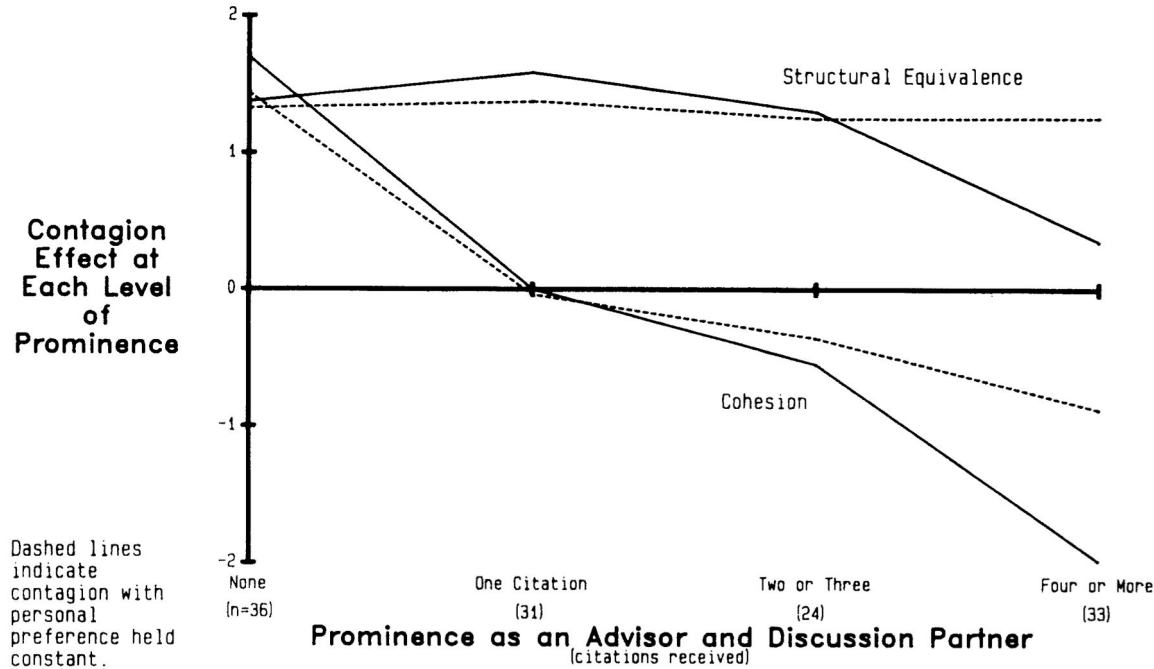


FIG. 7.—Social contagion within levels of prominence

Structure of Academic Disciplines

“Prestige principle” in academic labor markets

- Strong correlation between the prestige of the department where one acquires doctoral degree the prestige of the department that employs that doctorate

How does this principle look like in terms of the network structure of hiring relations?

Are the structures consistent across disciplines?

Block model structurally equivalent positions

Use triad census to compare the level vertical differentiation (hierarchy) and integration (cyclicity)

Structure of Academic Disciplines

Table 1
Number of entries and departments

Discipline	<i>N</i> of raw entries	<i>N</i> of inbred entries (%) ^a	<i>N</i> of inbred entries (%) ^b	<i>N</i> of departments
Economics	1113	14 (1.26)	965 (86.70)	419
English	3007	81 (2.69)	2663 (88.56)	808
History	1867	35 (1.87)	1659 (88.86)	642
Mathematics	1750	57 (3.26)	1512 (86.40)	601
Political Science	1554	21 (1.35)	1368 (88.03)	495
Psychology	1833	37 (2.02)	1666 (90.89)	647
Sociology	1417	23 (1.62)	1280 (90.33)	558
Total	12541	268 (2.14)	11113 (88.61)	

^a *N* of inbred entries/raw entries.

^b *N* of valid entries/raw entries.

