

Network Analysis:

The Hidden Structures behind the Webs We Weave

17-213 / 17-668

Social Capital 2: Benefits of Network Cohesion

Thursday, November 9, 2023

Patrick Park & Bogdan Vasilescu

2-min Quiz, on Canvas

When the node is the bridge

Structural holes



Ronald Burt

Extended the idea of bridging ties

- From ties to nodes
- The node is the bridge
- Emphasis on individual's agency
- Benefits that accrue to individual

Structural holes

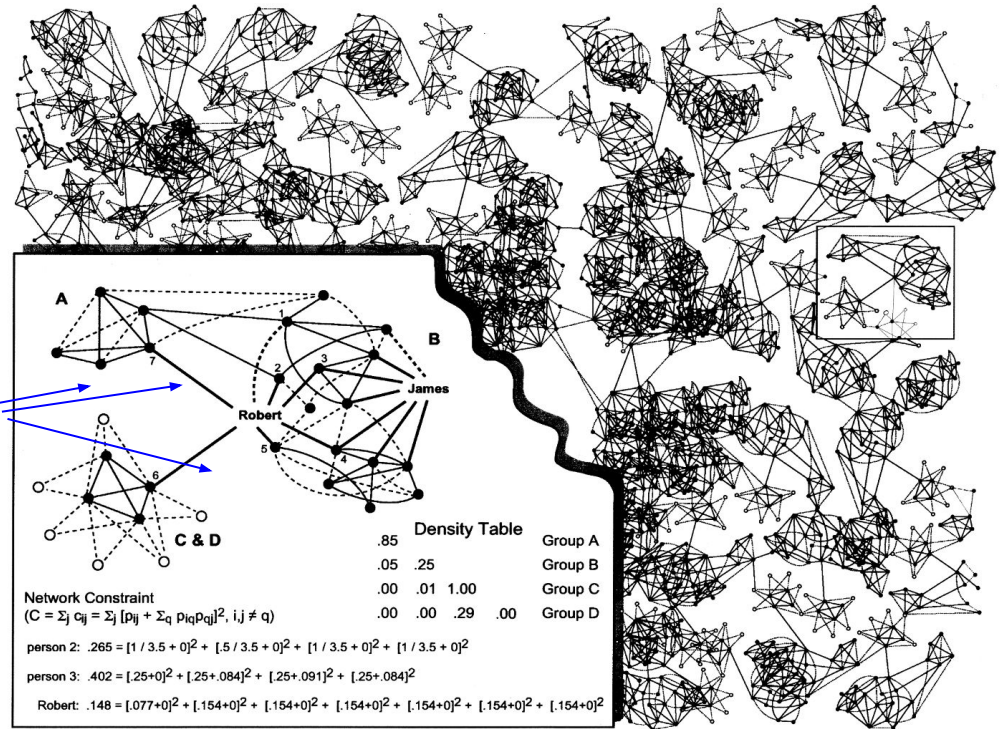


Ronald Burt

Extended the idea of bridging ties

- From ties to nodes
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Structural holes



James vs. Robert

How are their positions different?

Who spans more structural holes?

