

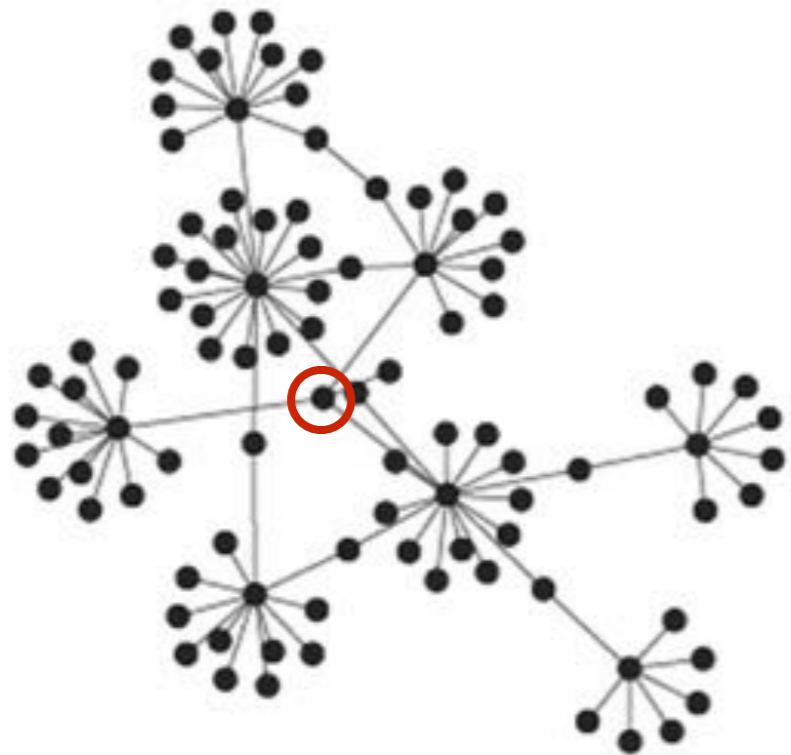
Social Networks, Social Interaction, and Outcomes

Social Networks and Social Interaction

Not all links are created equal:

- Some links are stronger than others
- Some links are more useful than others

Links are between individuals, but they can have far-reaching effects for people throughout the network



- Your links may help other people
- Your links may affect the outcomes of the entire network!

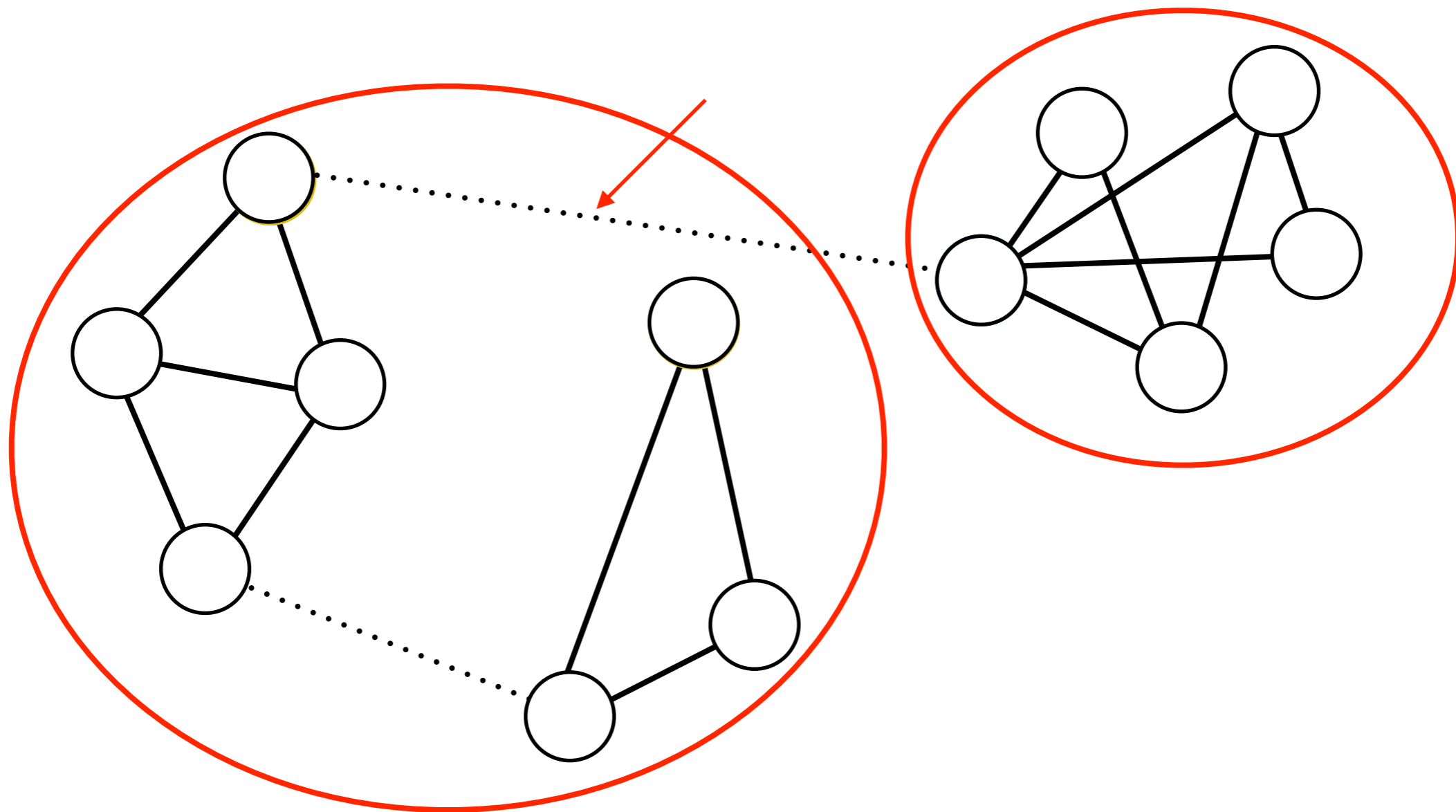
Social Networks and Social Interaction

Today:

- Triadic Closure
- Tie Strength
- Reciprocity
- Structural Holes
- Closure and Brokerage
- Social Capital
- Assortativity and Homophily

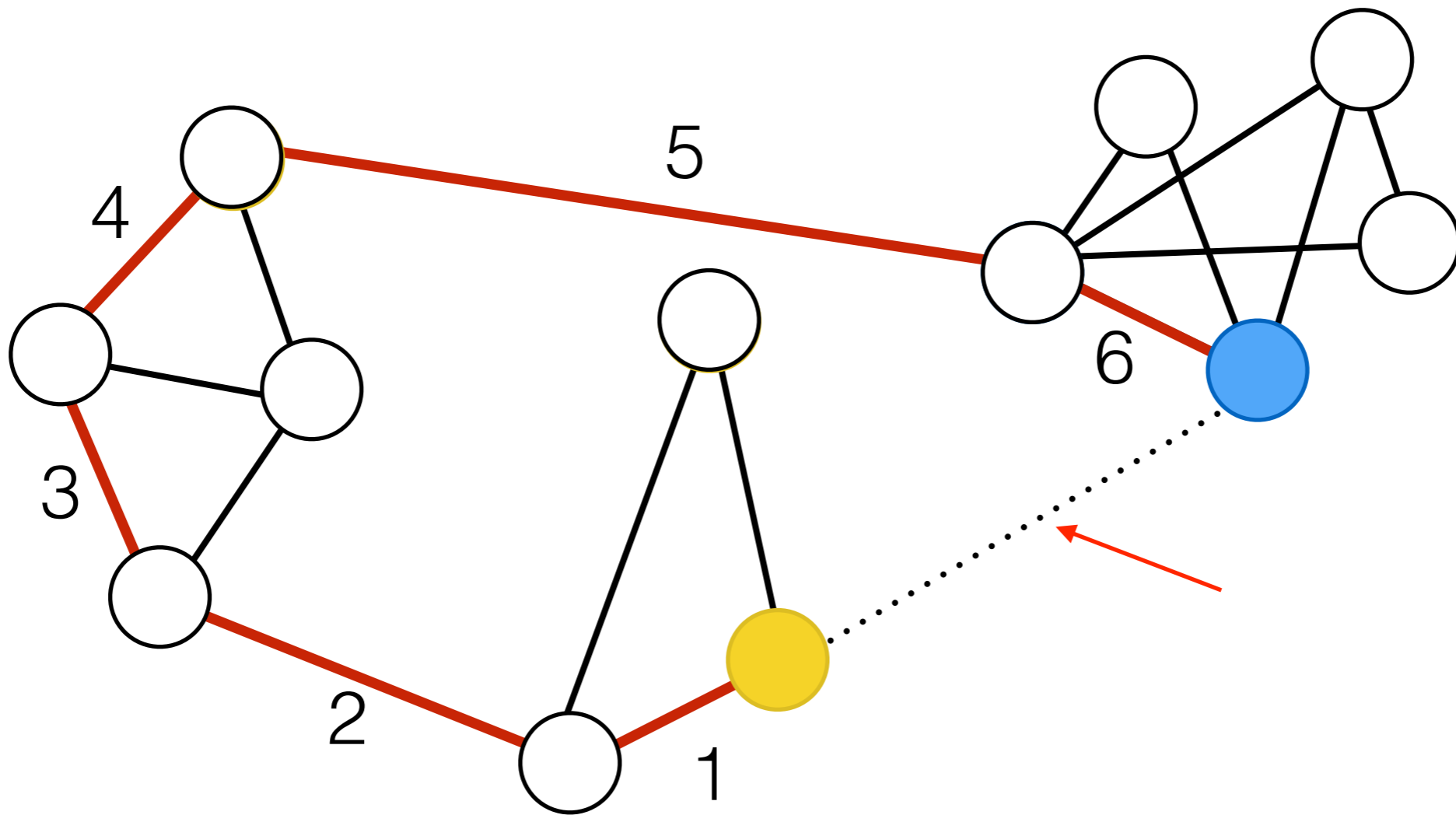
Bridges

Bridges are links that, if deleted, would put the connected nodes in different *components* (disconnected parts of the network)



Bridges

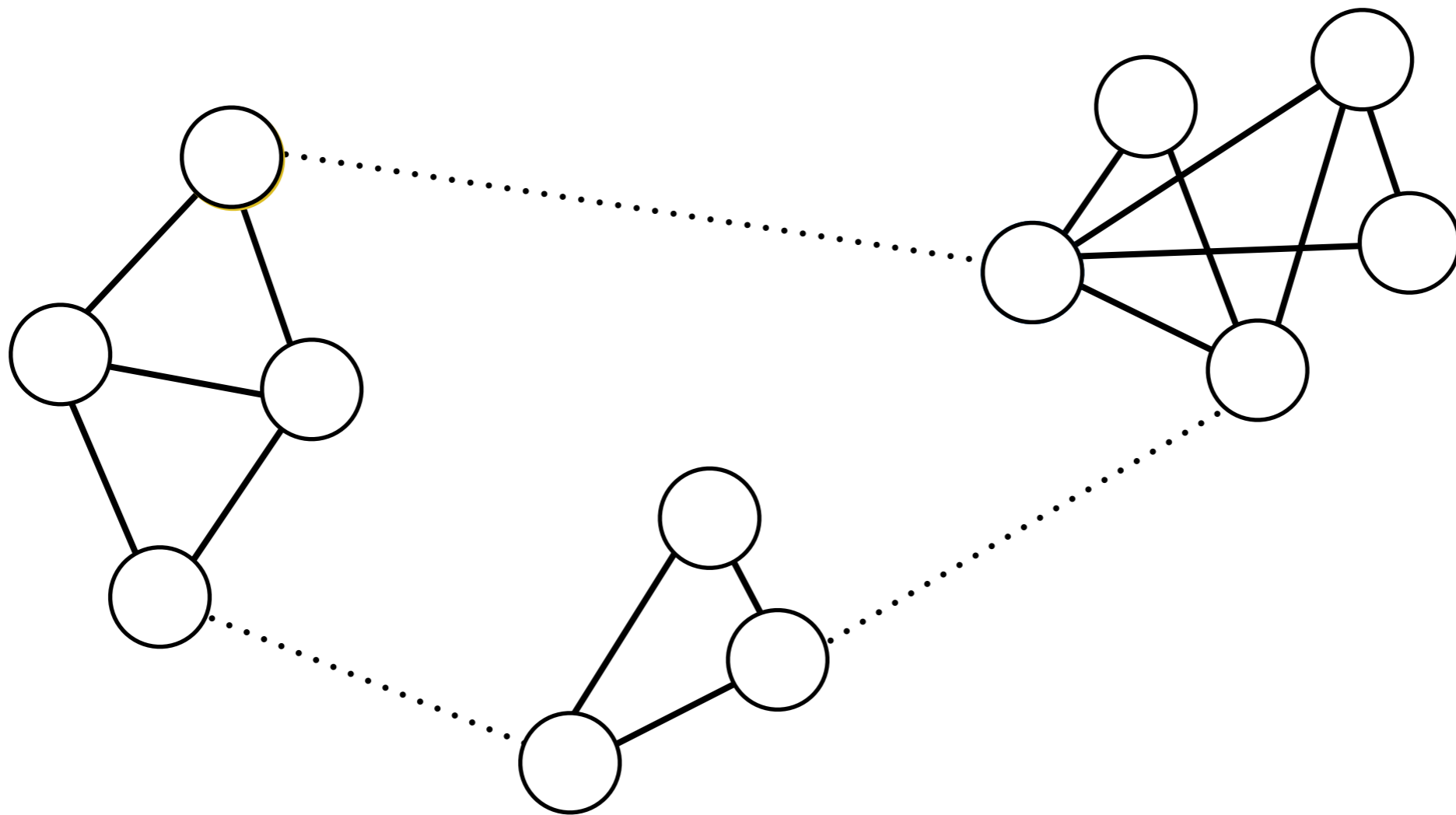
Local bridges are links that, if deleted, would put the connected nodes in much more distant parts of the network.



The *span* of a local bridge is the length of the geodesic between the two nodes once the bridge is removed

Bridges

Bridges and local bridges tend to be weaker than non-bridging links.



The intuition: strong ties tend to generate more social bonds

Are Bridging Ties Weak?