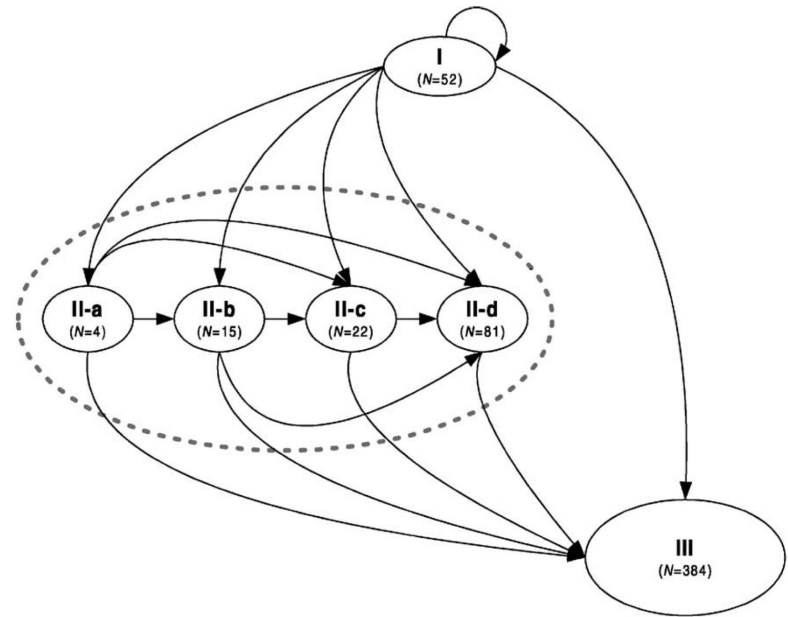


Fig. 1. Outline of feeder sequence (Sociology). [Notes: *N* refers to the number of departments classified into each class or block. Class II includes four blocks—II-a–d—encircled by dashed gray line. Arrows are drawn according to the block adjacency matrix in Table 2.]

Structure of Academic Disciplines

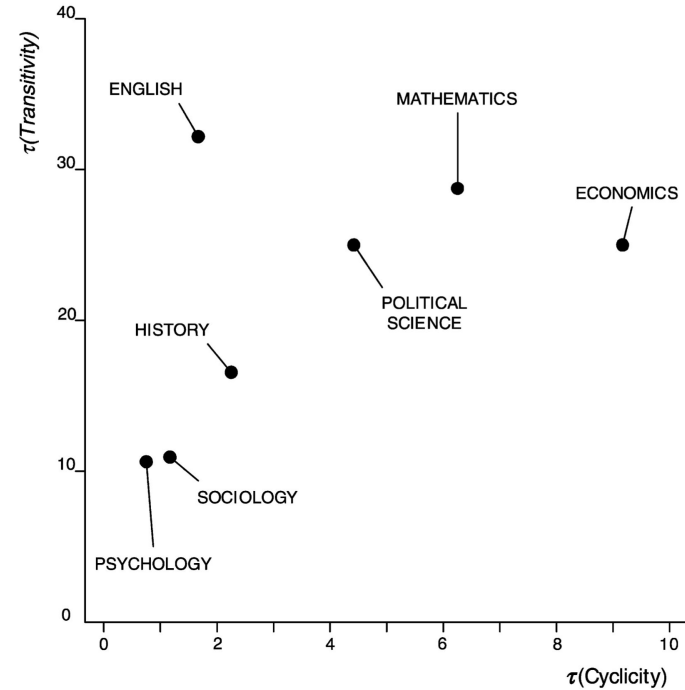
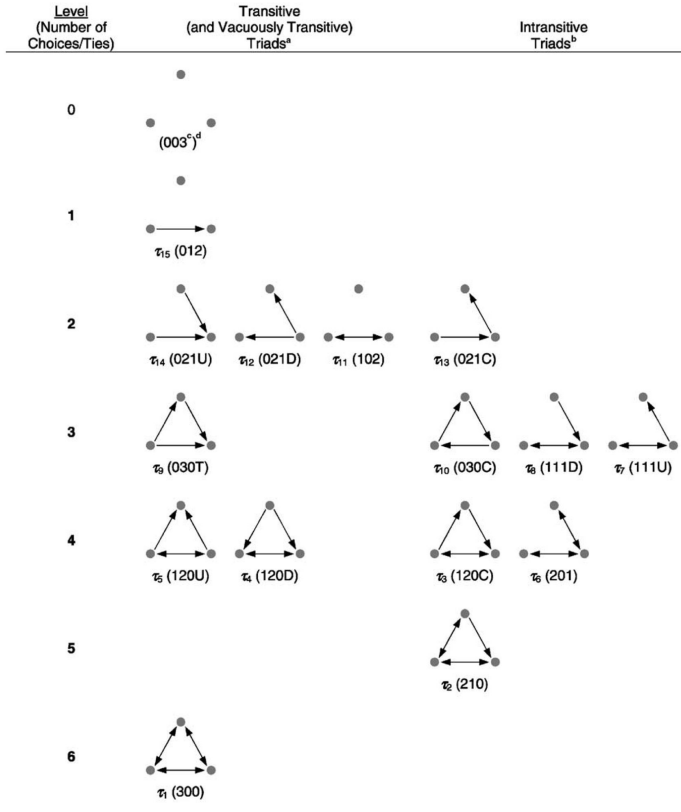


Fig. 5. Structural classification of disciplinary regimes. [Notes: The coordinates are taken from Table 6.]