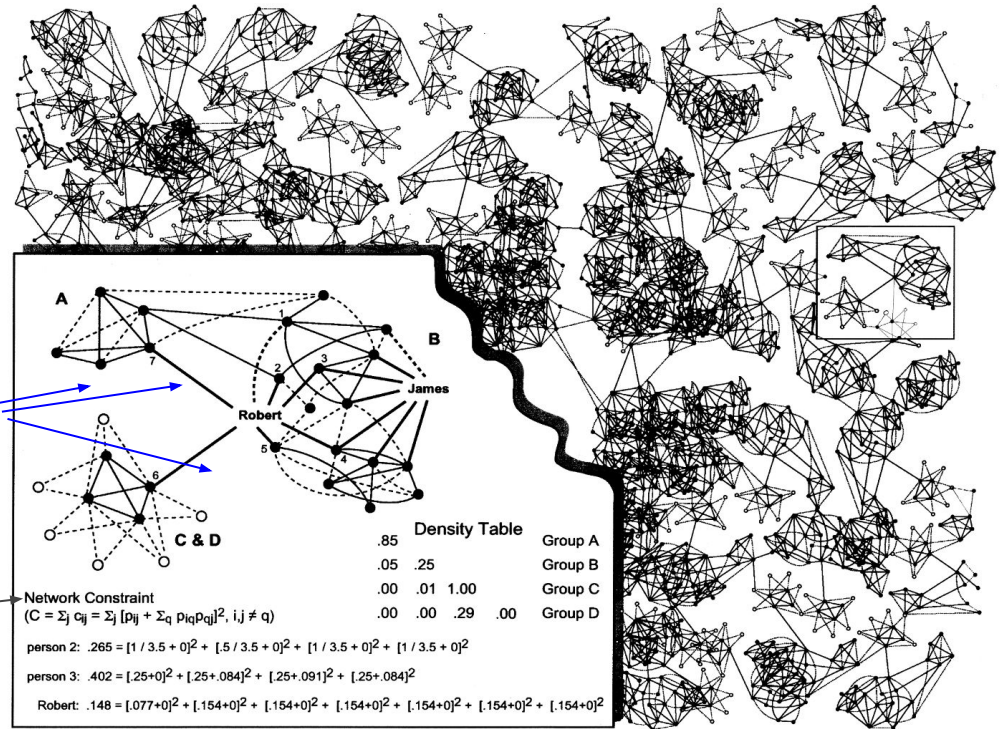
Structural holes

Structural holes create
arbitrage opportunities

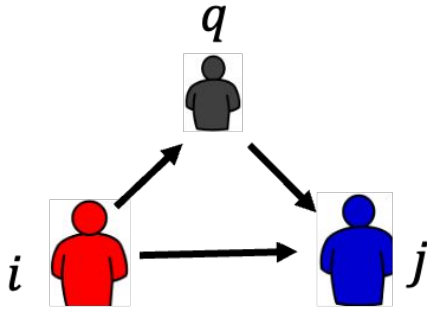
People who bridge more
structural holes have
advantages

Network Constraint quantifies
the amount of structural holes,
hence arbitrage potential

Structural holes



Relational constraints of network brokerage



$$c_{ij} = \left(p_{ij} + \sum_q p_{iq} p_{qj} \right)^2$$

i's dependence on *j*: Proportion of direct communication with *j* and the sum of the indirect communications with *j* through common neighbors, *q*

$$p_{ij} = \frac{z_{ij}}{\sum_q z_{iq}}$$
 communication with *j* relative to the sum of *i*'s total communications

$$C_i = \sum_j c_{ij}$$
 i's total constraint is the sum of *i*'s pairwise constraints

Relational constraints of network brokerage

Network constraint can be interpreted as a composite measure consisting of [size](#), [density](#), and [hierarchy](#).

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size

$$p_{ij} = \frac{z_{ij}}{\sum_q z_{iq}}$$

Larger size, less constrained

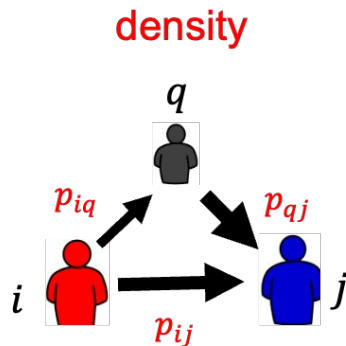
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Larger size, less constrained High density, more constrained

