Empirical Methods (17-803)

Introduction to Social Networks
Fall 2022

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Benefits of Network Diversity

Egonetwork level

One's diverse egonetwork can be more beneficial

Subgroup level

Team with diverse members perform better

Network level

Network with diverse connections are more robust

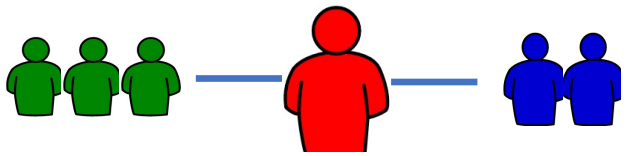
Today is about the local level (egonetwork and tie level)

Two Related Concepts

Network Bridging

- A shortcut that connects otherwise separated social contexts.

- Bridging ties are the conduits through which non-redundant information can flow through.



Network Brokerage

- The separation among one's alters
- Alters likely come from different social groups

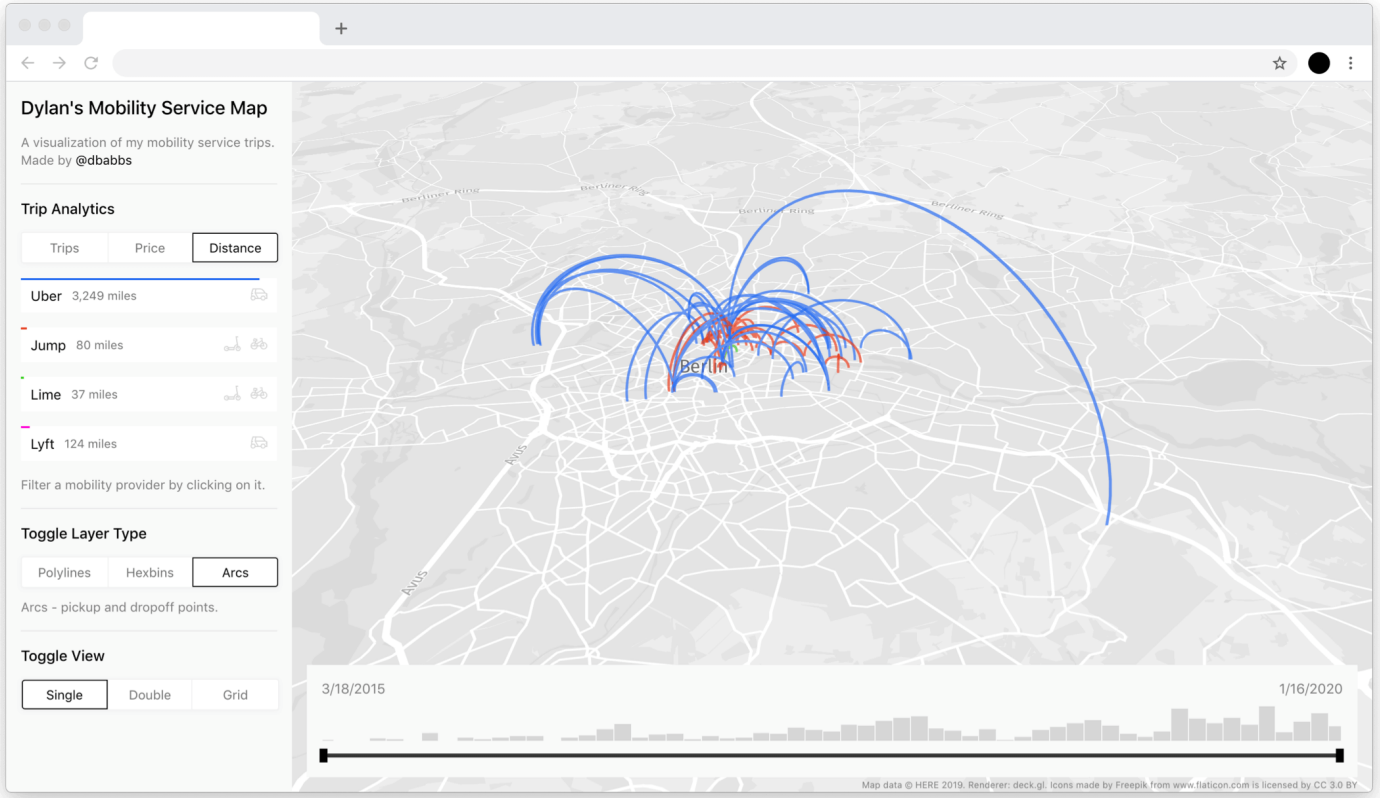
Two Related Concepts

Silk road was a socio-cultural, geographical bridge

Bridging and brokering are closely related ideas.

From a community's perspective, a **bridging** tie that connects to a far away community can bring diversity to the community (ideas, information, etc.)

Two Related Concepts



An individual bridges/brokers different communities

An individual **brokers** different communities and groups.

Information and other resources flow through the individual from one group to another

Network Bridging

Mark Granovetter

Dissertation: *Getting a Job*

- Strength of weak ties: explaining the puzzling finding of job information acquisition through acquaintances, not close friends
- Benefits bridging to individual and group

One of the most cited papers in the social sciences

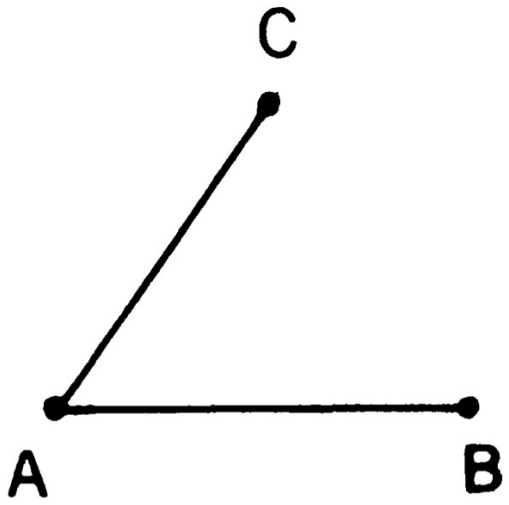
Network Brokerage

Ron Burt

Extended the idea of bridging ties

- From ties to nodes
- Emphasis on individual's agency
- Benefits that accrue to individual

Bridging Ties

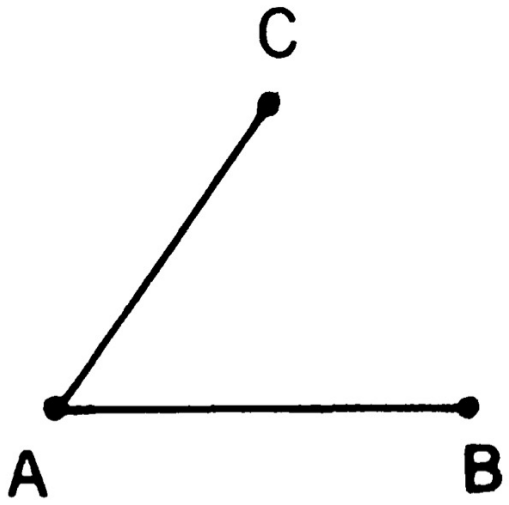


- Tie strength: interaction frequency, reciprocity, emotional intensity

- Forbidden triad: Due to people's desire for cognitive balance, one is likely to form a strong relationship with a close friend's close friend.

- Hence, a triad with only two "strong" ties are not likely. Because strong ties have the tendency to close the triad, they are not likely to be bridging ties.