Structure of Academic Disciplines

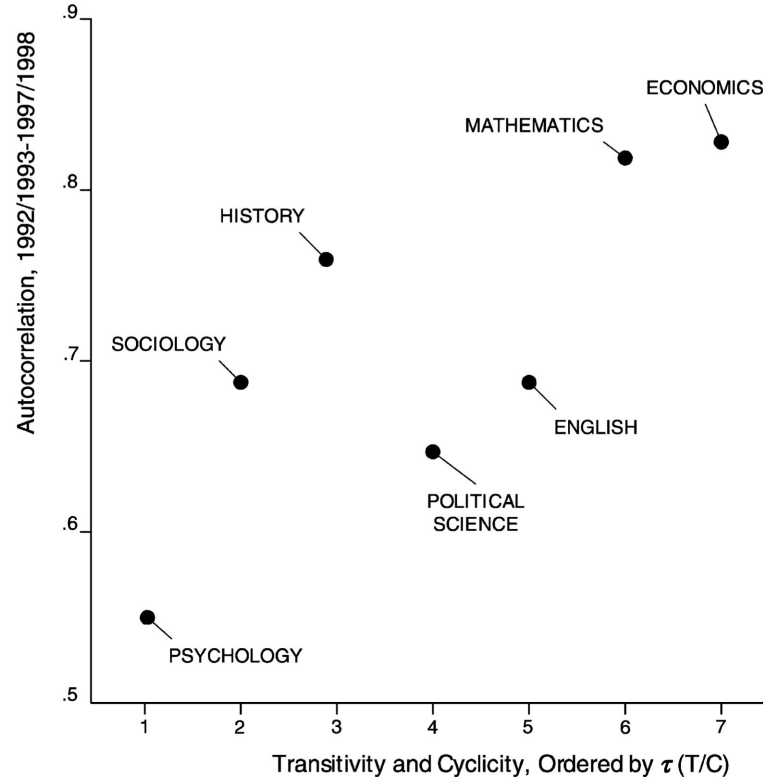
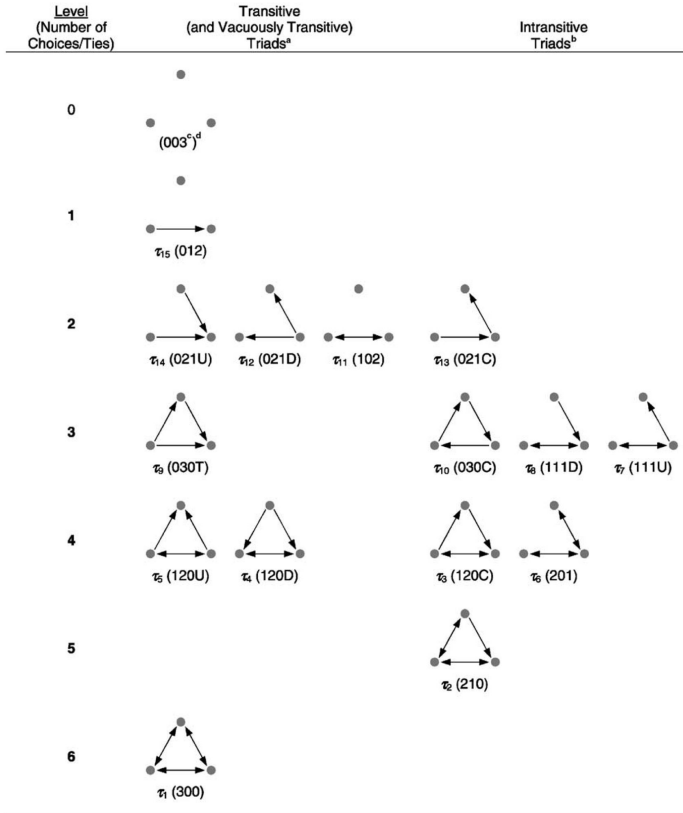


Fig. 6. Structural tendency and stability in rankings.