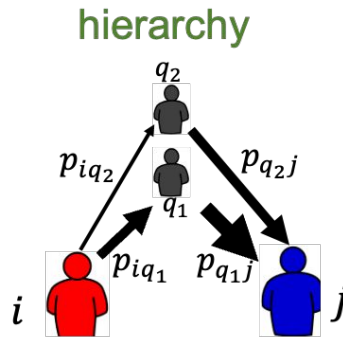
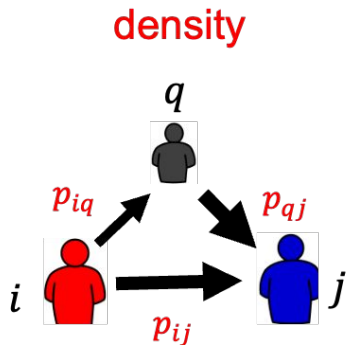
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Larger size, less constrained

High density, more constrained

Strong hierarchy, more constrained

Relational constraints of network brokerage

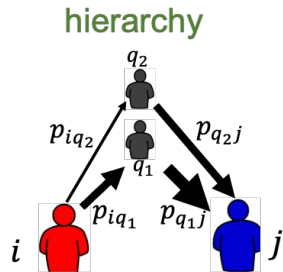
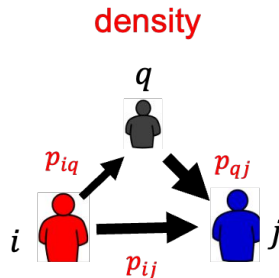
Scope condition of brokerage

- Cosimo de Medici
 - Krackhardt - Pies that torture
- Network constraint can be interpreted as a composite measure consisting of **size, density, and hierarchy**.
- Context collapse
 -

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size

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Larger size, less constrained

High density, more constrained

Strong hierarchy, more constrained

Bonding Social Capital

Social Capital in the Creation of Human Capital

Q: What is “human capital”?

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- Economic value that inheres in the **skills and experience**
- Example measure: years of education

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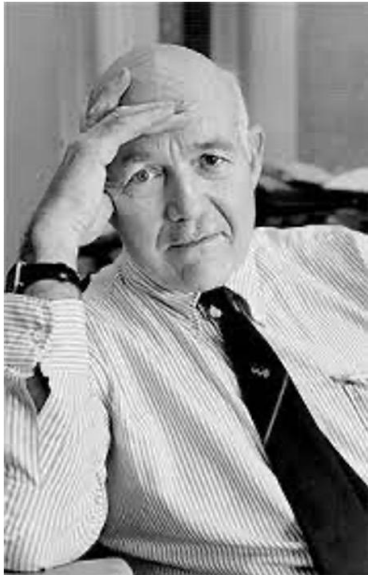
Q: What is social capital?

- Economic value that inheres in **social relationships**
- Example: bridging social capital, arbitrage, brokerage, structural holes, etc.

So far, we considered economic value that is derived from the **absence of relationships**

Social Capital in the Creation of Human Capital

Now, let's consider the social capital that comes from the **presence of relationships**



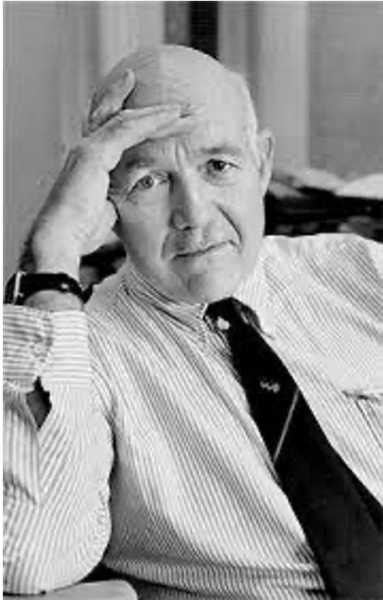
James Coleman

Mathematical sociologist

Social theorist:

- Reconciling social structure and individual rationality
- Proposed the “boat model” of social change

Explaining Social Action



What makes people act the way they do socially?