Bridging Ties



- On the other hand, acquaintances, or weak ties do not have embedding tendency

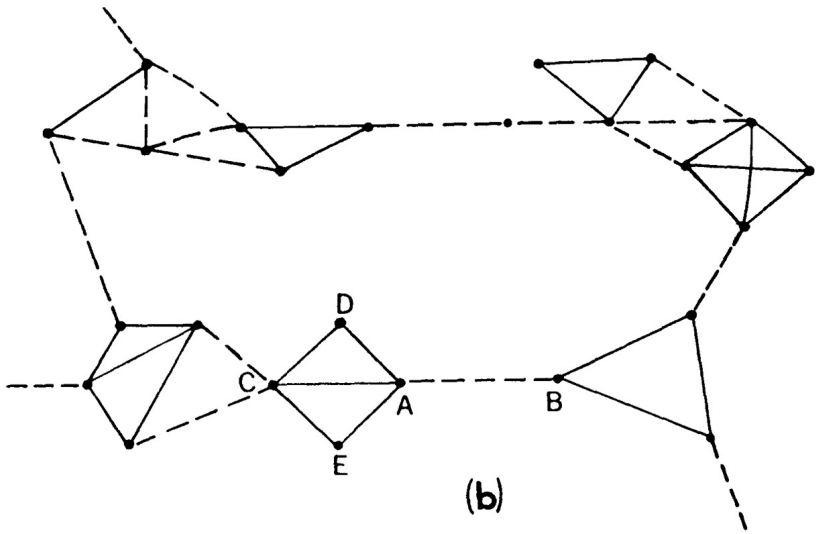
- There is much less psychological need for cognitive balance

- Weak ties interact infrequently, so less chance to form common neighbors.

- Hence, Weak ties are more likely to be bridges.

- Key assumption:
Strong ties are embedded, weak ties are bridging

Local Bridges



Granovetter created a measure of bridge length → “Local bridge of degree *n*”

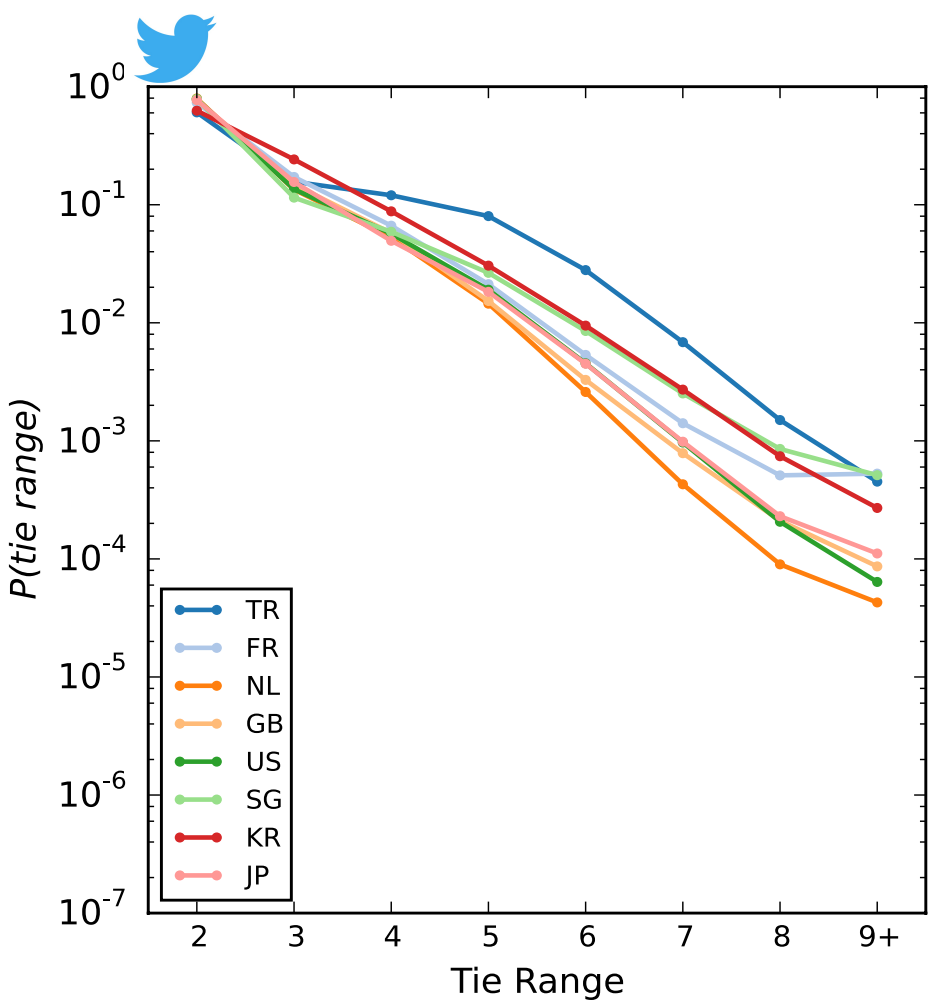
Bridge length of the A-B tie:

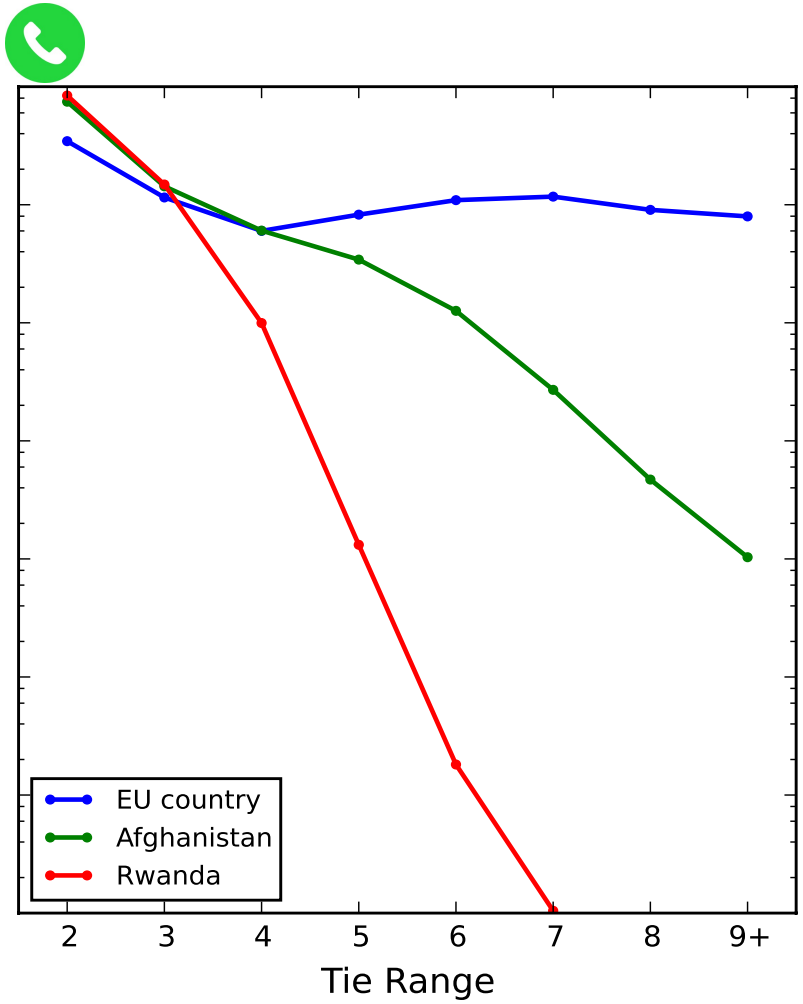
- second shortest path length

This measure requires global network information, unmeasurable before internet

Weakness of ties was a good proxy for bridging ties

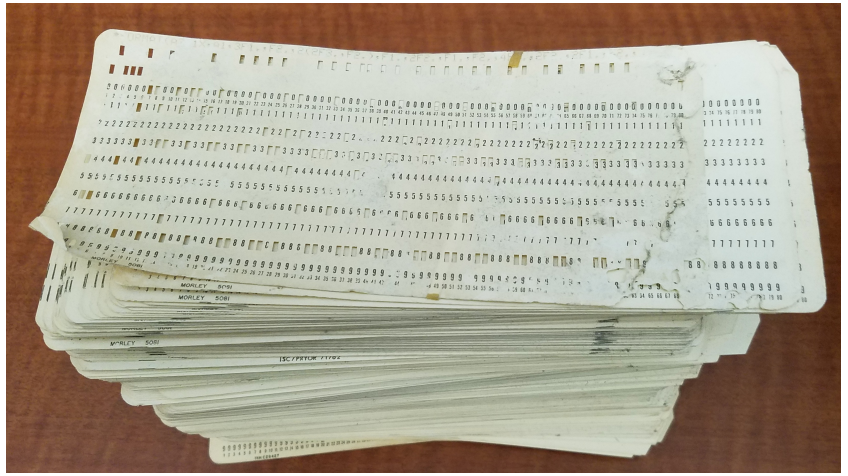
Long-Range Ties Are Rare





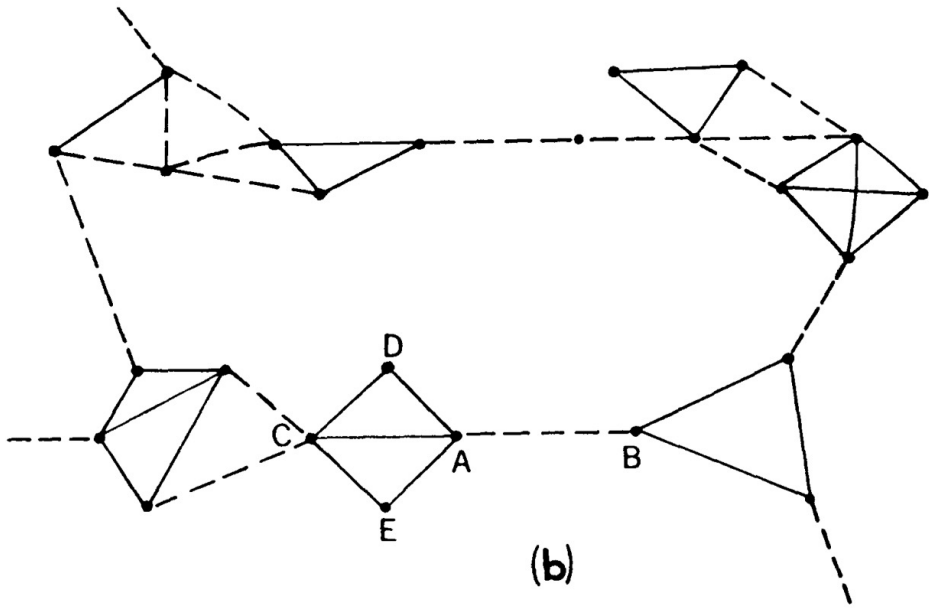
Granovetter would not have discovered globally long bridging ties

Weak Ties and Getting a Job



- From his dissertation work at Harvard, Granovetter discovers that people tend to find new job opportunities through acquaintances rather than close friends.

Continuing Debates

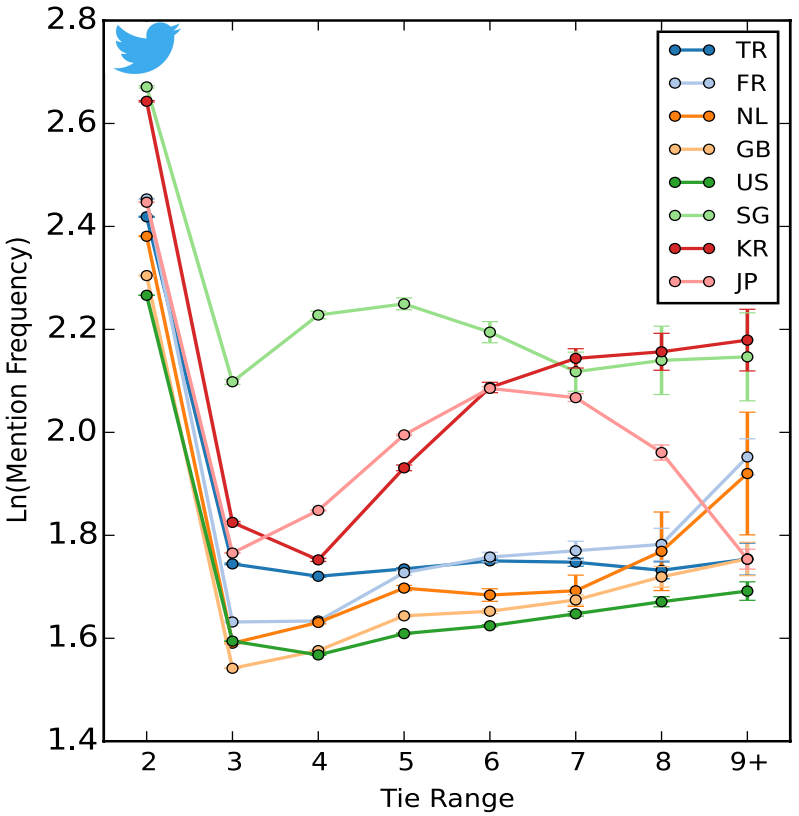


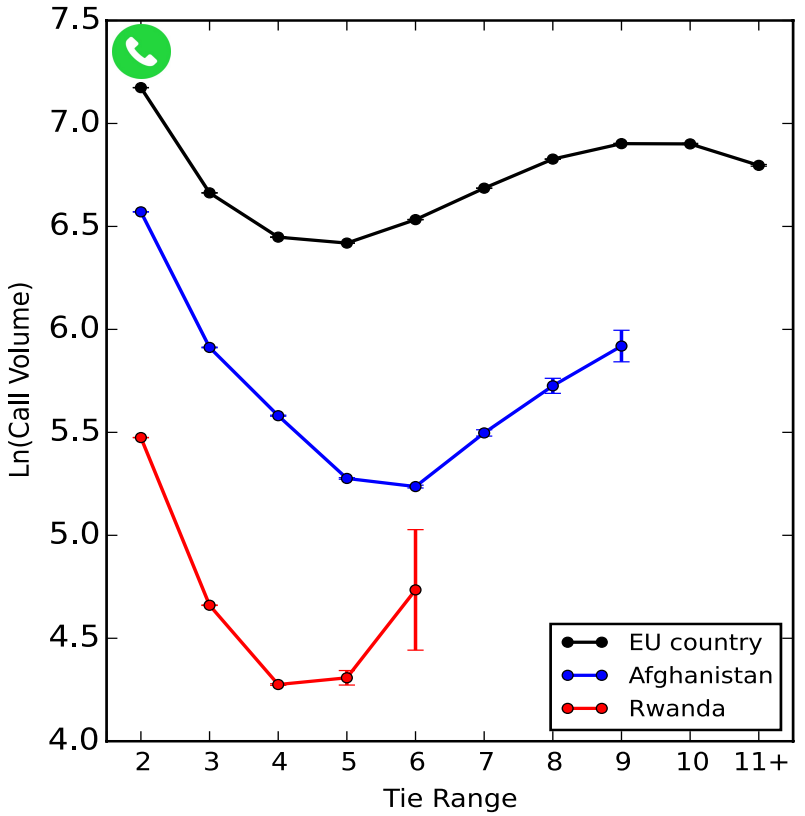
Getting a job with weak ties

A Facebook study finds that a person is most likely to eventually work with a weak tie because weak ties collectively make up most of a person's social network. However, **strengthening an existing tie increases the probability that one will work with that specific friend**.
(Gee et al. 2017)