Structure of Academic Disciplines

Structural similarity at the macro level (almost identical block structure)

Variations in structure exist

- Sociology: low integration, high hierarchy
- Economics: high integration, high hierarchy
- These two dimensions create stability (fluctuations in ranking over time)

Q: How would computer science, physics, and engineering disciplines vary along integration and hierarchy?

Examples: Affiliation Networks

Examples of Two-Mode Networks

Political polarization and the structure of the **board interlock network**

- Longer geodesic, less cohesion

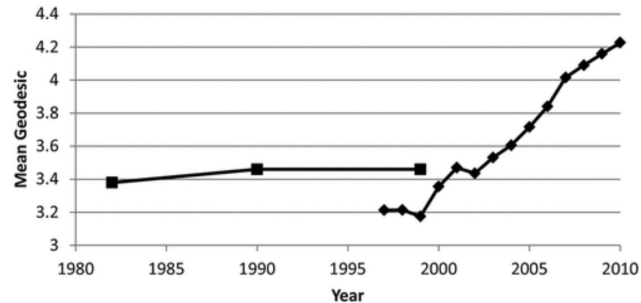


Fig. 1. Mean geodesic in main component of board interlock networks, 1982–2010. Data for 1982–99 are from Davis et al. (2003); 1997–2010, this study; study population differs across the sources.

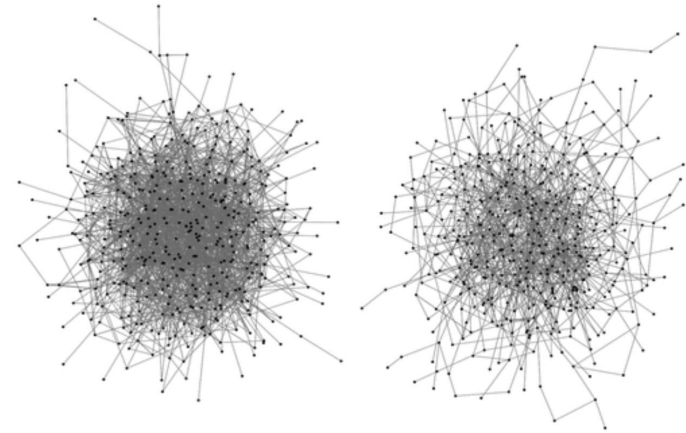


Fig. 2. S&P 500 interlock network main component, 1996 (left) and 2010 (right)

Examples of Two-Mode Networks

Political polarization and the structure of the board interlock network

- Longer geodesic, less cohesion

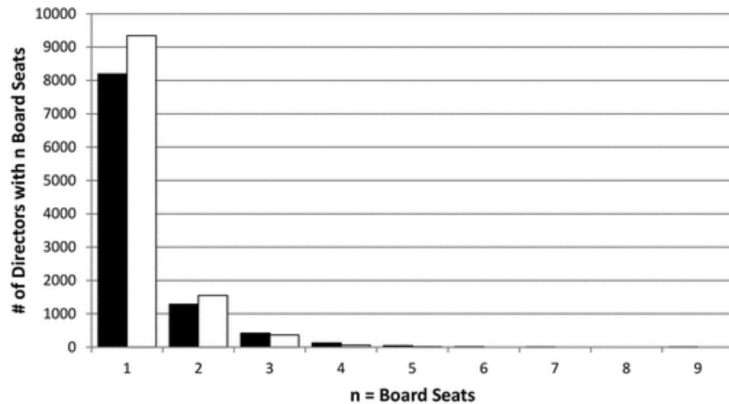


Fig. 3. Distribution of directors by number of S&P 1500 board seats, 2000 (*black bars*) and 2010 (*white bars*).