Agency: Individuals behave rationally to maximize their gains

- Economics, rational choice theory, game theory

Structure: Individuals are enabled and constrained by the social structures in which they are embedded

- Sociology, normative action, structuralism

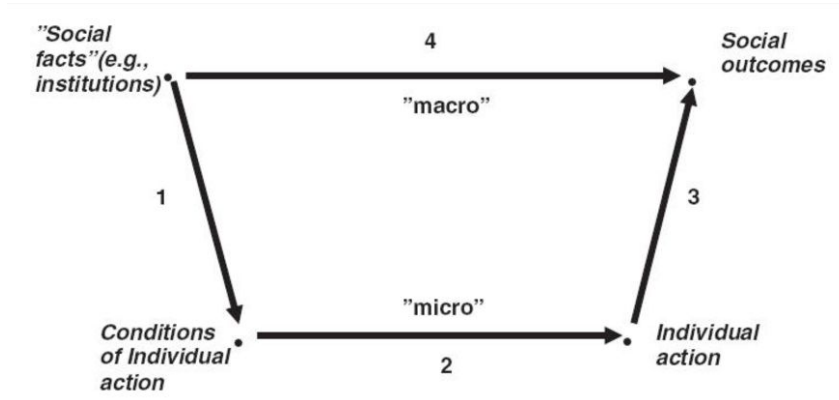
Coleman's question:

How can we combine individual agency and rationality with the social contextual contingencies that enable and constrain social actors?

Coleman's Boat Model

Given social structural opportunities and constraints, individuals calculate utility of choosing one action over another

Collective outcomes emerge from individuals' rational choices
These collective outcomes shape social structure



Coleman's idea of Social Capital

Coleman does not give a clear definition

- A concept defined by its **function**
- Inheres in the **structure of relations** between actors and among actors.
- Social capital can be a variety of different **entities** that have some aspect of social structure and **facilitate certain actions** within that structure.

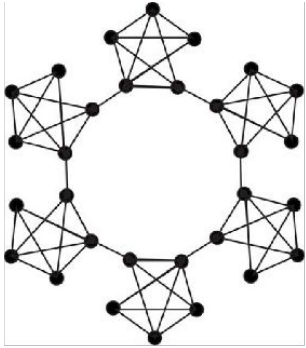
Example forms of social capital



Example 1: Obligations and expectations

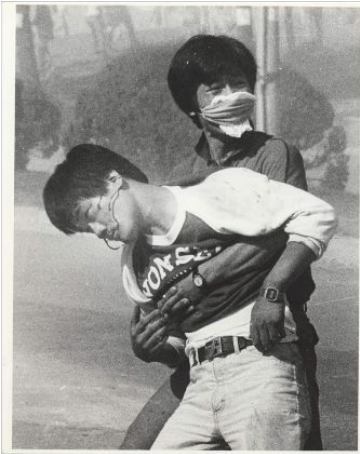
- Jewish diamond merchants
- Dense network ties ensure trust
- Multiplexity enables exchange of diverse obligations (financial vs. social support)
- Reduces transaction cost (doing business without formal contracts, lawyers, etc.)

Example forms of social capital



Example 2: Social similarity (homophily)

- Radical student organization (South Korea)
- Same hometown, high school, university
- High stakes, life vs. death
- High levels of trust required



Example forms of social capital



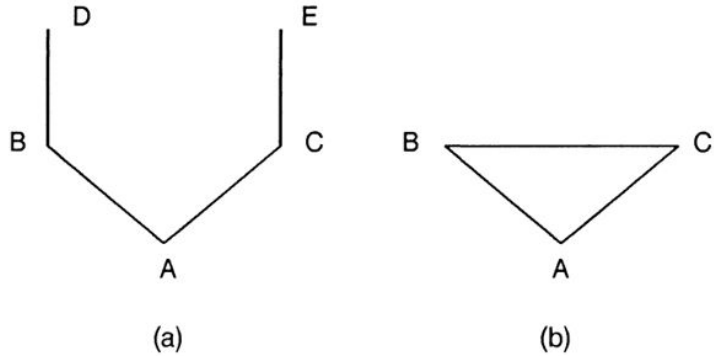
Example 3: Social norms

- Israeli parents benefit from the social norm that strangers will look after kids
- Less direct supervision required
- It takes a village to raise a child