A LinkedIn study finds that **weak ties are effective** for job transmissions, but diminishing returns to tie weakness.
(Rajkumar et al. 2022)

Continuing Debates





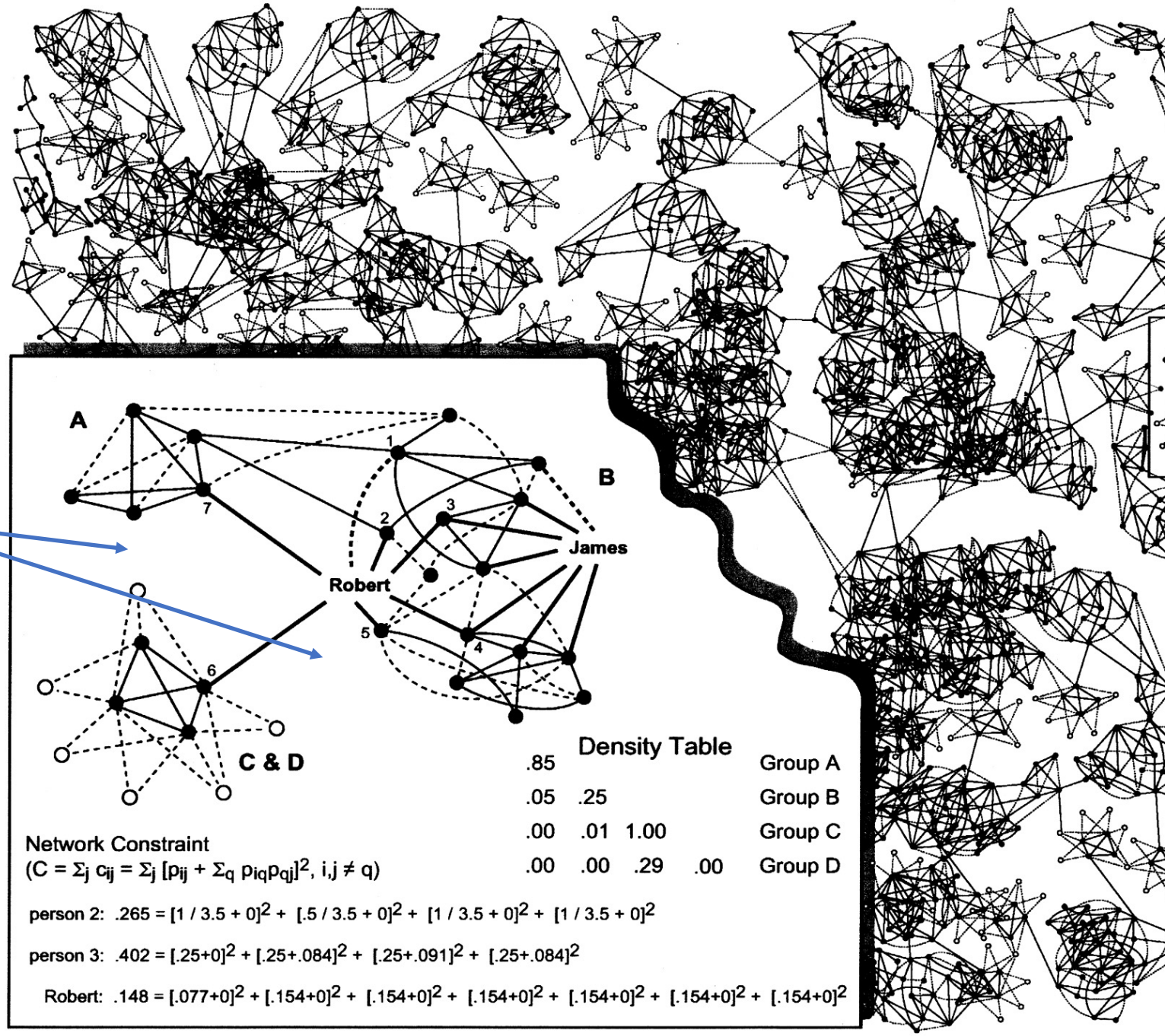
Bridging ties are not necessarily weak

Brokerage

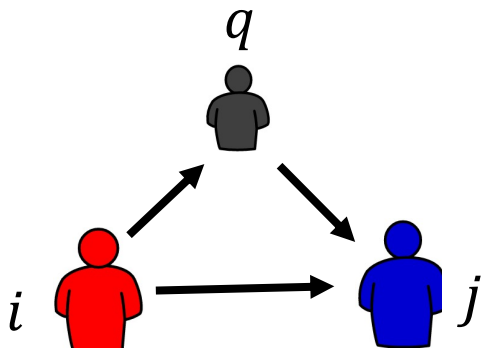
Structural hole

James vs. Robert

How are their positions different?
Who spans more structural holes?



Network Constraint



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

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

Network Constraint

Network constraint can be interpreted as a composite measure consisting of size, density, and hierarchy.

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$$c_{ij} = {p_{ij}}^2 + 2\left(p_{ij}p_{iq_1}p_{q_1j} + p_{ij}p_{iq_2}p_{q_2j} + \cdots\right) + \left(p_{iq_1}p_{q_1j} + p_{iq_2}p_{q_2j} \ldots\right)$$

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size

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

Larger size, less constrained

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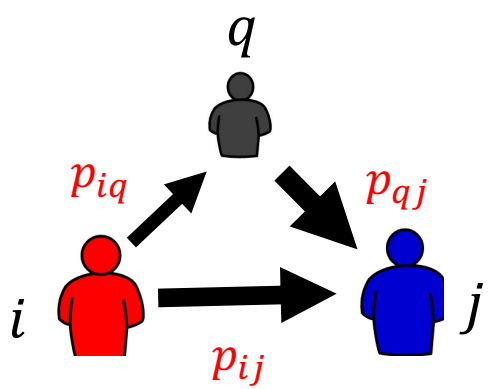

Larger size, less constrained

High density, more constrained

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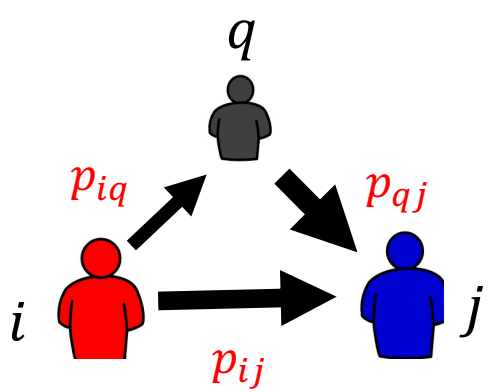
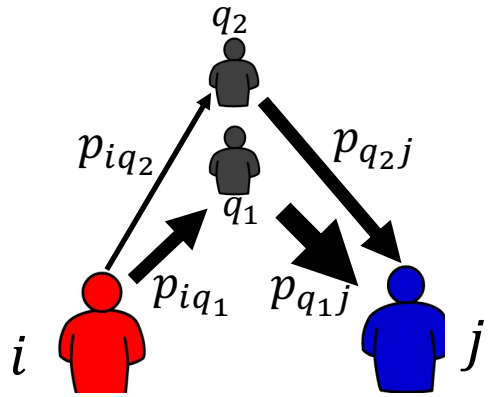
Larger size, less constrained