Real-world testing

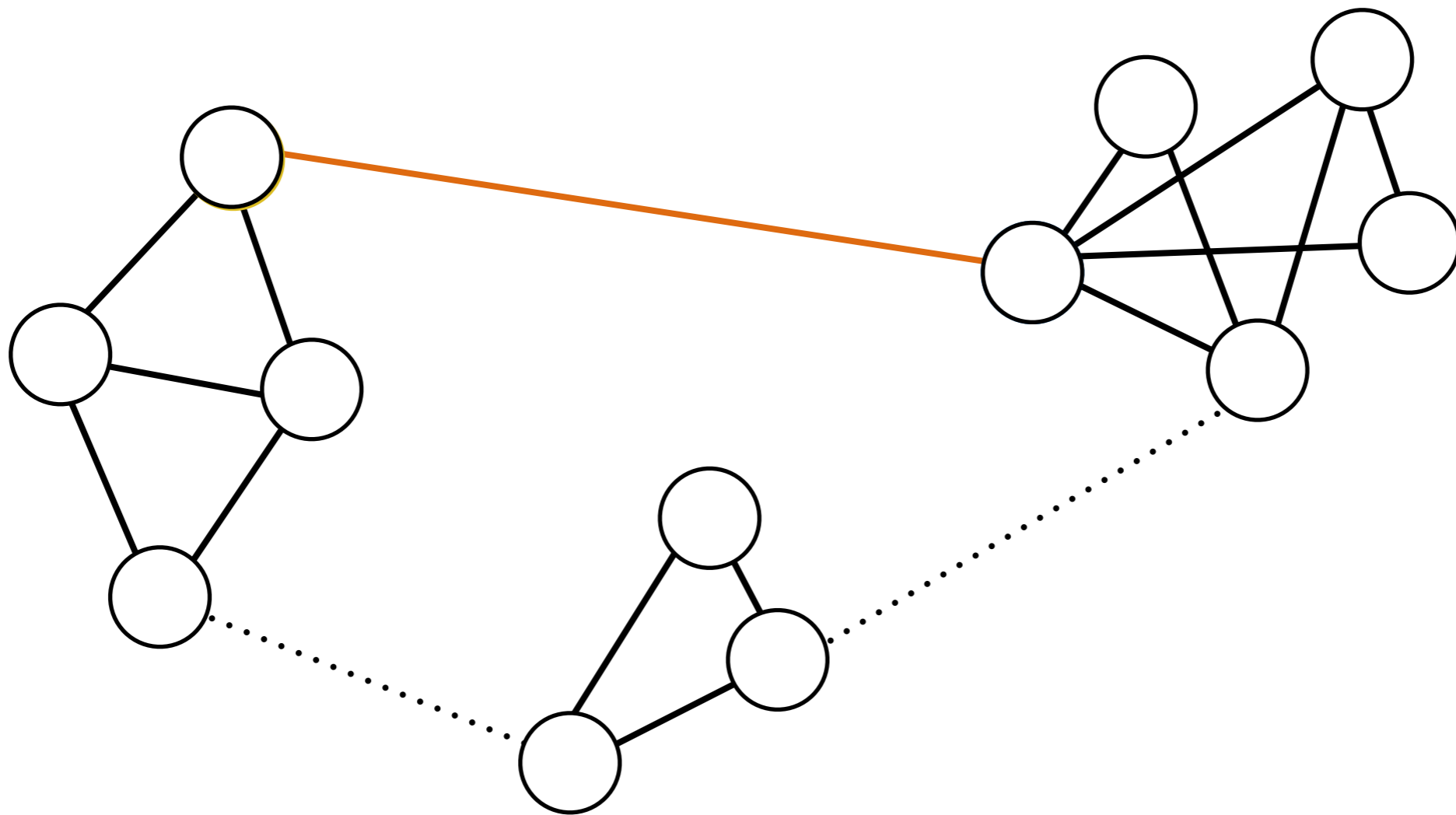
- Cell phone networks: number of calls
- Facebook networks: volume and type of interaction
- Twitter: passive interaction (follows) vs active (messages)

Ties that bridge between different groups *do* tend to be weaker than those within groups

- Fewer calls to people in other social groups
- Fewer likes/comments for people with few mutual friends
- Direct referrals to people in a group

Bridges

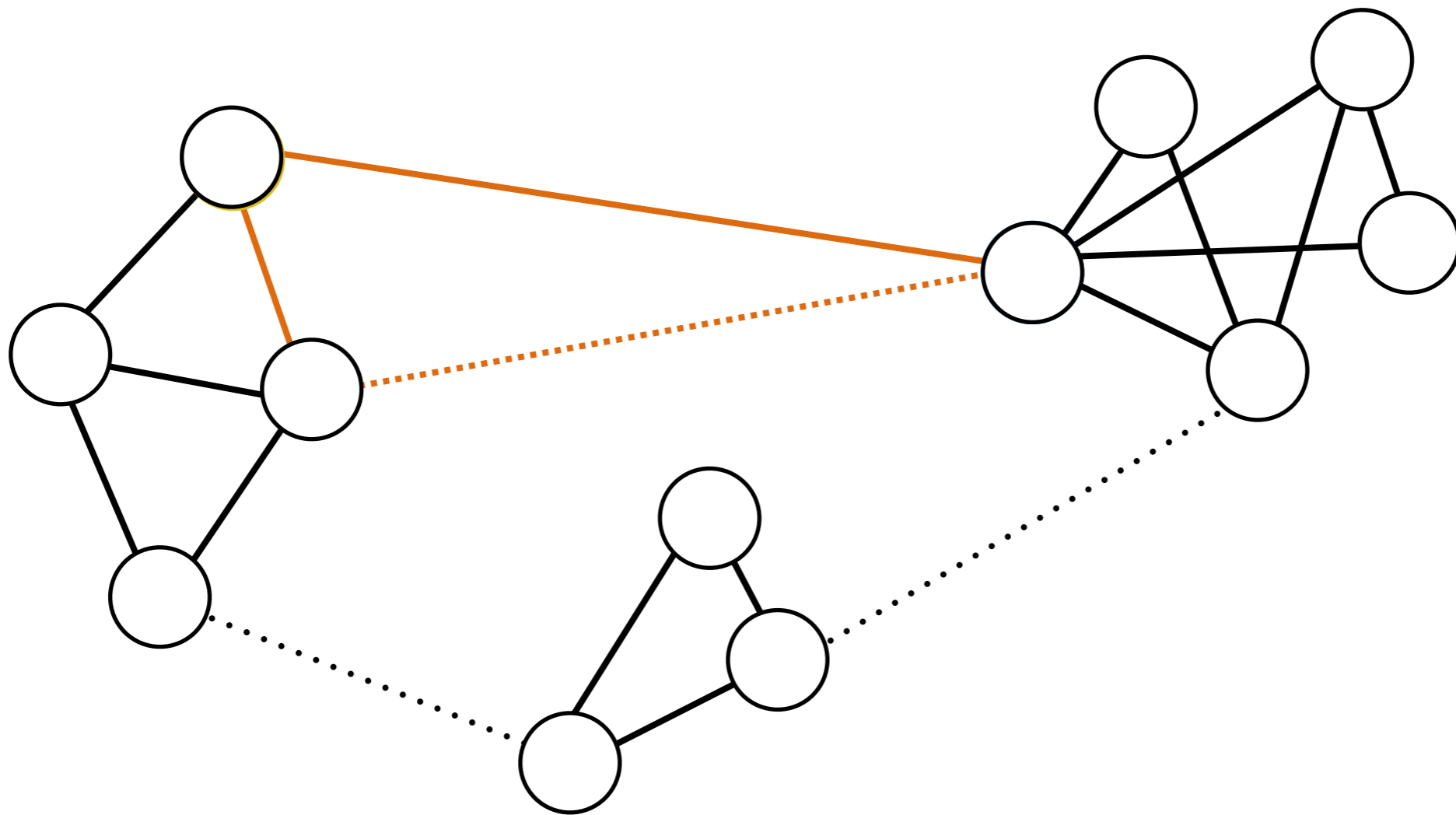
Bridges and local bridges tend to be weaker than non-bridging links.



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Bridges

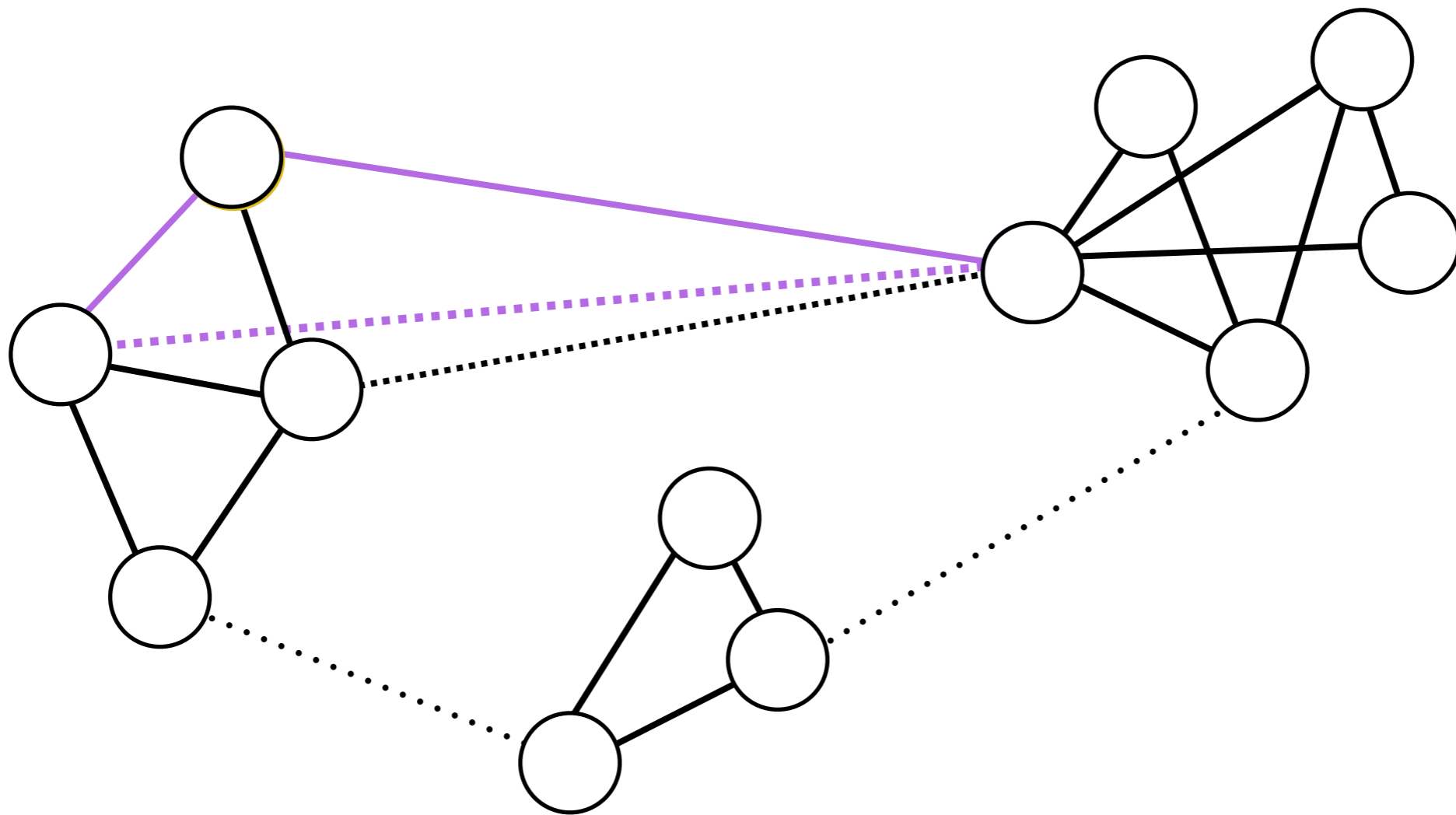
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Bridges

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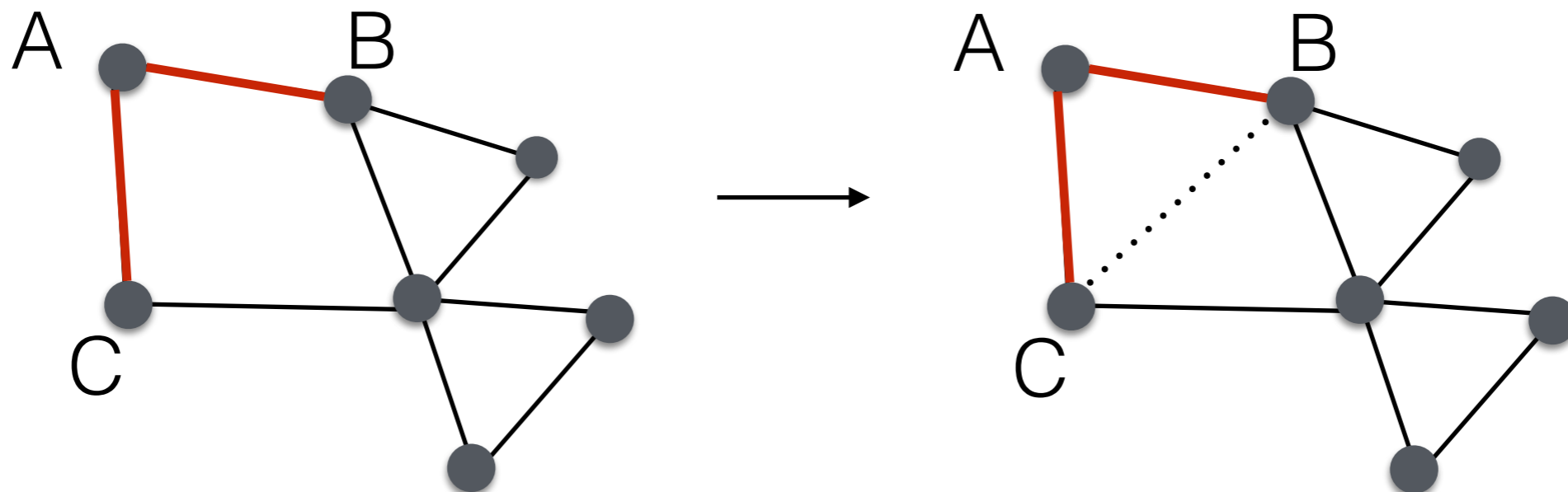
The intuition: strong ties tend to generate more social bonds