General trust underlies the effects of social norms in the creation of social capital

Open vs. Closed Networks



Open network benefits A (left)

Closed network constrains A (right)

Open network can isolate A (left)

Closed network can offer support to A (right)

Norms can be enabling for some but
constraining for others

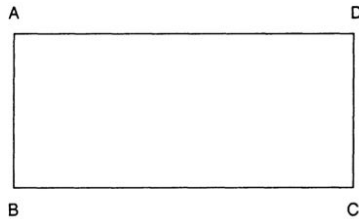
Some social structures facilitate particular
forms of social capital (e.g., open
networks offer vision advantage)

Collective sanctions are ineffective in open
structures

Open vs. Closed Networks



(a)



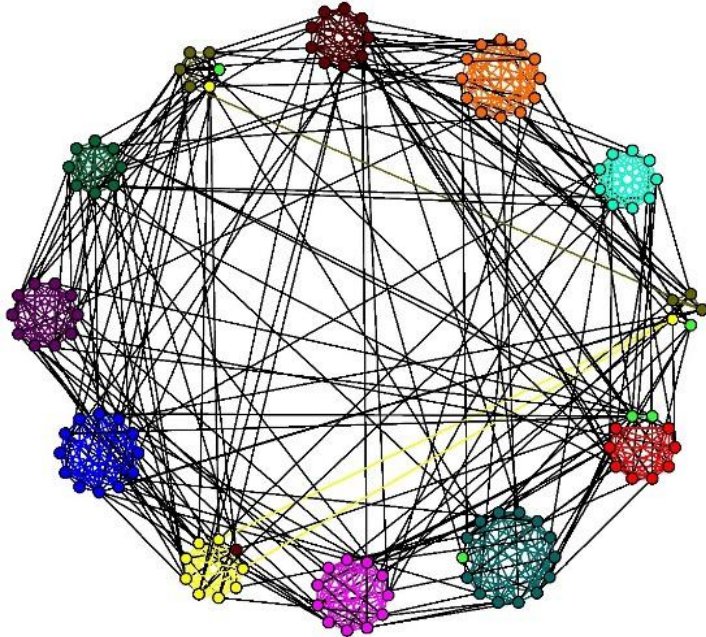
(b)

Q: What might be the benefits for **A and D** in the open network structure (top) and the closed network structure (bottom)?

Q: What might be the benefits for **B and C** in the top and the bottom network structures?

B, C are high school friends
A, D are parents

Growth in networks and social capital



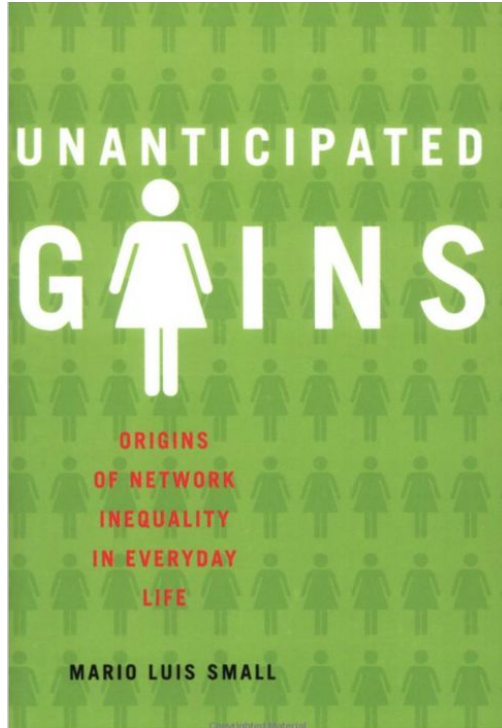
Small groups to larger groups to societies

Network density decreases, so closure becomes exponentially difficult to maintain.

Q: Then, how is social order possible?

- What inventions replace the function of closed network structures in large social entities?