density



High density, more constrained

hierarchy



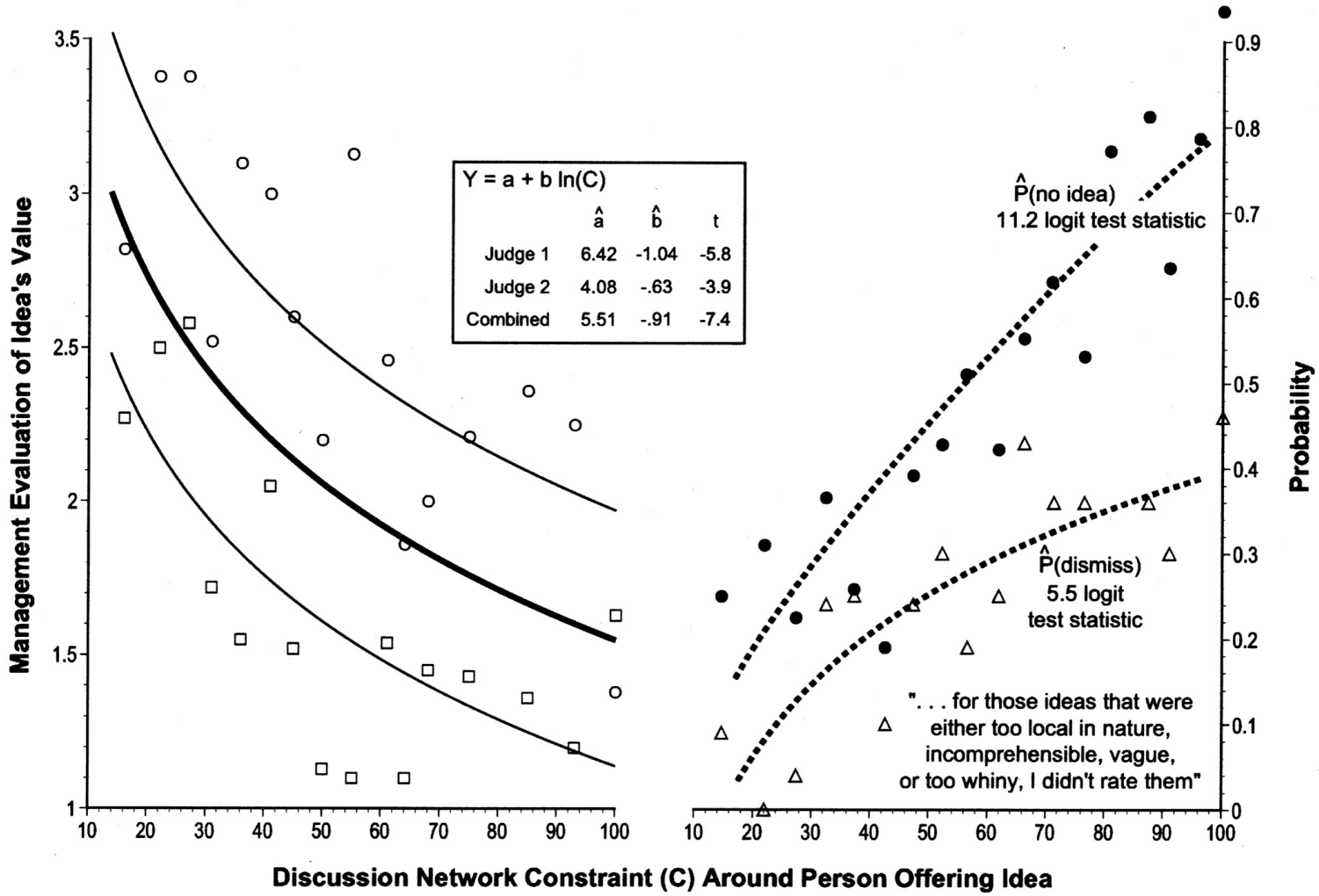
Strong hierarchy, more constrained

Structural Holes and Good Ideas

Vision Advantage Hypothesis

People whose networks span structural holes have early access to diverse, often contradictory, information and interpretations, which give them a competitive advantage in seeing good ideas. Hence, brokerage should be associated with good ideas.