Triadic Closure

This is called *Triadic Closure*

Two people with a common friend are more likely to become friends themselves

→ Triangles tend to form

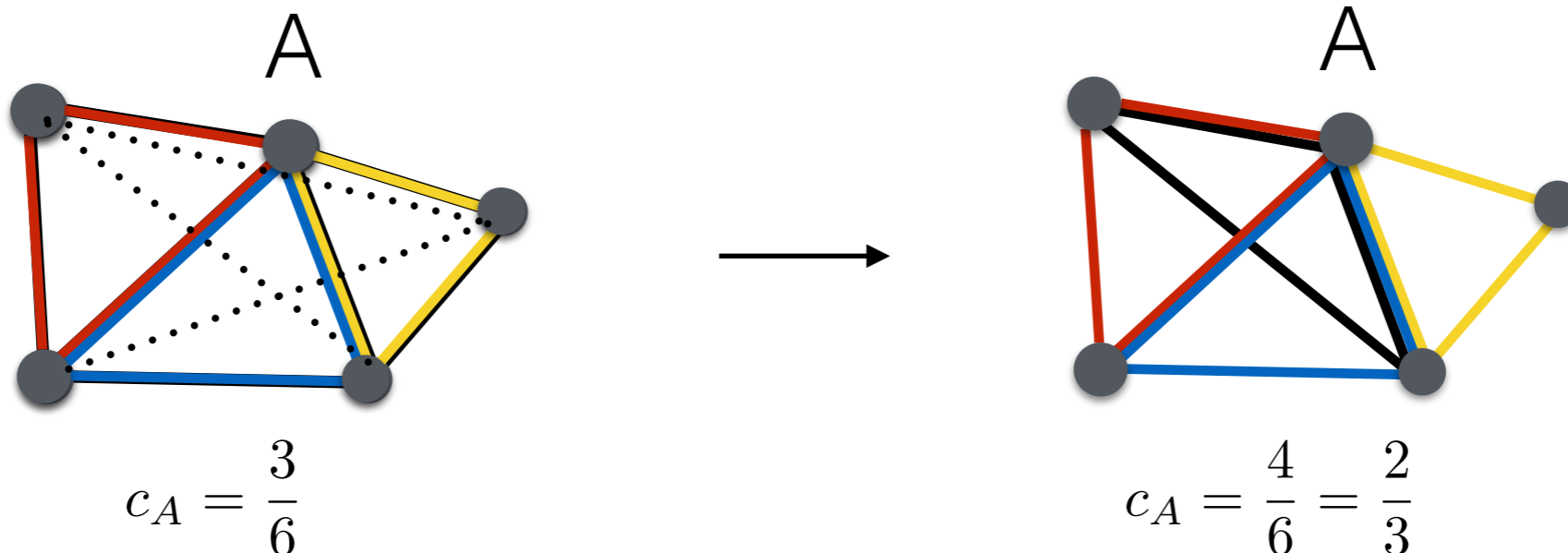


Triadic Closure

Triadic closure boosts the clustering coefficient of nodes in the network

→ Clustering = Fraction of my friends who are friends with each other

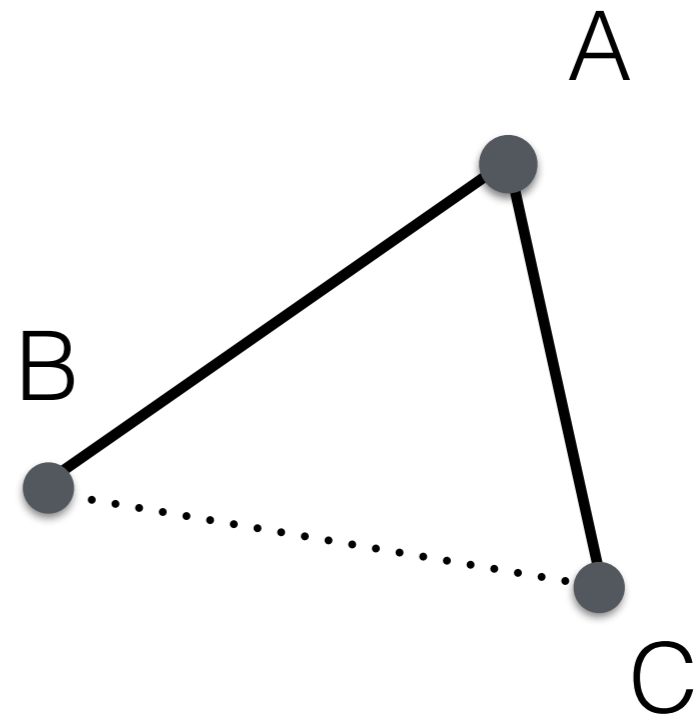
→ Clustering = Fraction of possible triangles completed



Triadic Closure

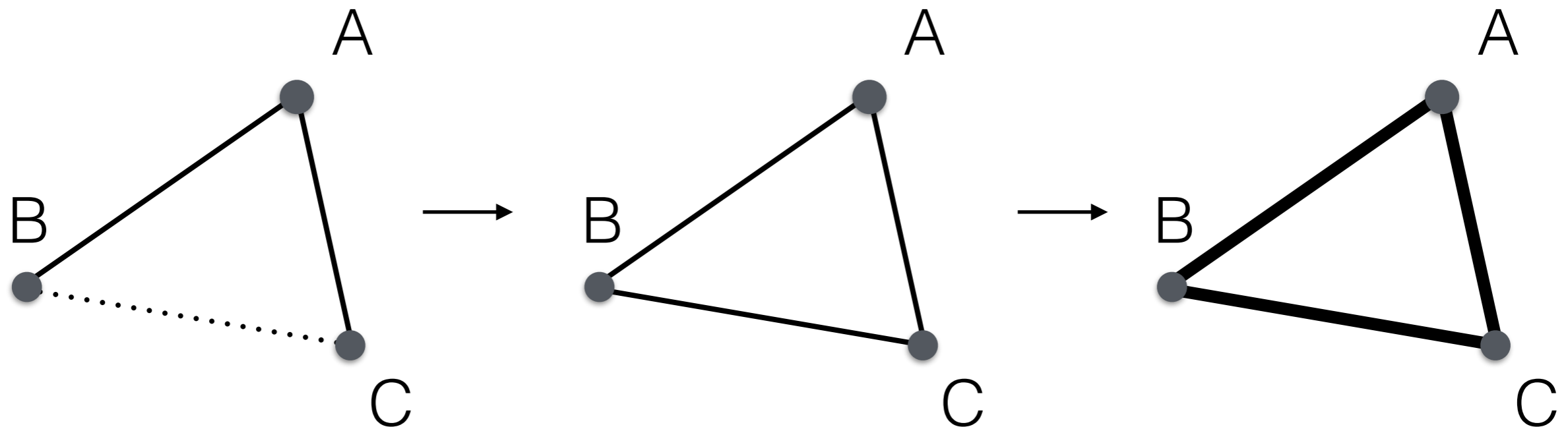
Why does triadic closure happen?

- Opportunity: A, B, and C live in the same area
- Trust: B and C trust each other because they both know A
- Social Frictions: it's awkward for B and C to *not* be friends
- Homophily: A's friends are likely to have a lot in common



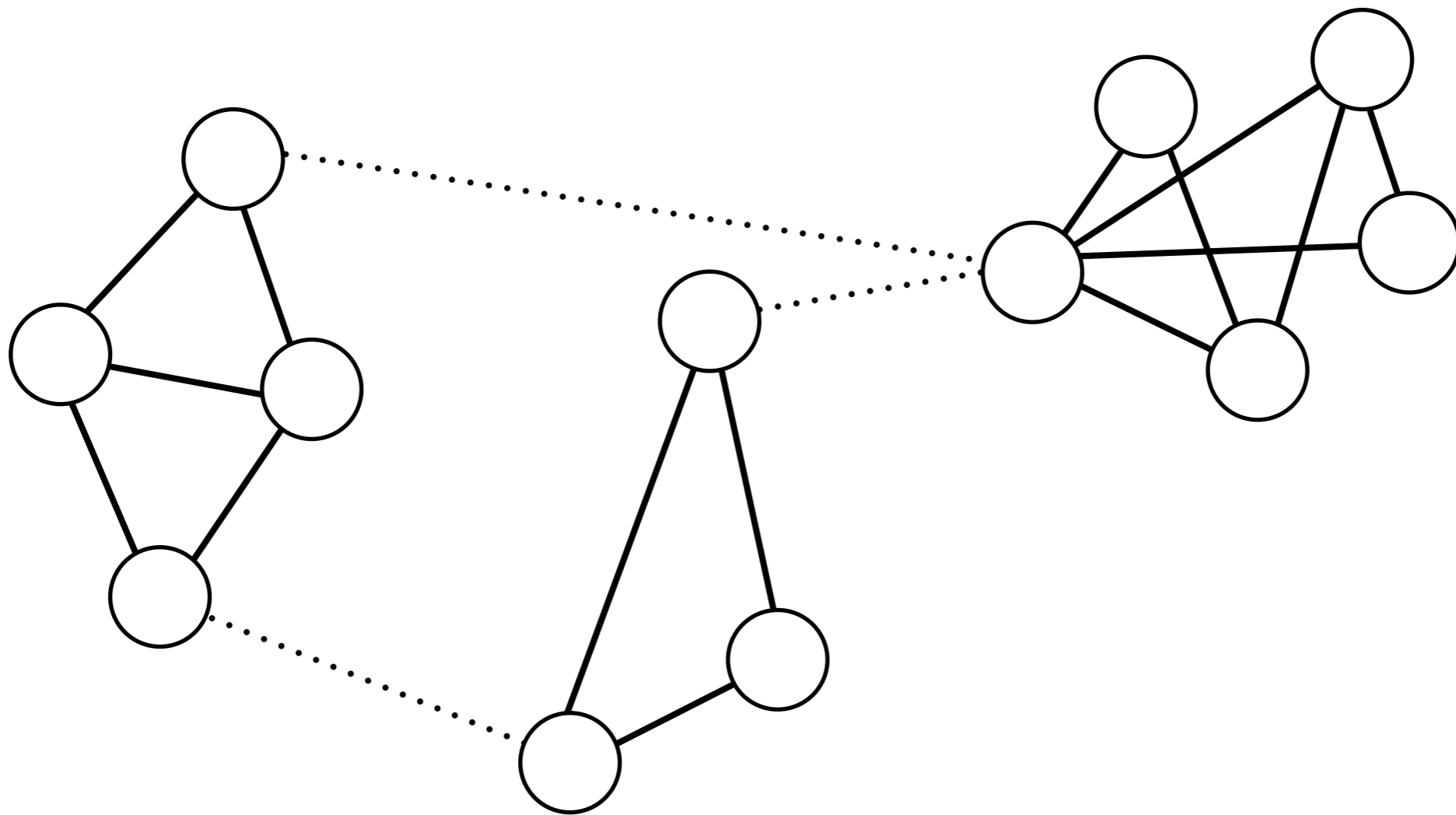
Triadic Closure

For the same reasons, Triadic Closure also boosts the strength of existing ties



Tie Strength and Information

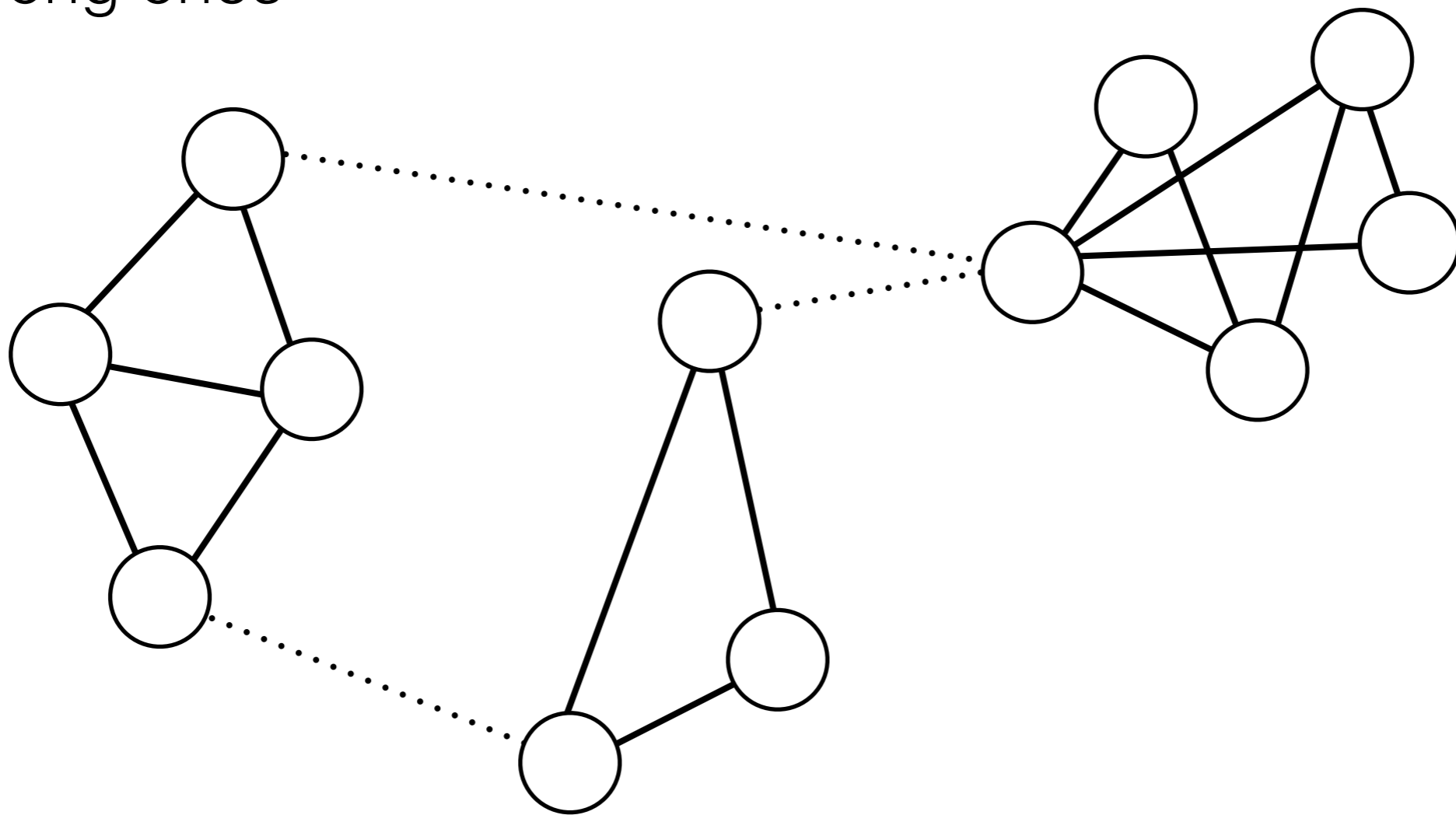
Question: If you were looking for a job, which would be the most valuable in your search: strong ties, or weak ties?