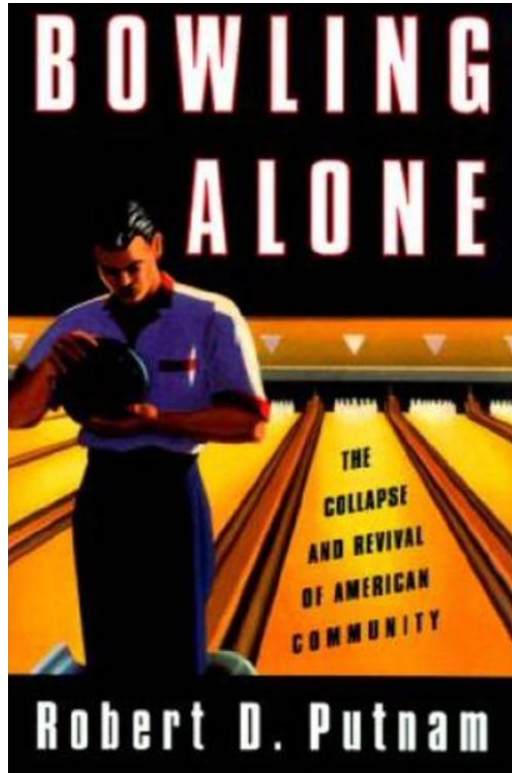
Creation of Social Capital through Relational Spillovers



Multiplex relations create spillovers in social capital

- Resources in one relationship can be appropriated for use in other relationships
- Organizations shape the context of interaction (e.g., friendly vs. competitive)
- Hence, how much people gain from their connections depends on institutional conditions
- Example: Child care center policies correlated to the size of friendship network of mothers
- The social support that mothers gained

Creation of Social Capital through Relational Spillovers



Decline of social capital in the U.S.?

Communal activity and civic engagement declined over the decades

People bowl alone, sign fewer petitions, join fewer organizations

Grassroots organizations (institutions) on the decline

Public goods aspect of social capital



Because social capital inheres in relationships:

Individuals do not have direct control over production and access

The producer may not directly or exclusively benefit



Social capital can become “privatized” as lake front beaches become private residences

- Examples: ?

Connectivity of the network as social capital

In network measurement, bonding social capital is conceptually related to density and triangles of the network

Others have proposed connectivity as another conception of bonding social capital

- Structural cohesion

Connectivity of the network as social capital

A cohesive network:

- Is robust to removal of ties
 - component size does not change significantly
- Is effective in transmitting information while minimizing attrition, distortion of information from node A to node B
 - multiple paths through which information can flow, such that attrition in one path does not affect transmission

“A group is structurally cohesive to the extent that multiple independent relational paths among all pairs of members hold it together.”

Connectivity of the network as social capital

k-Components

- Maximally connected component where every node is connected to every other node through k or more paths
- A set of nodes that breaks into subcomponents with the removal of at least k nodes