Structural Holes and Good Ideas

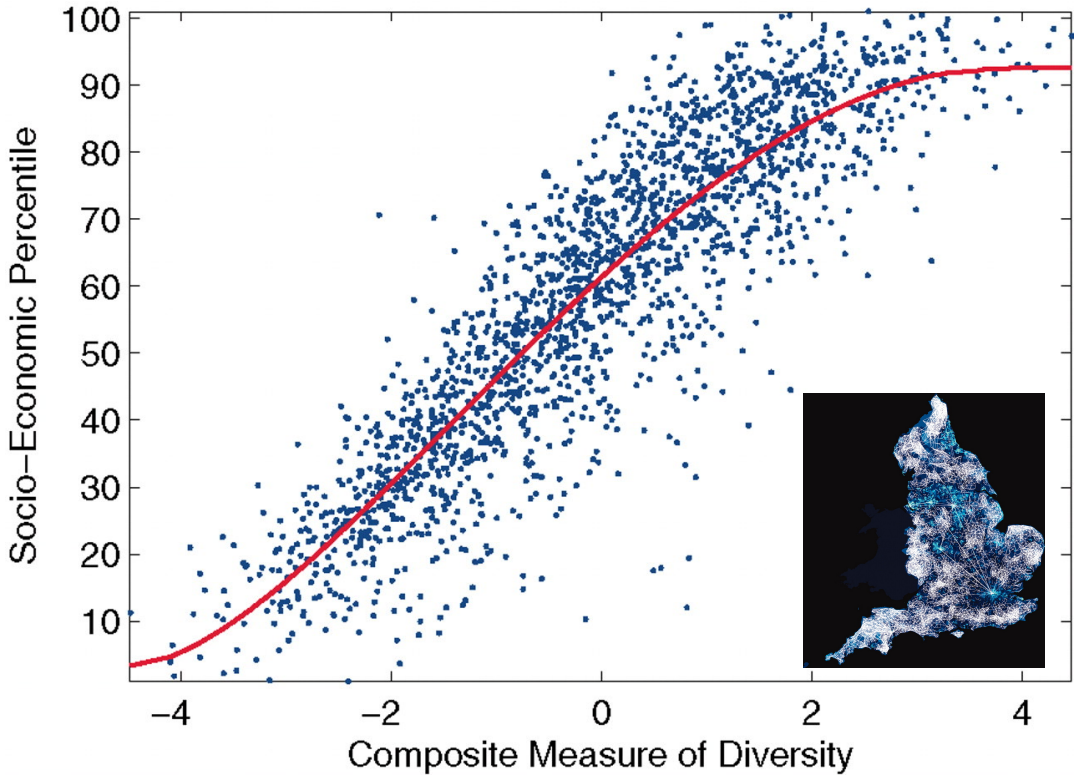


Structural Holes and Good Ideas

	1 Salary		2 Salary		3 Evaluation		4 Promotion	
Manager 1	−31,099**	(2,882)	−35,707**	(3,498)	−.973	(.678)	.689	(.670)
Manager 2	−16,652**	(2,745)	−19,892**	(3,479)	−.863	(.631)	1.165	(.648)
Manager 3 (reference)	. . .		. . .		. . .		. . .	
Sr. manager	19,638**	(3,782)	15,484**	(4,143)	.116	(.843)	−.635	(.885)
Executive	65,394**	(4,522)	61,930**	(4,835)	.423	(1.01)	.221	(1.08)
Purchasing	754	(1,351)	1,811	(1,884)	.410	(.313)	.478	(.345)
Age	338**	(52)	300**	(71)	−.085**	(.013)	−.084**	(.013)
Bachelor	1,610	(1,003)	200	(1,401)	−.211	(.237)	.118	(.240)
Graduate	734	(864)	−451	(1,155)	−.208	(.203)	.182	(.204)
Hightech	3,516**	(880)	3,150*	(1,189)	.087	(.209)	.162	(.210)
Lowtech	−6,927**	(1,481)	−6,607*	(2,375)	−.351	(.342)	−.409	(.378)
Urban 1	3,613**	(1,046)	3,947**	(1,456)	.423	(.247)	−.152	(.252)
Urban 2	5,049**	(1,010)	5,585*	(1,427)	−.564	(.238)	−.052	(.243)
Network constraint	−7	(25)	−1	(38)	−.014**	(.004)	−.022**	(.006)
Mgr2 × constraint	−19	(35)	−47	(58)	.004	(.008)	−.008	(.009)
Mgr3 × constraint	−47	(38)	−159*	(59)	−.007	(.009)	.003	(.009)
SrMgr × constraint	−214*	(75)	−216*	(84)	−.005	(.017)	.010	(.019)
Executive × constraint	−681**	(124)	−697**	(132)	−.011	(.028)	.024	(.030)
N	673		398		673		638	

Constraint is bad especially for leadership positions

Brokerage



Brokerage positions are beneficial beyond organizations

- United Kingdom phone data
- Average constraint score at phone area code level correlates with the area's economic development

Brokerage

Critique to structural hole theory:
Simmelian Ties

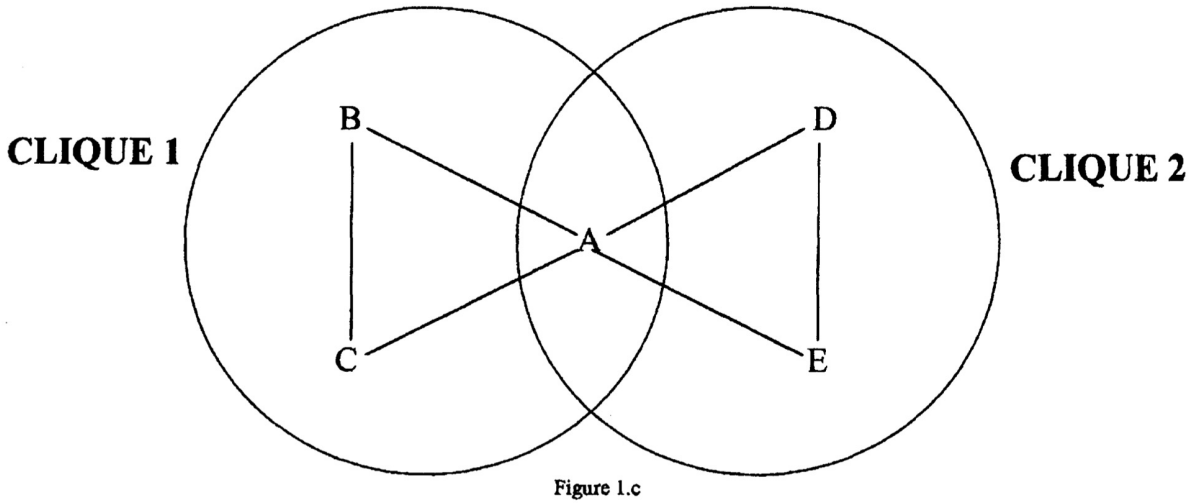


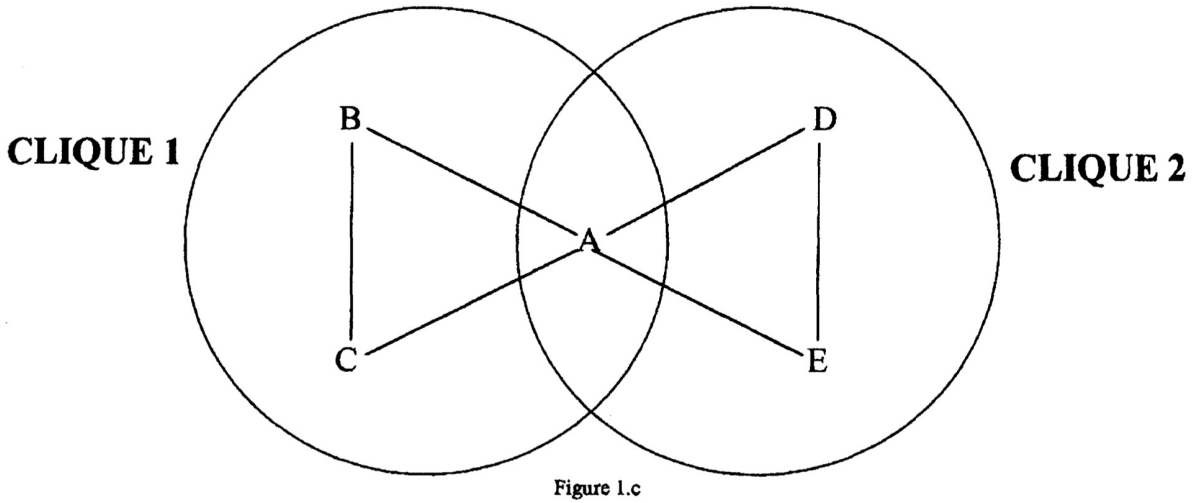
Figure 1.c

Constraints on A in Figure 1.c: must satisfy two cliques' sets of norms: $s1 \cap s2$

(Krackhardt, 1999)

Brokerage

Critique to structural hole theory: Simmelian Ties



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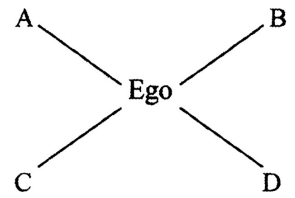


Figure 2.a

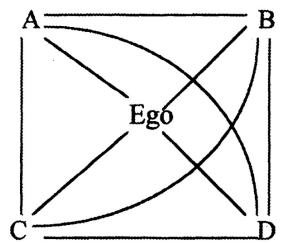


Figure 2.b

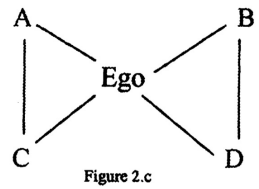


Figure 2.c

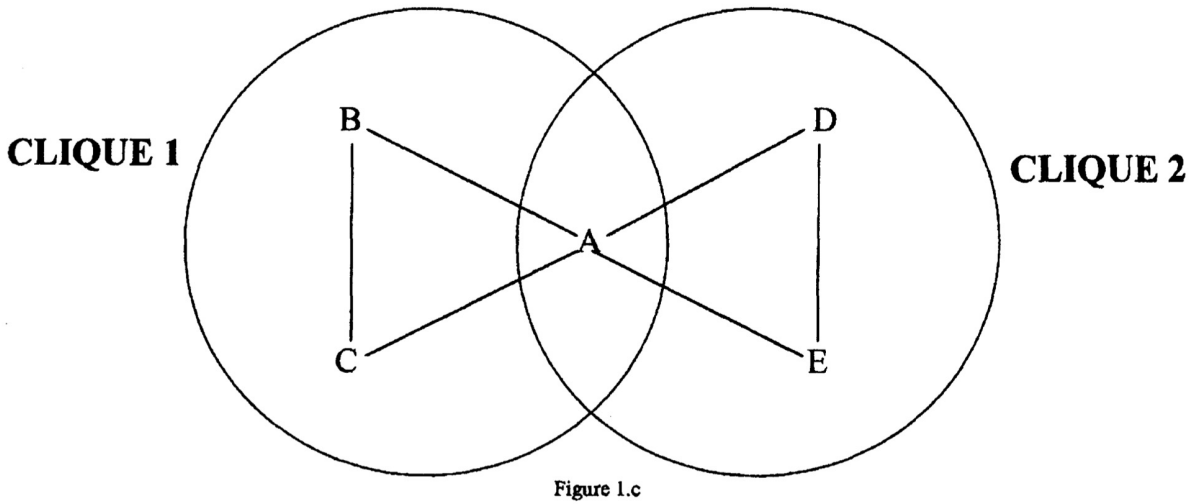
Figure 2. Constraint on Ego According to Structural Holes vs. Simmelian Tie Theories

Which is least constraining?