→ Famous study by Mark Grannovetter

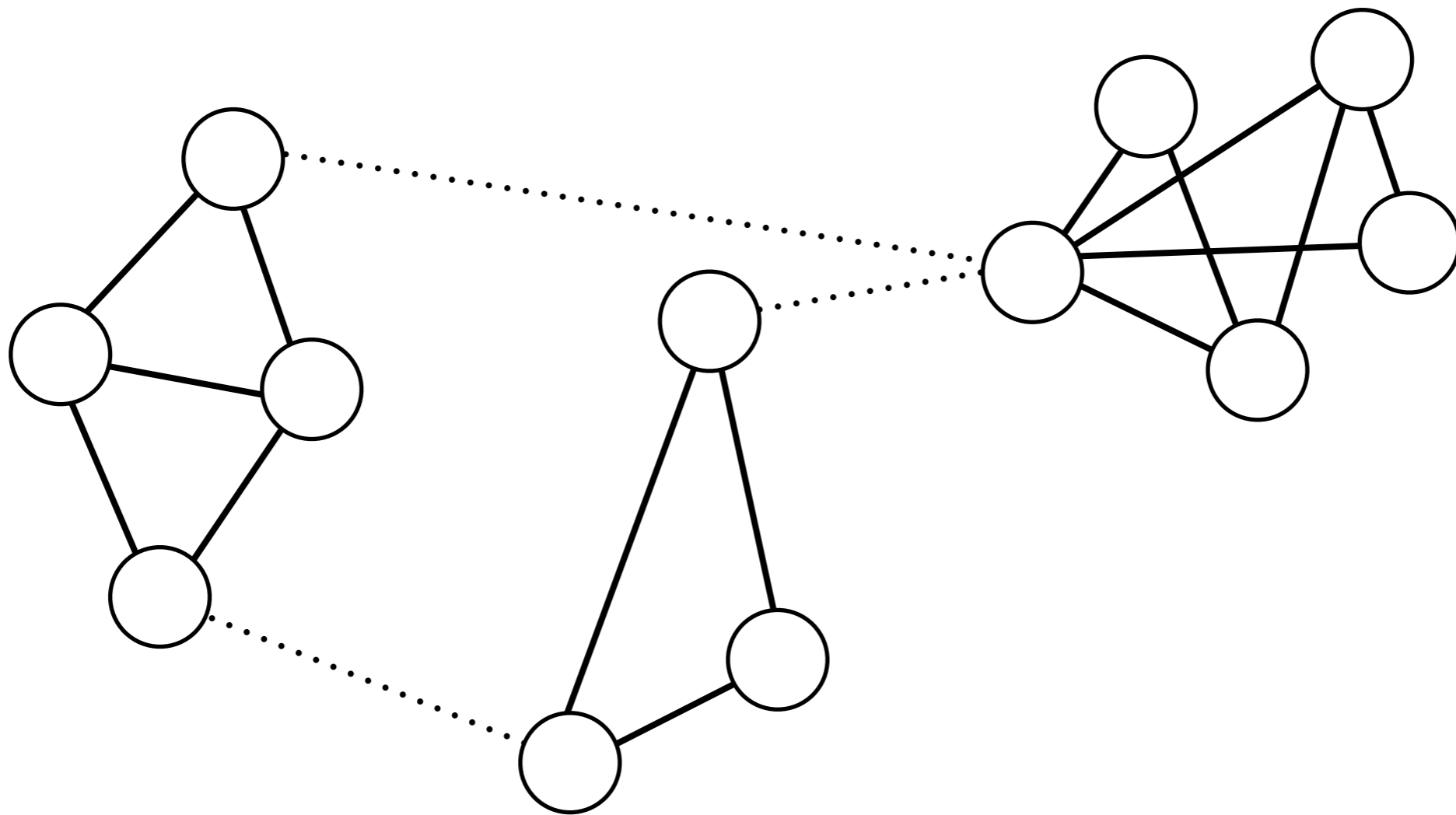
Granovetter: The Strength of Weak Ties

Result: When you are trying get or spread information (eg: about job openings) weak ties are more important than strong ones



Granovetter: The Strength of Weak Ties

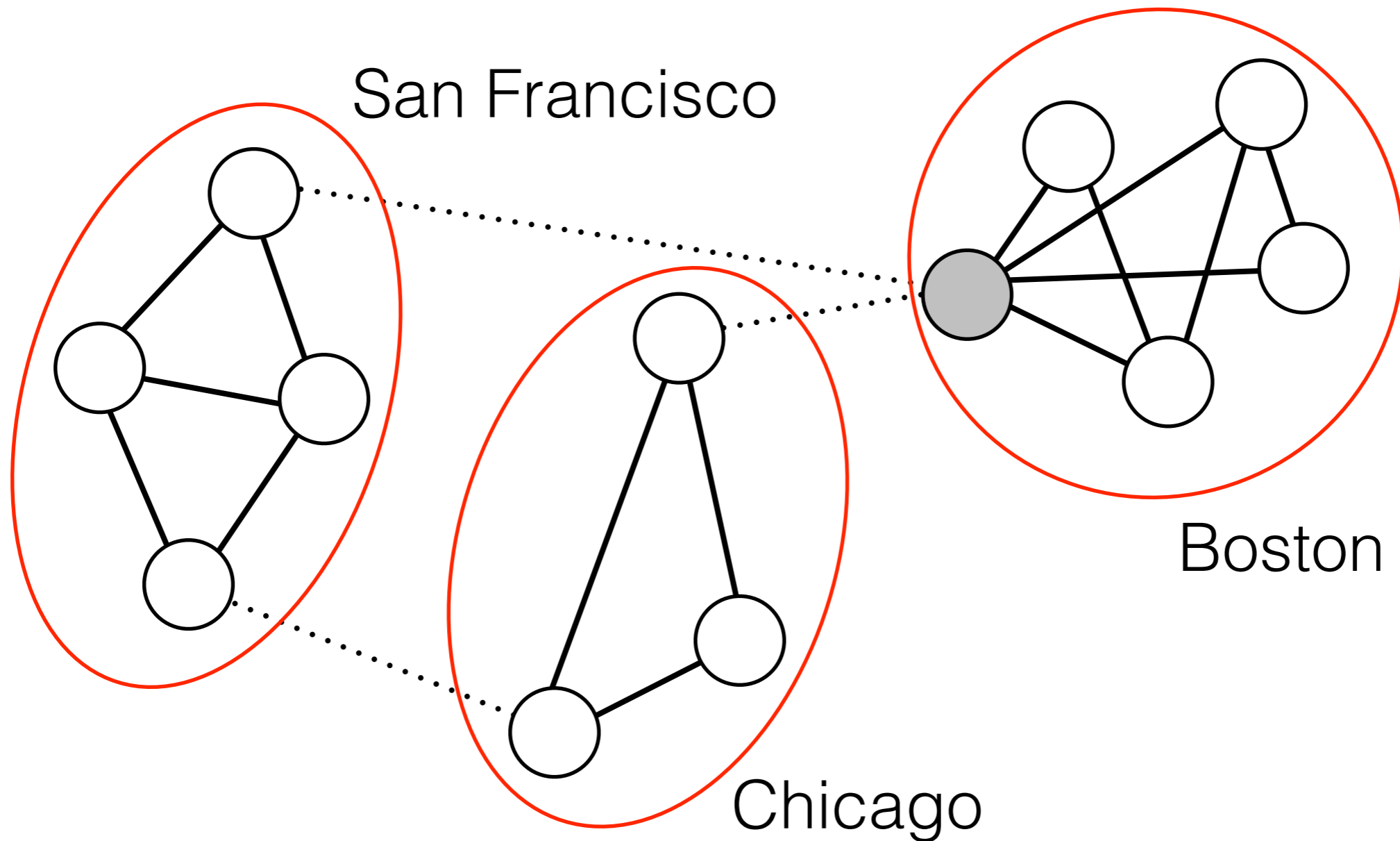
Intuition: Your strong ties are with people similar to you, who have similar information



Weak ties tend to bridge, and link you to people much different than yourself, who have different information