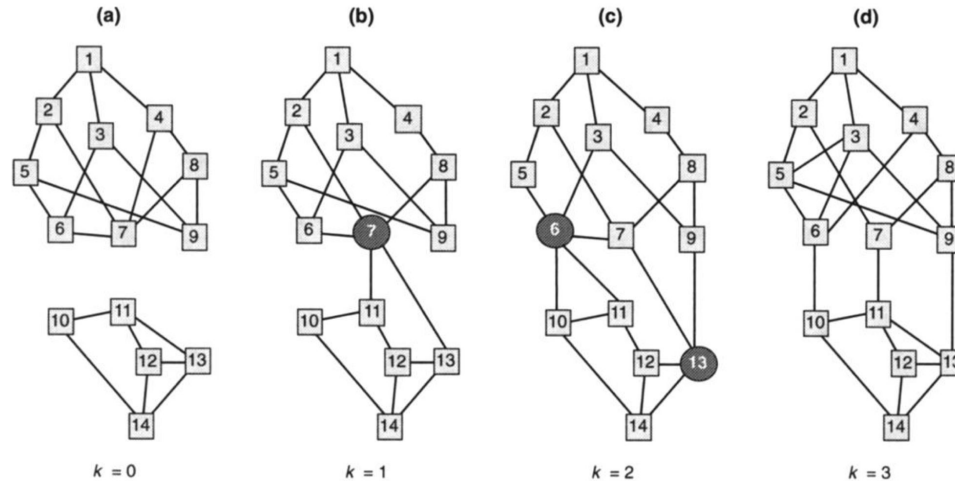


Figure 1. Examples of Connectivity Levels

Connectivity of the network as social capital

$k+1$ -Components are nested in k -components

Example: bicomponent is a subset of nodes in a component

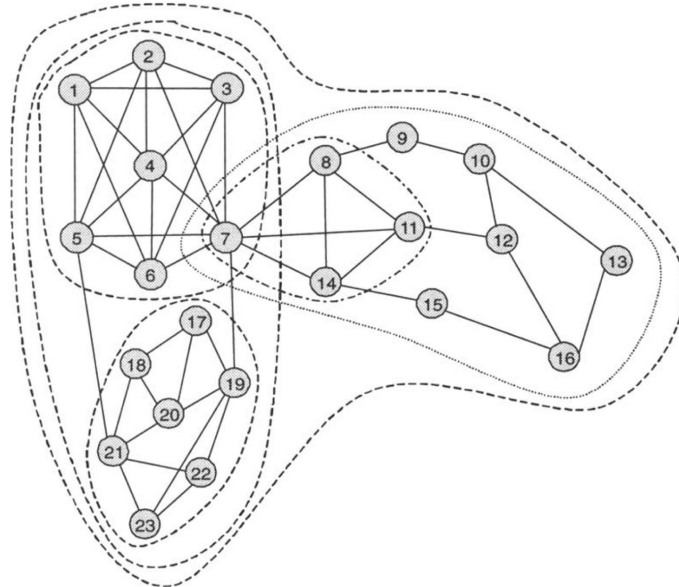


Figure 2. Nested Connectivity Sets

Connectivity of the network as social capital

If the size of the $k+1$ component sharply diminishes relative to the k -component, this indicates low structural cohesion at the level of k