Which is most constraining?

Brokerage

Critique to structural hole theory: Simmelian Ties



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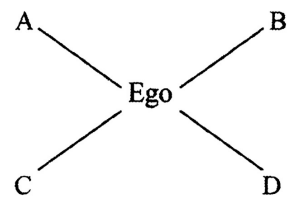

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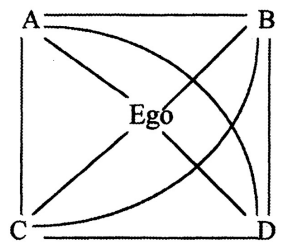

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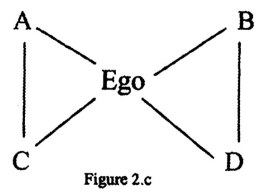


Figure 2.c

	Burt's Structural Hole Theory	**Simmelian Tie Theory**
Figure 2.a	Least Constrained	Least Constrained
Figure 2.b	Most Constrained	Somewhat Constrained, but only by 1 Clique
Figure 2.c	Somewhat Constrained, but also empowered as bridge between 2 Cliques	Most Constrained, must satisfy 2 Cliques

Figure 2. Constraint on Ego According to Structural Holes vs. Simmelian Tie Theories

Predicting Romantic Relationships

Backstrom and Kleinberg (2014)

Textbook case of combining:

- deep consideration about the nature of the tie (romantic) and
- corresponding metrics construction

Nature of the Romantic Tie

Recall from Wellman and Wortley

Intimate ties (psychology):

- a sense of intimacy, voluntary investment in the tie and companionship
- an interest in **being together** as much as possible through interactions **in multiple social contexts** over a long period
- a sense of **mutuality** and support for partner's needs

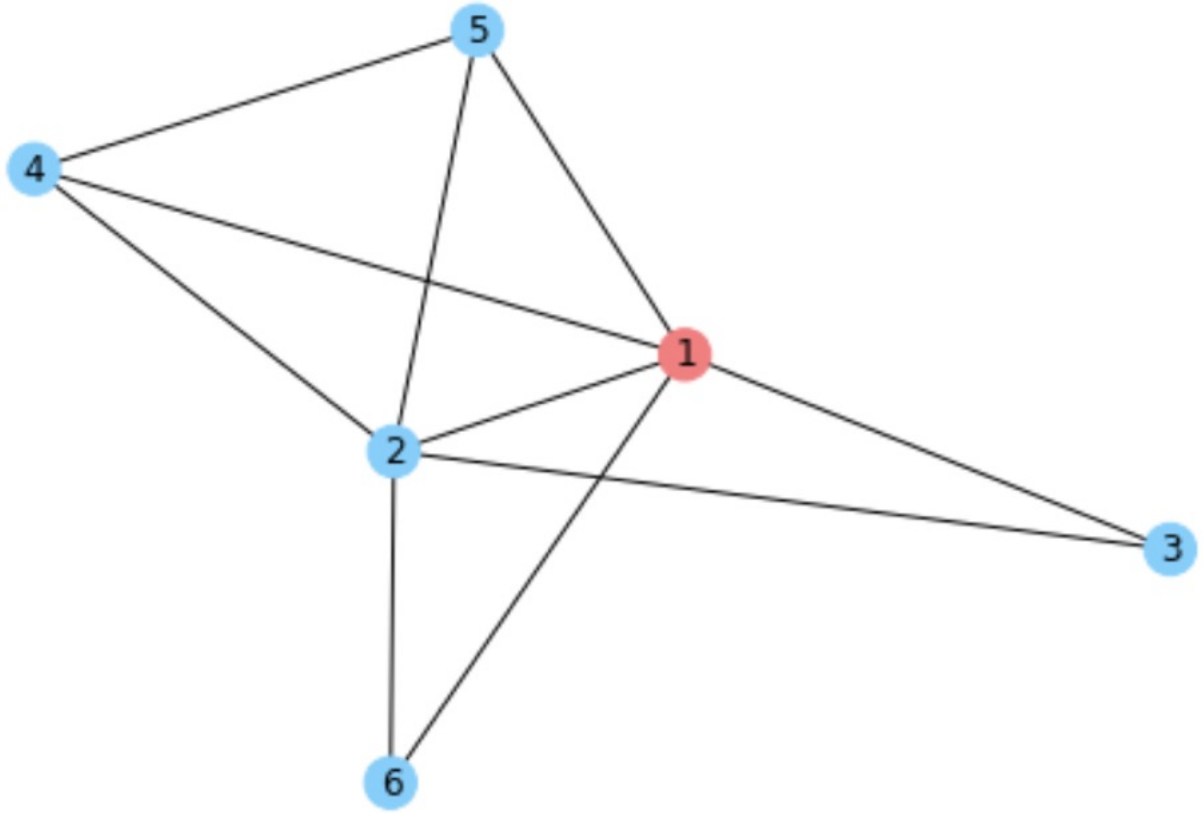
Metric Construction

Network **dispersion**:

A new measure that extends the observations and intuition that relationship psychologists made about intimate relationships.

"… the links to a person's relationship partner or other closest friends may have lower embeddedness, but they will often involve mutual neighbors from several different foci, reflecting the fact that the social orbits of these close friends are not bounded within any one focus."