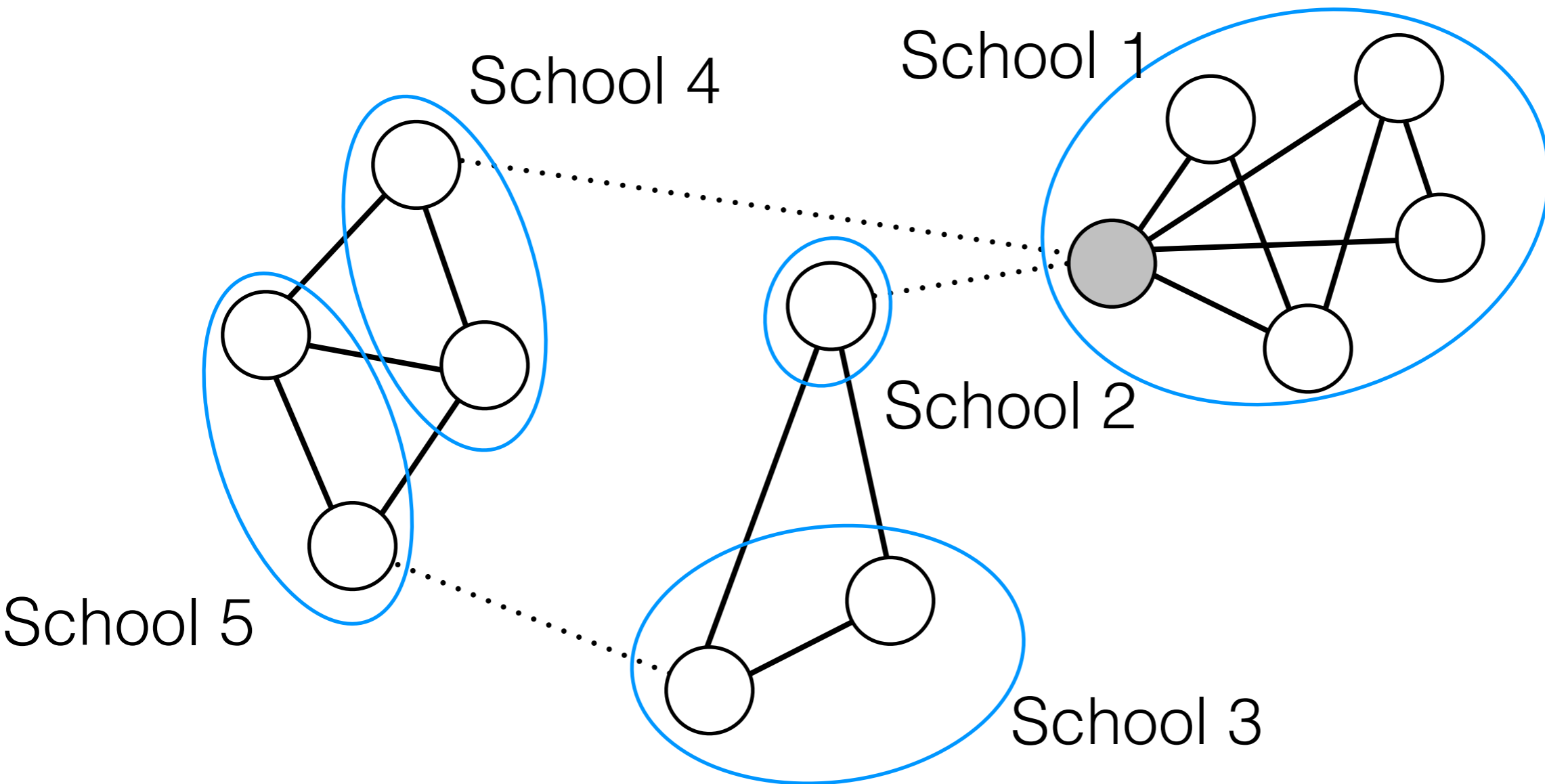
Granovetter: The Strength of Weak Ties

Geography



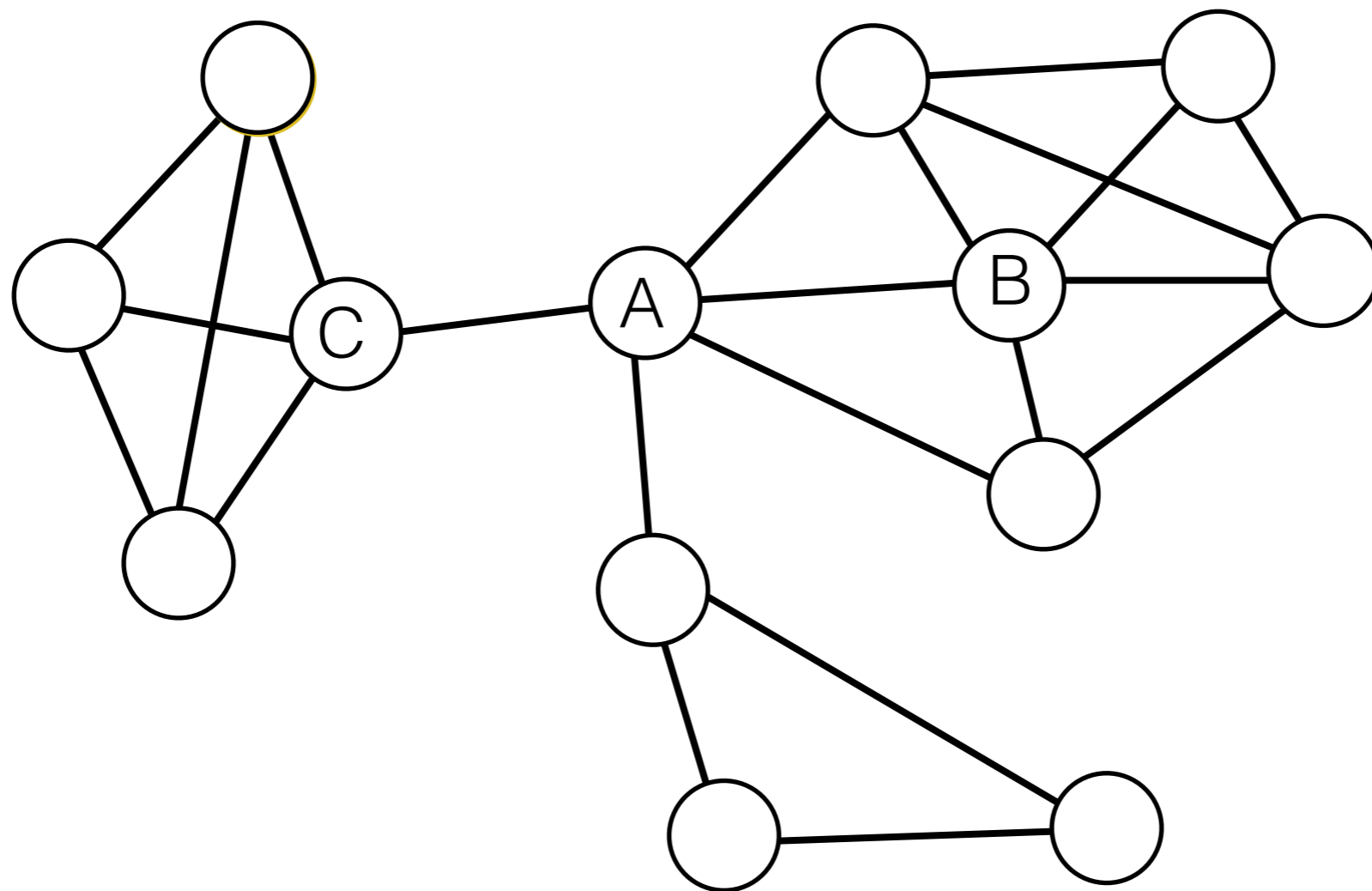
Granovetter: The Strength of Weak Ties

Schools



Closure, Structural Holes, and Social Capital

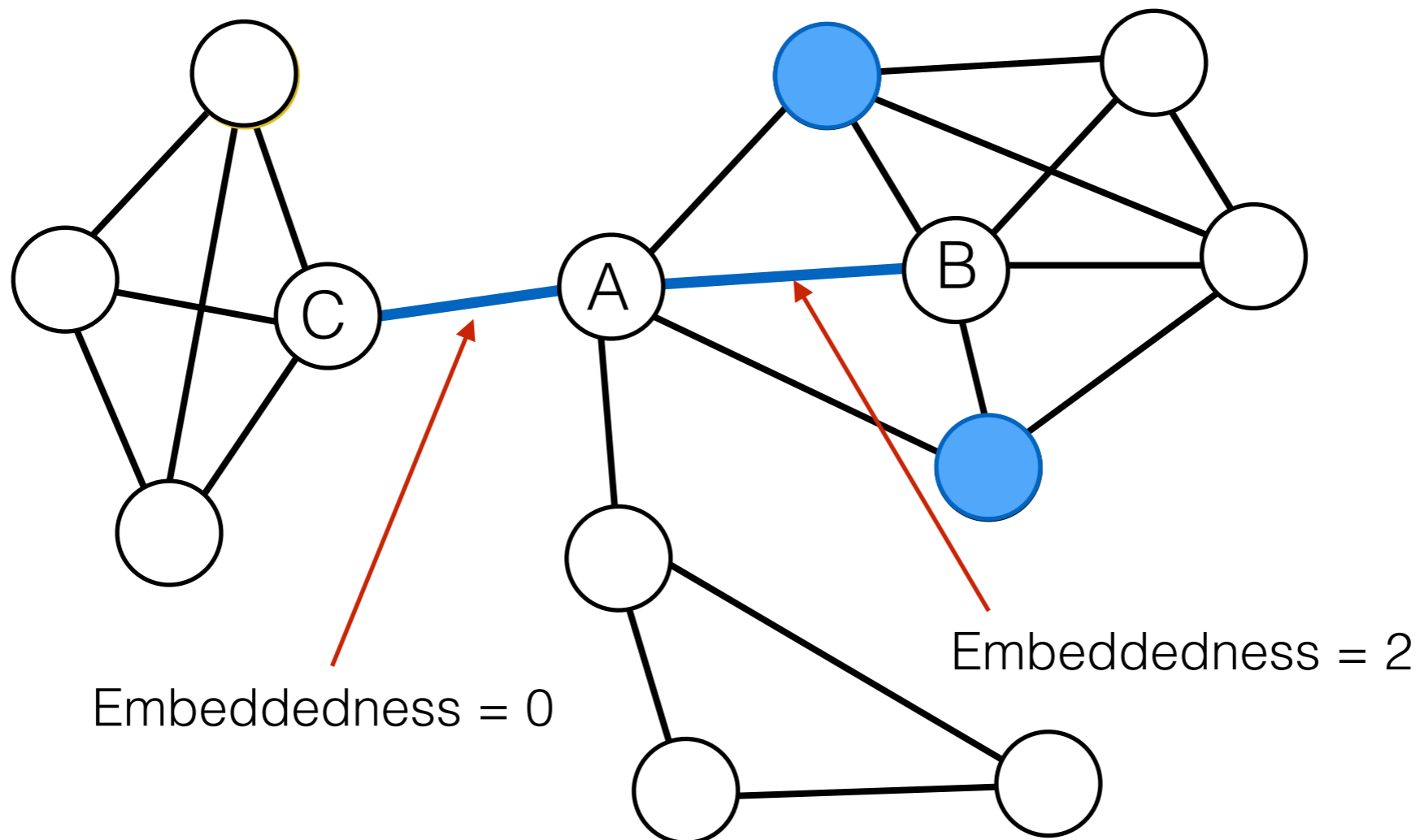
These weak, bridging links are clearly not evenly distributed among the nodes in the network



Embeddedness

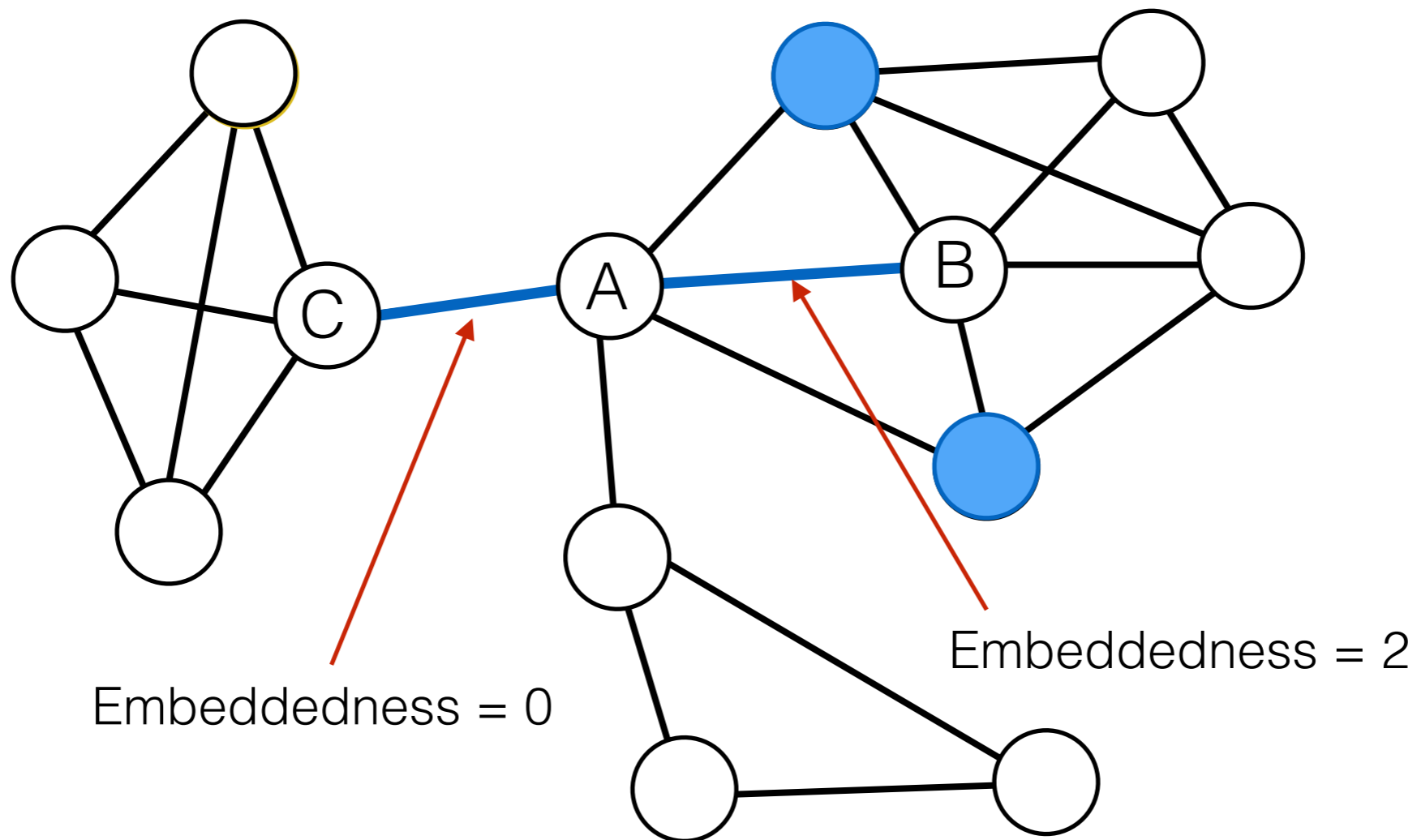
Embeddedness of an edge: the number of common neighbors shared by the two endpoints

→ Note: all bridging links have embeddedness of 0



Embeddedness

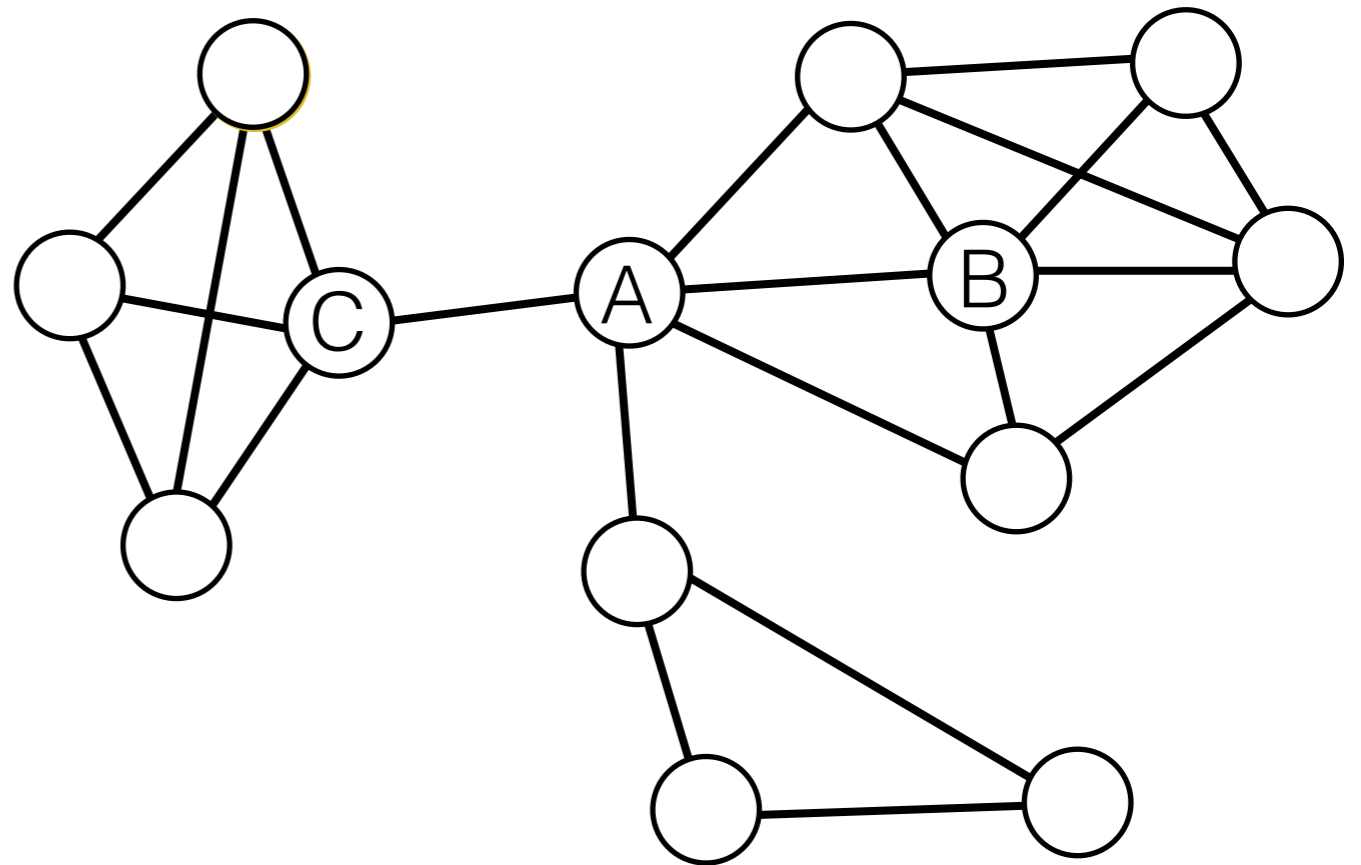
Node B's links are much more embedded than Node A's → Node A occupies a much different place in the network



Closure, Brokerage, and Social Capital

Social Capital is the benefit that an individual gains from their position in the social network