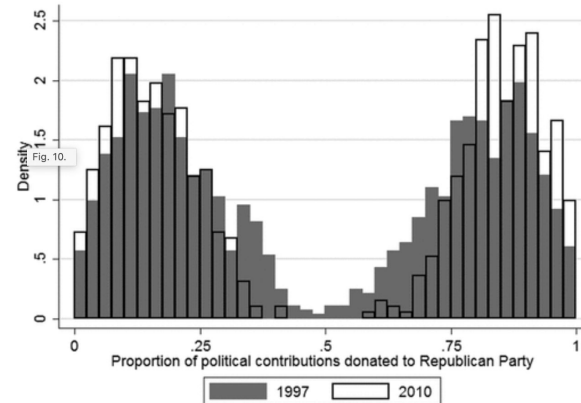


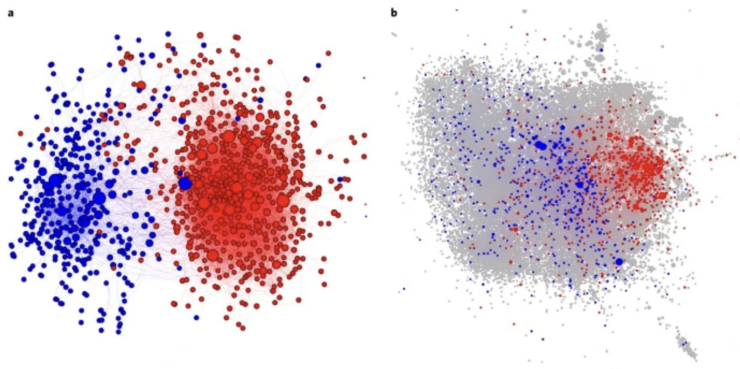
Fig. 10. Simulated distribution of number of executives by proportion of political contributions allocated to the Republican Party.