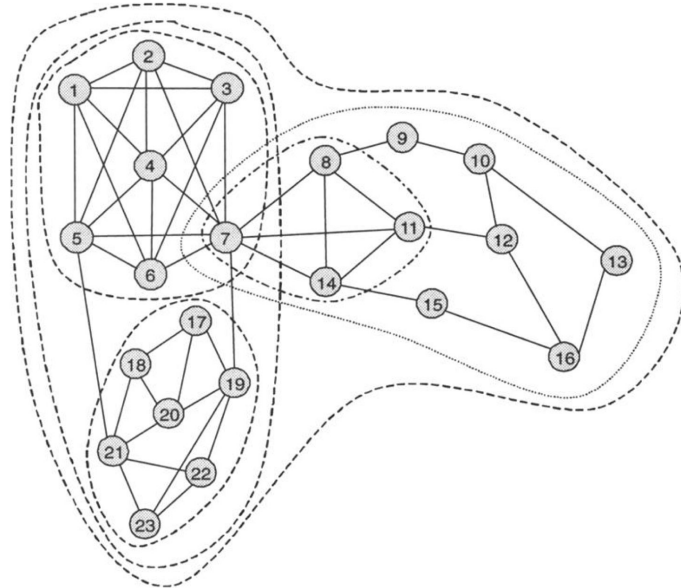


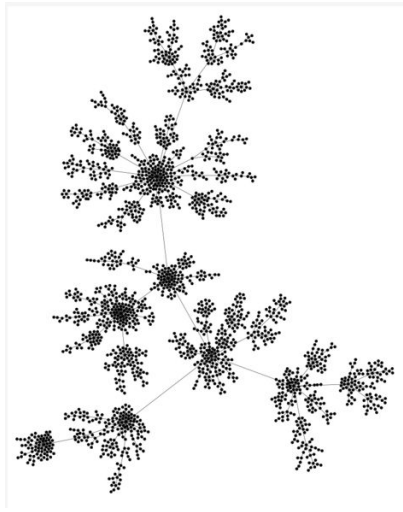
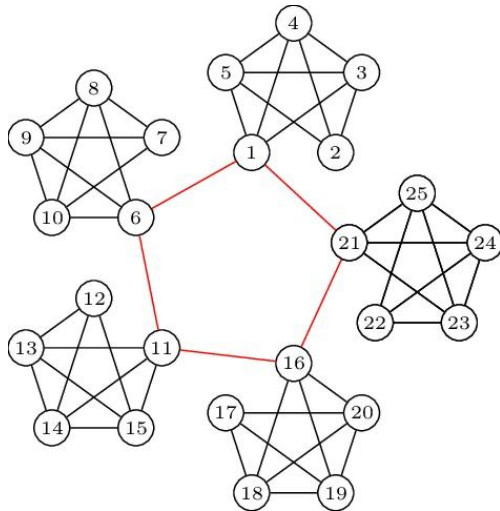
Figure 2. Nested Connectivity Sets

Example: Coauthorship network in sociology

Sociology is an extremely diffuse discipline

Some speculated that the structure of sociology consists of isolated components: Subfields do not talk to each other much

→ Sociology is a connected caveman graph

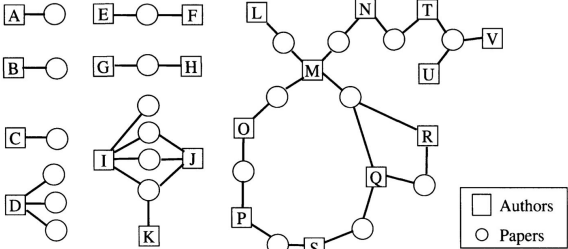


Example: Coauthorship network in sociology

Sociology is neither scale-free nor caveman-like

Structural cohesion characterizes coauthorship network

a) Individual Publications



b) Collaboration Network

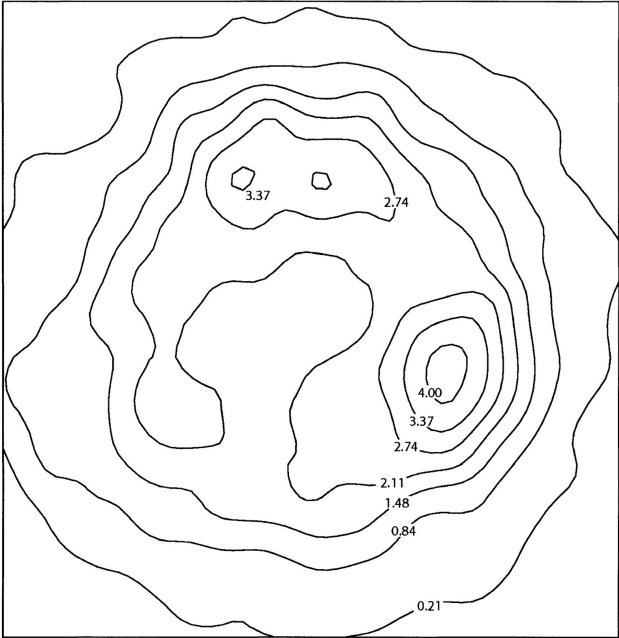
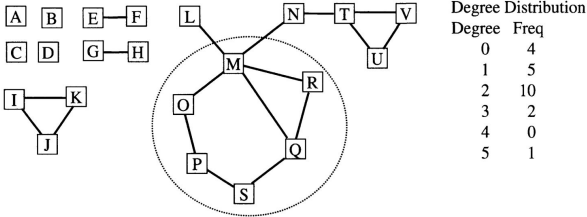


Figure 2. Constructing Collaboration Networks

Summary

Random Networks

Bonding social capital inheres in the community

Alternative conceptions of bonding social capital → Structural cohesion (k-components)