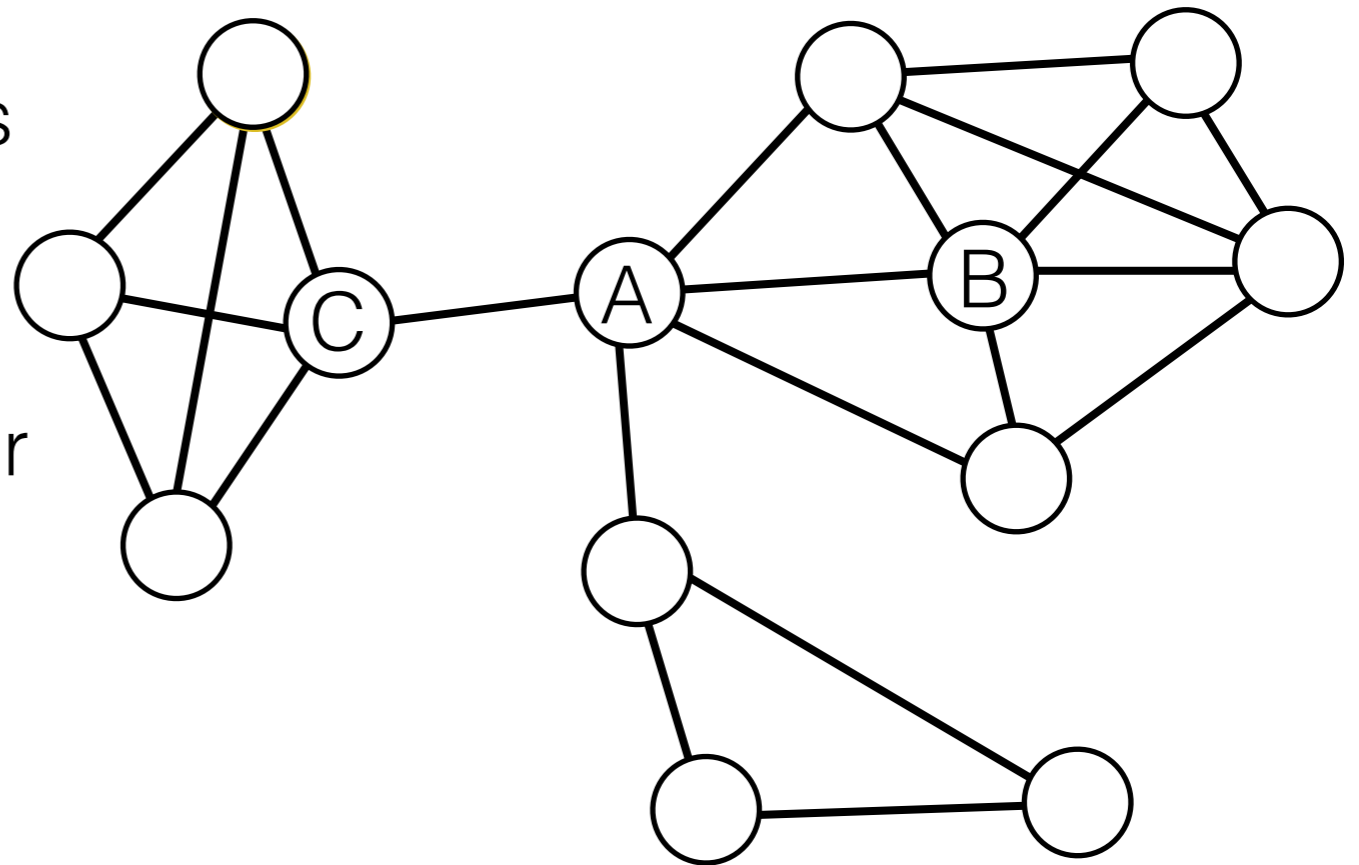
- analogous to physical capital and human capital
- Nodes A and B gain different kinds of social capital



Closure, Brokerage, and Social Capital

There are advantages to embedded links

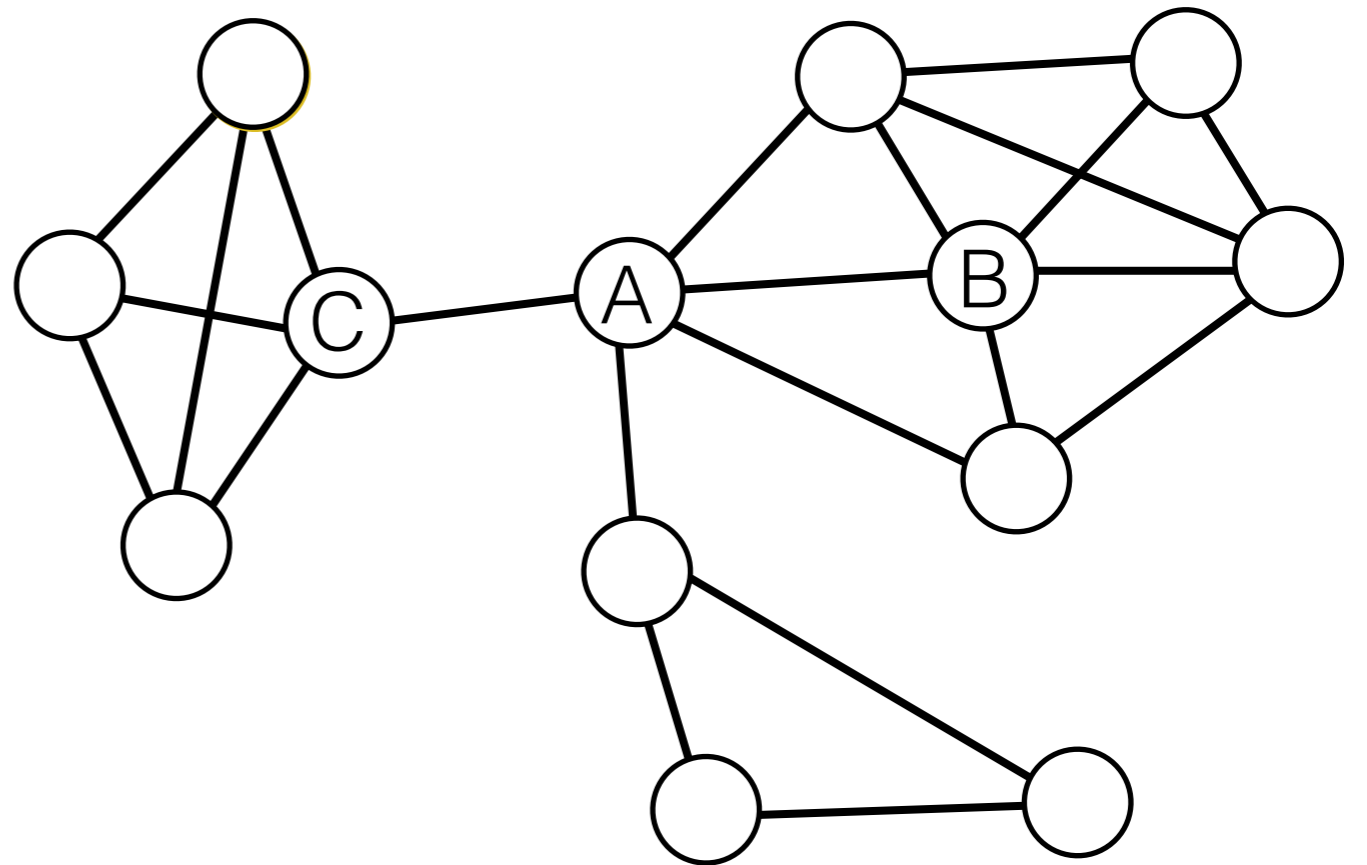
- embedded links breed trust (if you cheat your friend, your mutual friends might find out!)
- interactions along non-embedded links are riskier
- non-embedded links may mean more than one set of social norms



People who have many embedded links and high clustering gain social capital from *closure*

Closure, Brokerage, and Social Capital

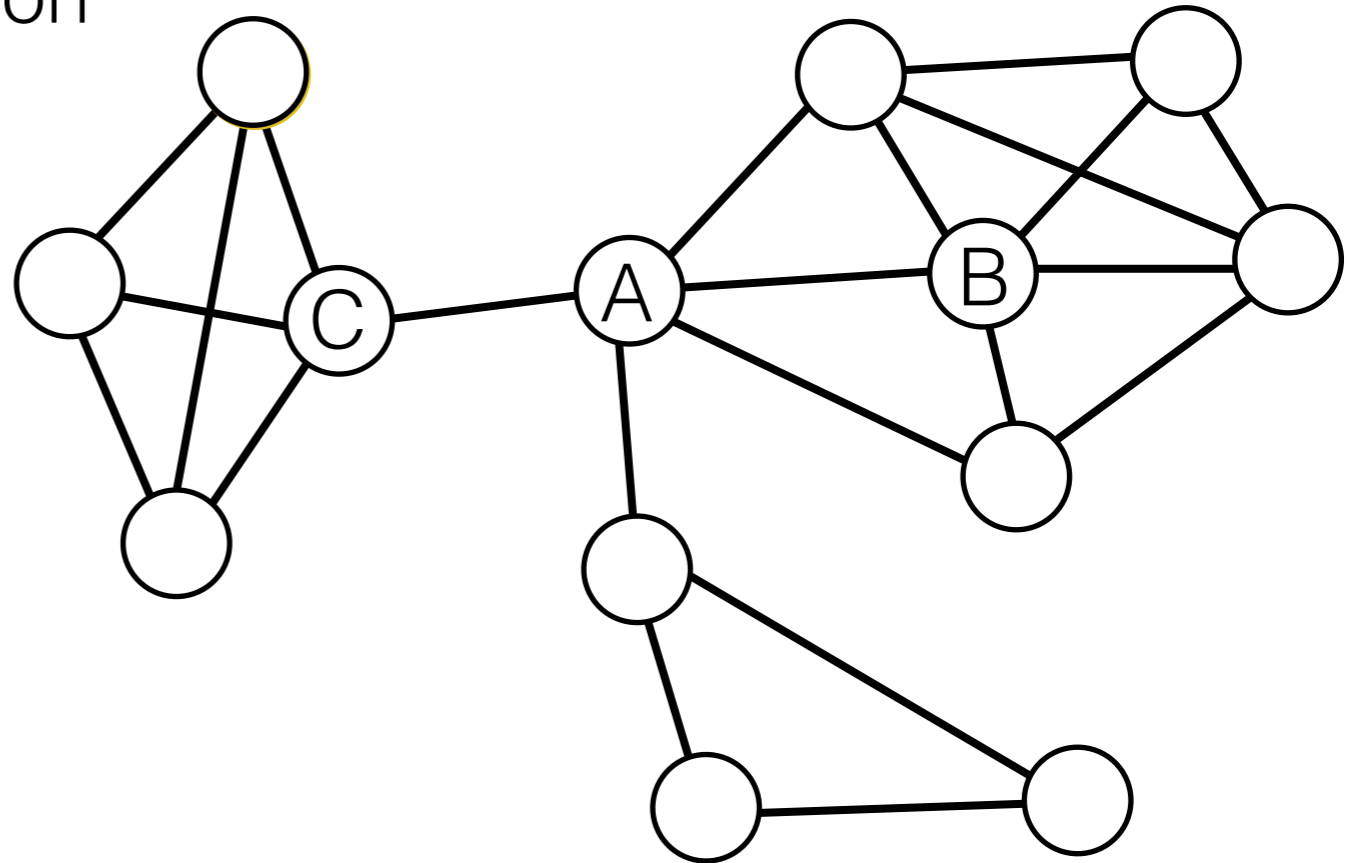
People whose links have low embeddedness are said to bridge *structural holes*



Closure, Brokerage, and Social Capital

Bridging structural holes also has advantages

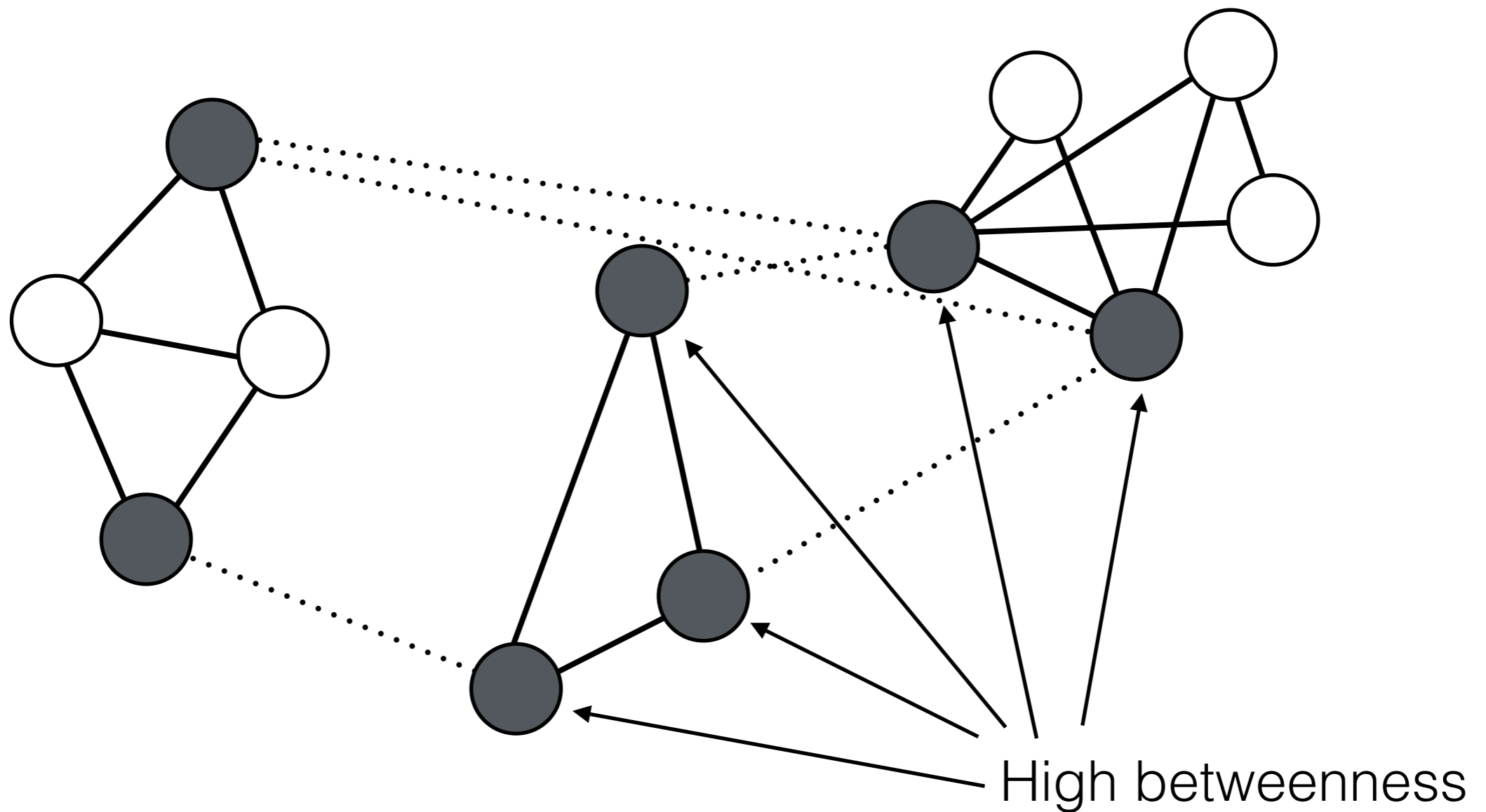
- people who bridge have better access to information
- they serve as “gatekeepers” between different communities
- they face less competition from fundamentally similar neighbors