Examples of Two-Mode Networks

Is science politicized?: Partisan difference in the consumption of science

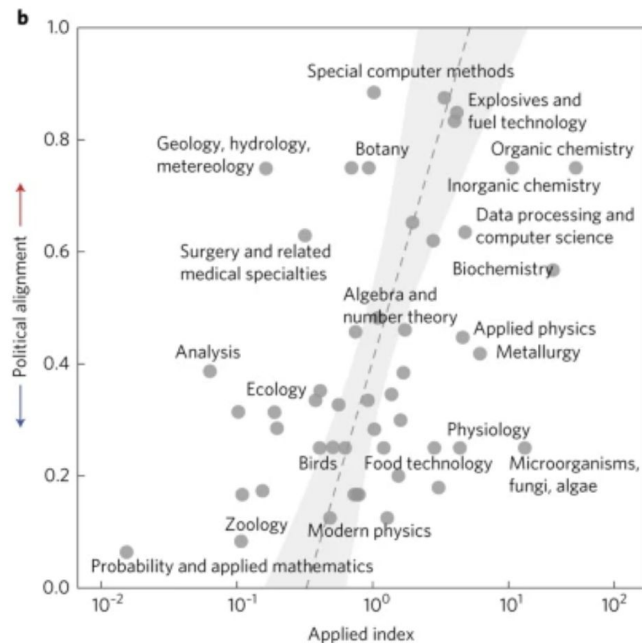
- Amazon book co-purchase data

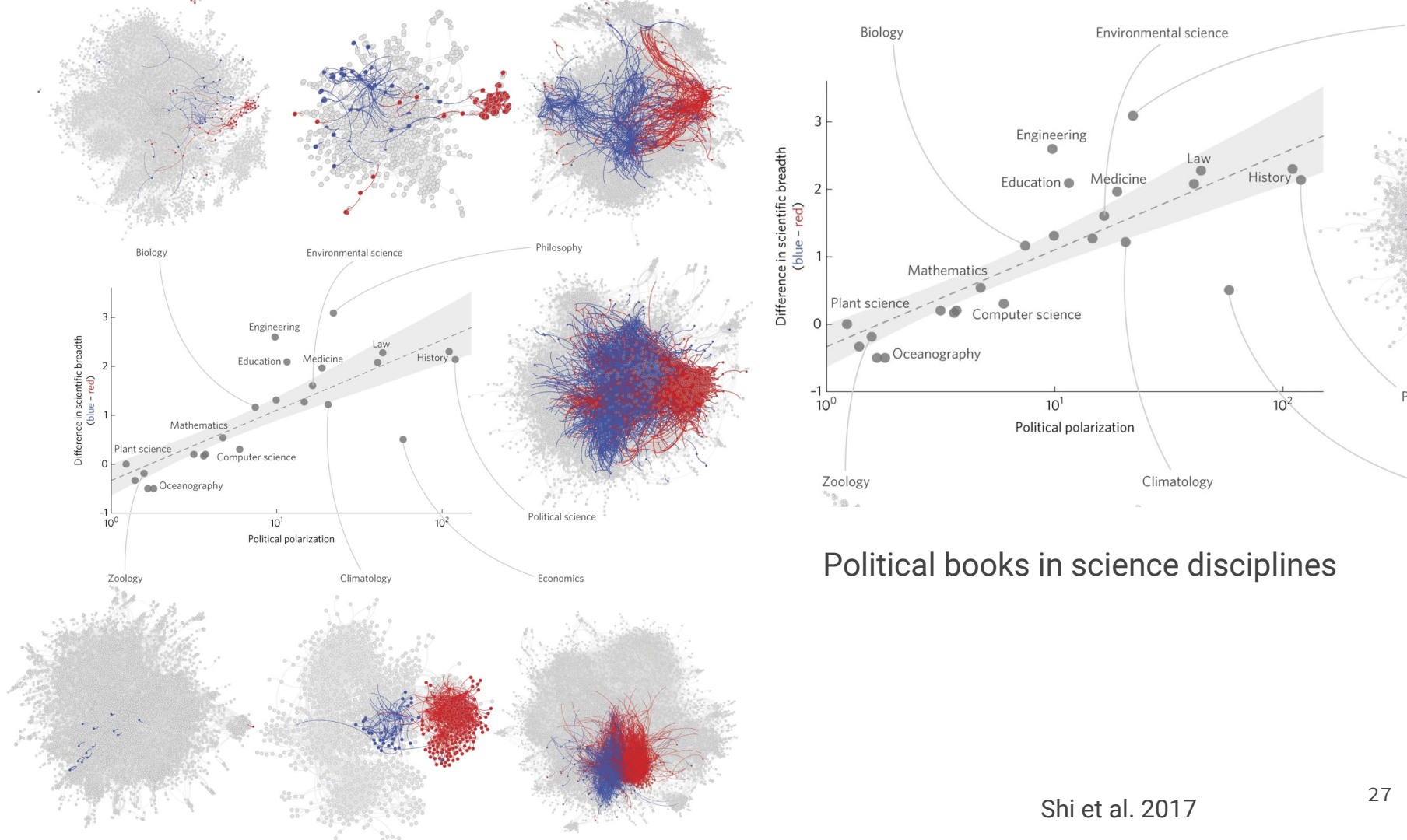
Figure 1: Visualization of the co-purchase network among liberal, conservative and scientific books.



a, Links between 583 liberal (blue) and 673 conservative (red) books. **b**, Links between these books and science (grey) books. As shown in **a**, 97.2% of red books linked to other reds and 93.7% of blue books

Shi et al. 2017



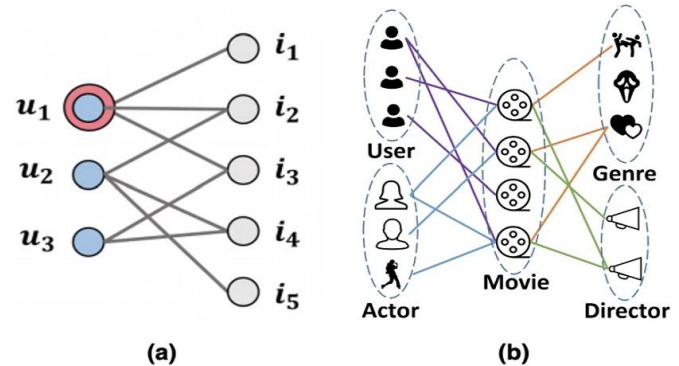
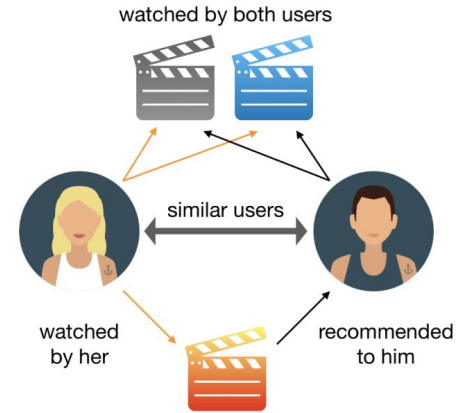


Political books in science disciplines

Affiliation networks and Prediction

Affiliation networks are also widely used to predict and recommend products to online users

- based on similarities in people's connections to artifacts (affiliations)



Summary

Affiliation networks can reveal interesting relationships on both sides of the bipartite graph.

We need to rethink many of our one-mode measures.