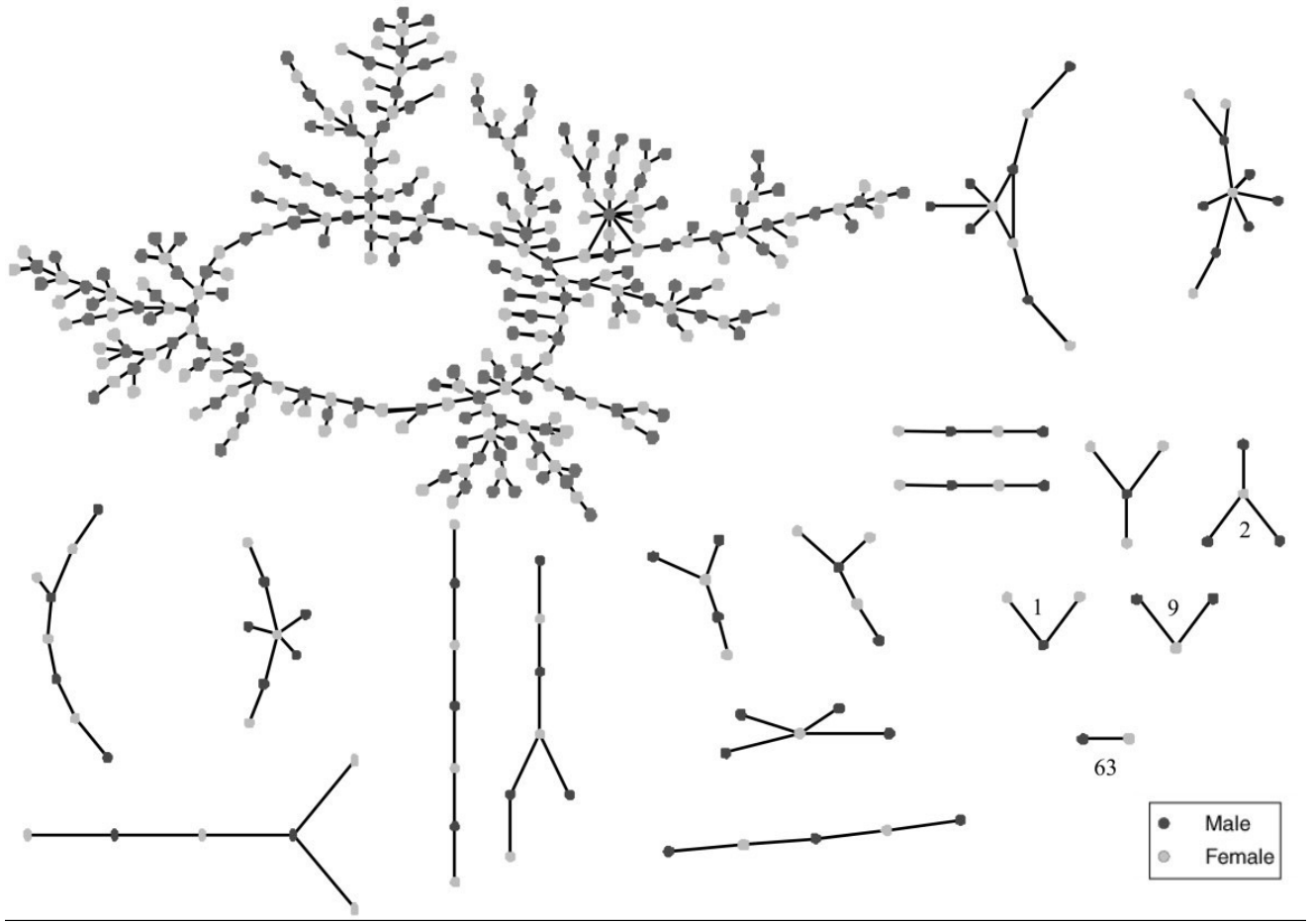
Operationalizing the Intuition



$$disp(u,v) = \sum_{s,t \in C_{uv}} d_v(s,t)$$

$$d_v(s,t) = \begin{cases} 1, \text{if s and t are not linked and have 0 common neighbors} \\ 0, \text{otherwise} \end{cases}$$

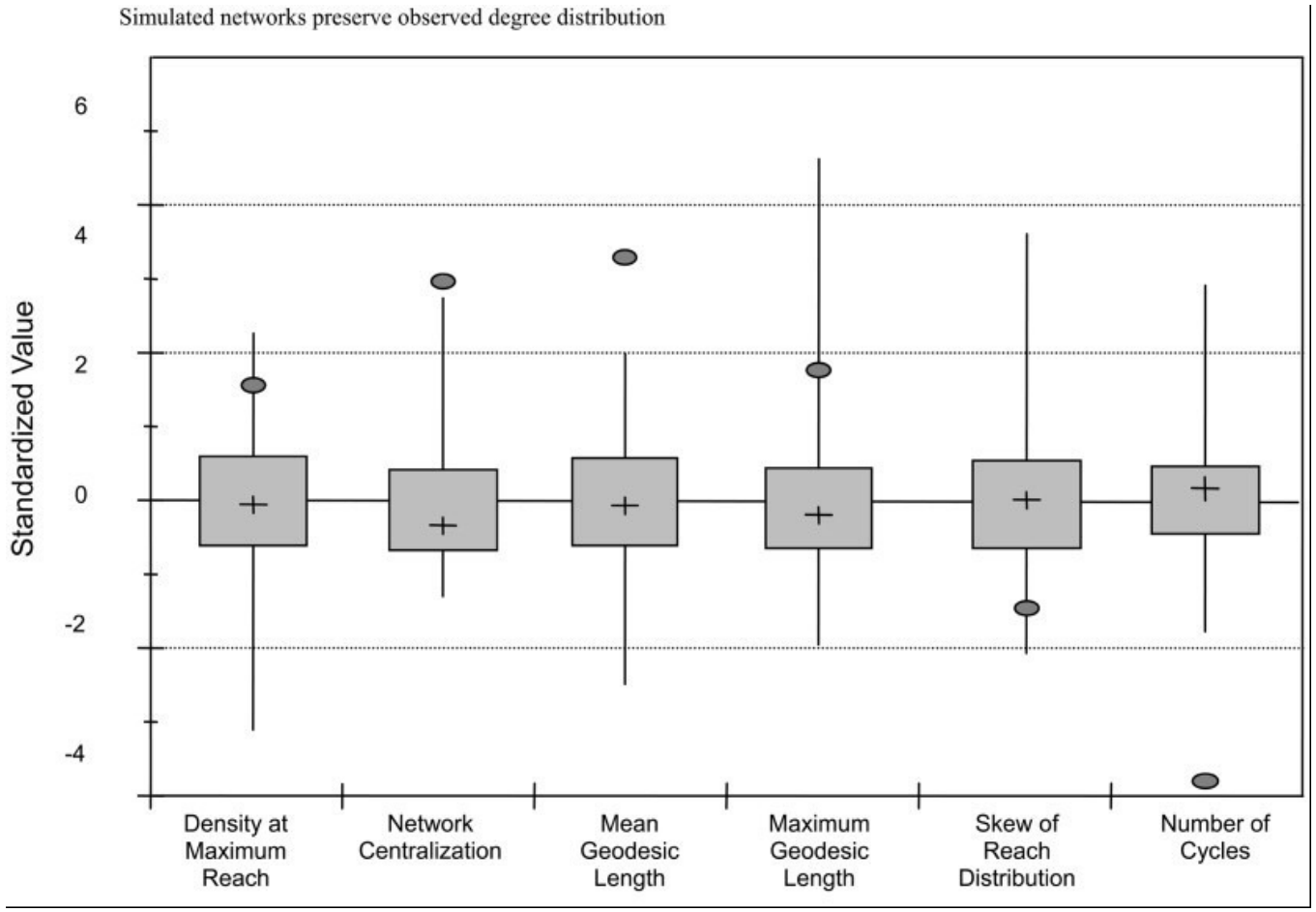
Explaining Network Structures



Network scientists employ random graphs as baseline

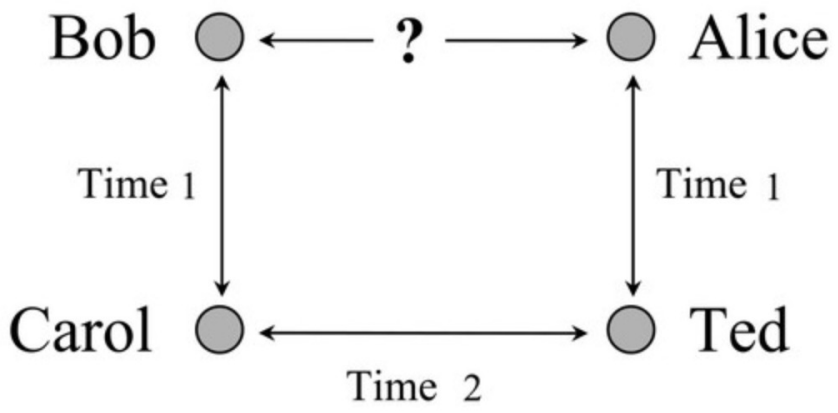
Divergence of observed network from baseline offers clues to its structure

Explaining Network Structures



The clue: Absence of four cycles in the high school network, relative to random baseline

Authors “theorize” behavioral reasons why the cycles are absent



Questions?