People who bridge structural holes gain social capital from *brokerage*

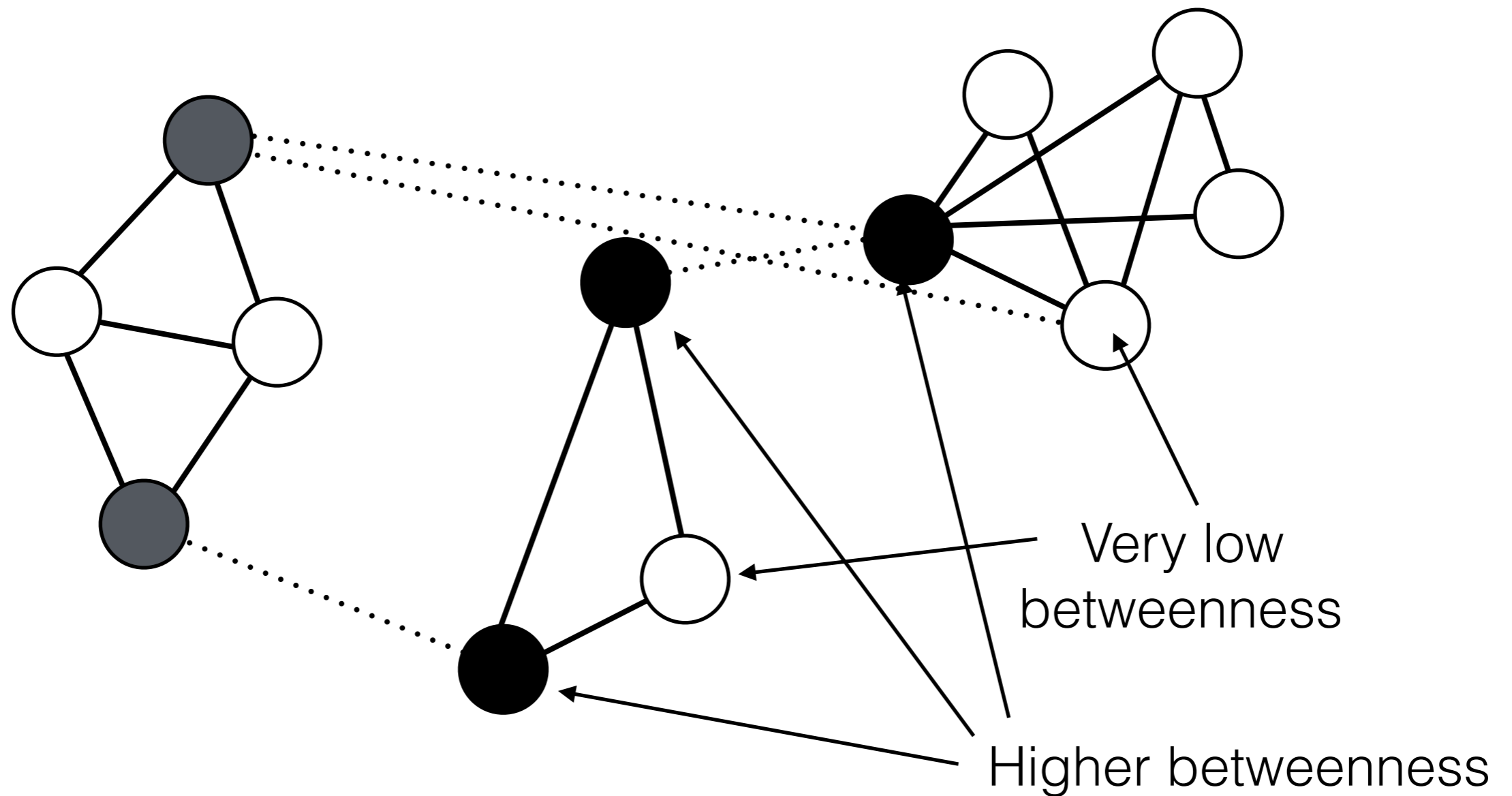
Closure, Brokerage, and Social Capital

Links are local, but deleting them can have affects on other nodes too



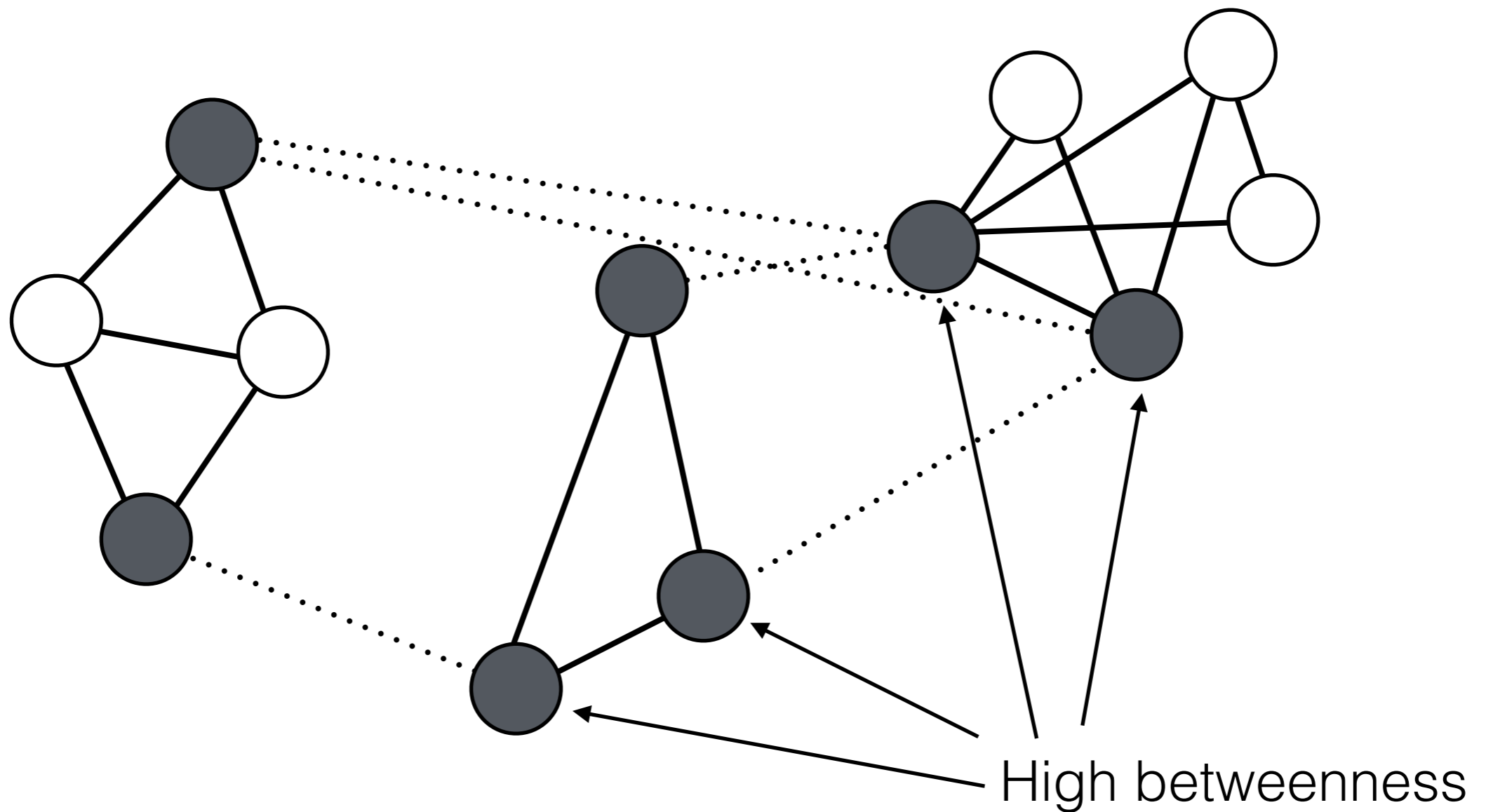
Closure, Brokerage, and Social Capital

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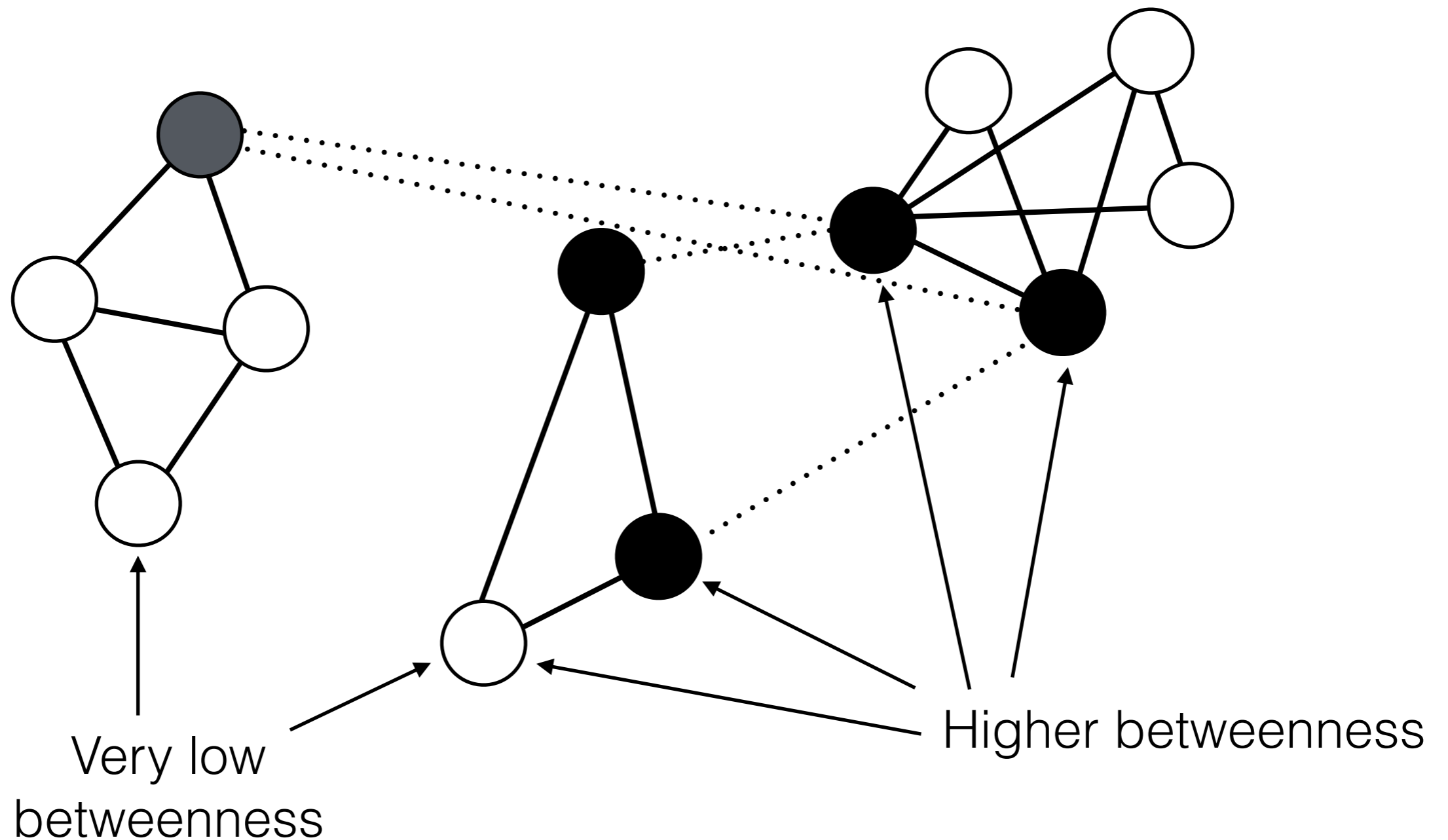
Closure, Brokerage, and Social Capital

Or even quite distant parts...



Closure, Brokerage, and Social Capital

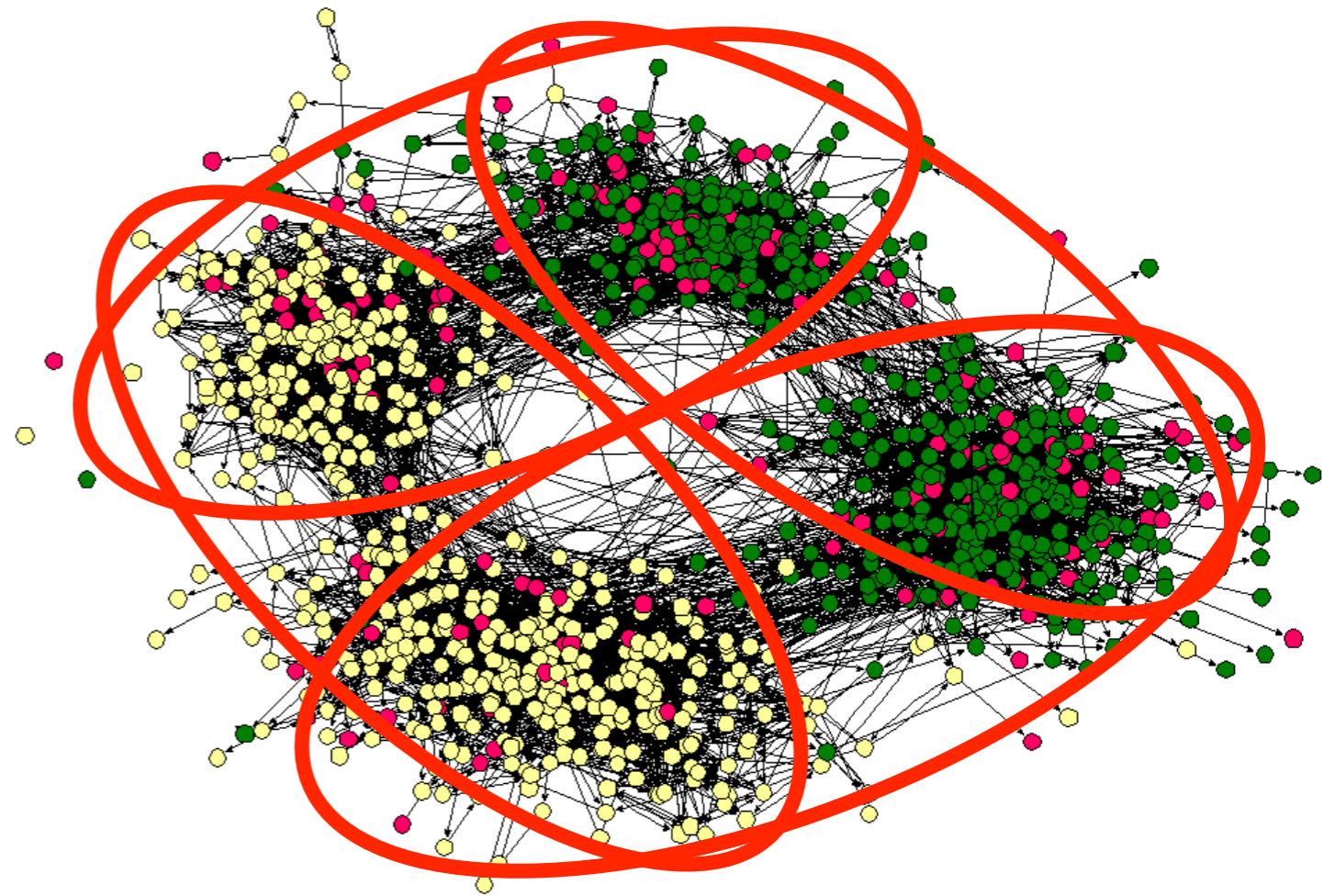
Or even quite distant parts...



Assortativity and Homophily

Homophily: we tend to know people who are similar to us on one or more dimensions

- Race
- Age
- Gender
- College major
- Profession
- Belief system
- Socioeconomic status
- Lifestyle and Habits



ref: James Moody (2001)

Assortativity and Homophily

Homophily can make it difficult to sort out cause and effect in social situations:

- Do you smoke because all of your friends smoke? (link \Rightarrow behavior)
- Or are you friends with them because they smoke? (behavior \Rightarrow link)

(Spoiler alert: it's probably a bit of both)

Assortativity and Homophily

Homophily also affects the spread of ideas and opinion formation by creating an echo chamber:

- If all of your friends are like you, you have less exposure to new ideas (have you unfriended that conspiracy theorist yet?)
- You will also have a skewed perception of the makeup of the general population, and their opinions (everyone supports Bill Bradley for president, right?)

Assortativity and Homophily

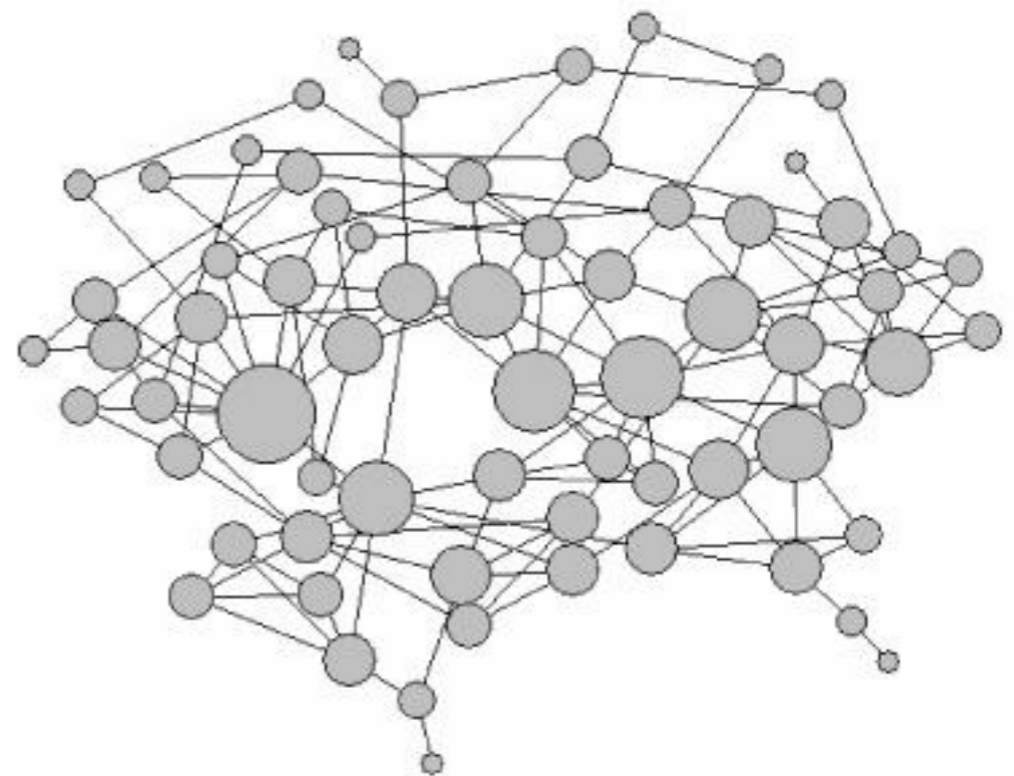
Assortativity: when nodes with high degree are connected to other nodes with high degree

Examples:

Very social students tend to be friends with other very social students

High profile scholars write papers with other high profile scholars

Popular blogs link to other popular blogs



prison network: Newman "Assortative Mixing in Networks"

Assortativity and Homophily

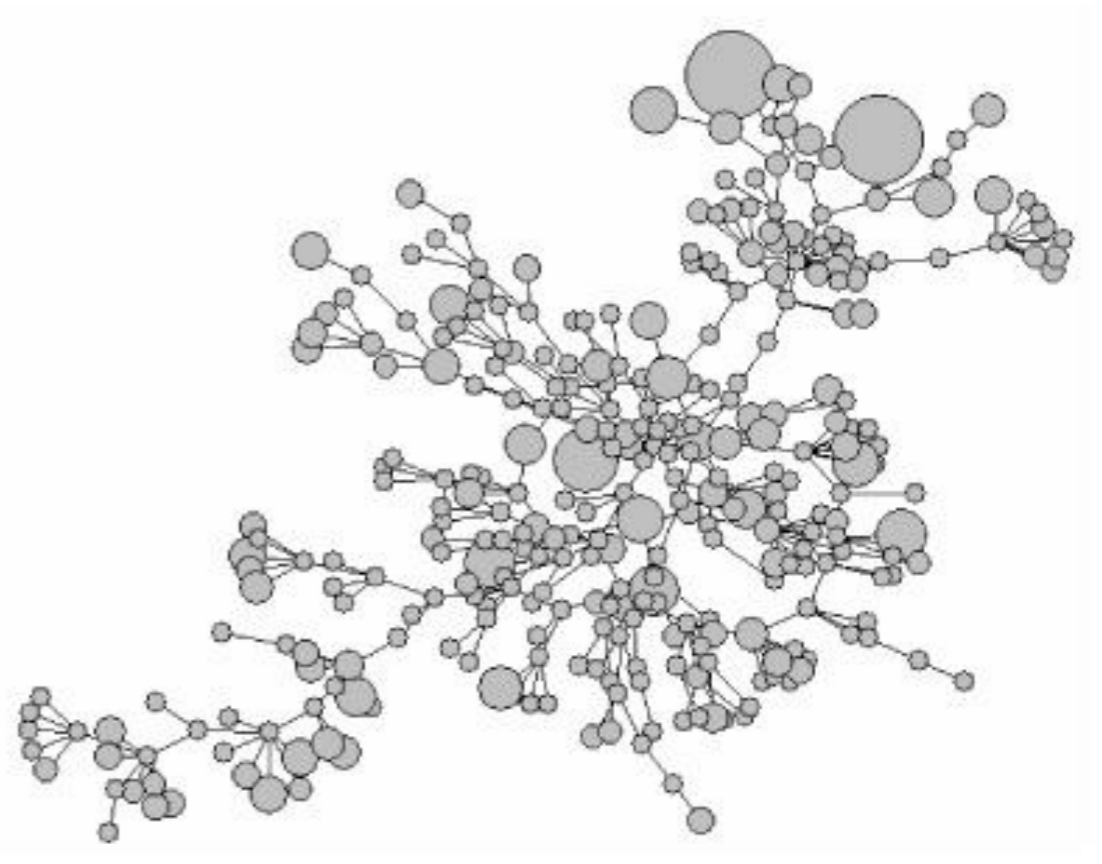
Disassortativity: when nodes with high degree tend to be connected to nodes with low degree

Examples:

In sexual contact networks, people with many partners don't tend to find each other

In financial networks, large banks tend to be connected to smaller ones

In the power grid, large stations are connected to smaller ones.



CO Springs sexual contact network: Newman
"Assortative Mixing in Networks"

Assortativity and Homophily

r is the assortativity coefficient:

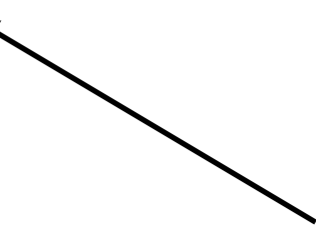
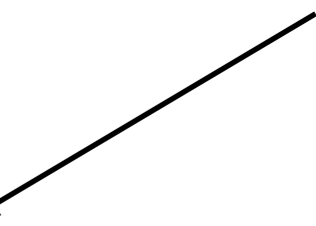
$r > 0 \Rightarrow$ assortative mixing

$r < 0 \Rightarrow$ disassortative mixing

calculated by comparing the number of connections between high-degree nodes to the number expected if the network were random

	network	n	r
real-world networks	physics coauthorship ^a	52 909	0.363
	biology coauthorship ^a	1 520 251	0.127
	mathematics coauthorship ^b	253 339	0.120
	film actor collaborations ^c	449 913	0.208
	company directors ^d	7 673	0.276
	Internet ^e	10 697	-0.189
	World-Wide Web ^f	269 504	-0.065
	protein interactions ^g	2 115	-0.156
	neural network ^h	307	-0.163
	food web ⁱ	92	-0.276

Social Networks



Biological and Information Networks

ref: Newman "Assortative Mixing in Networks"

Assortativity and Homophily

Assortativity is important when it comes to *diffusion* (the spread of disease, information, and failure across a network).

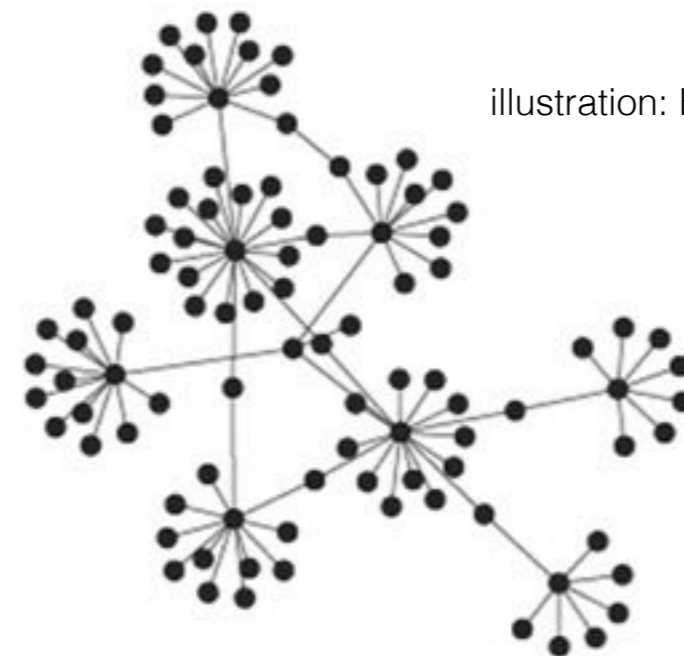
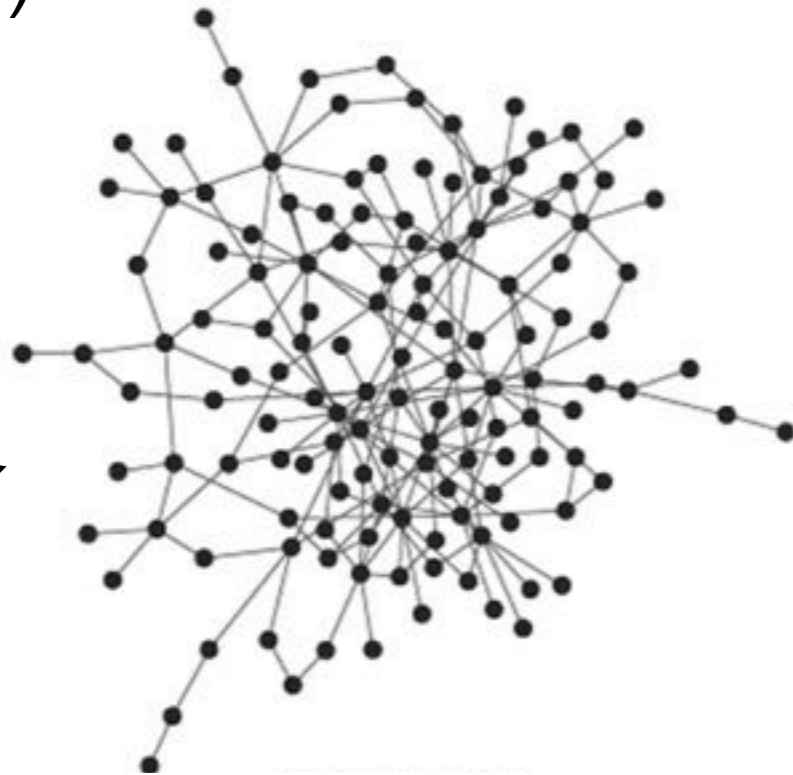


illustration: Hao et al (2011)

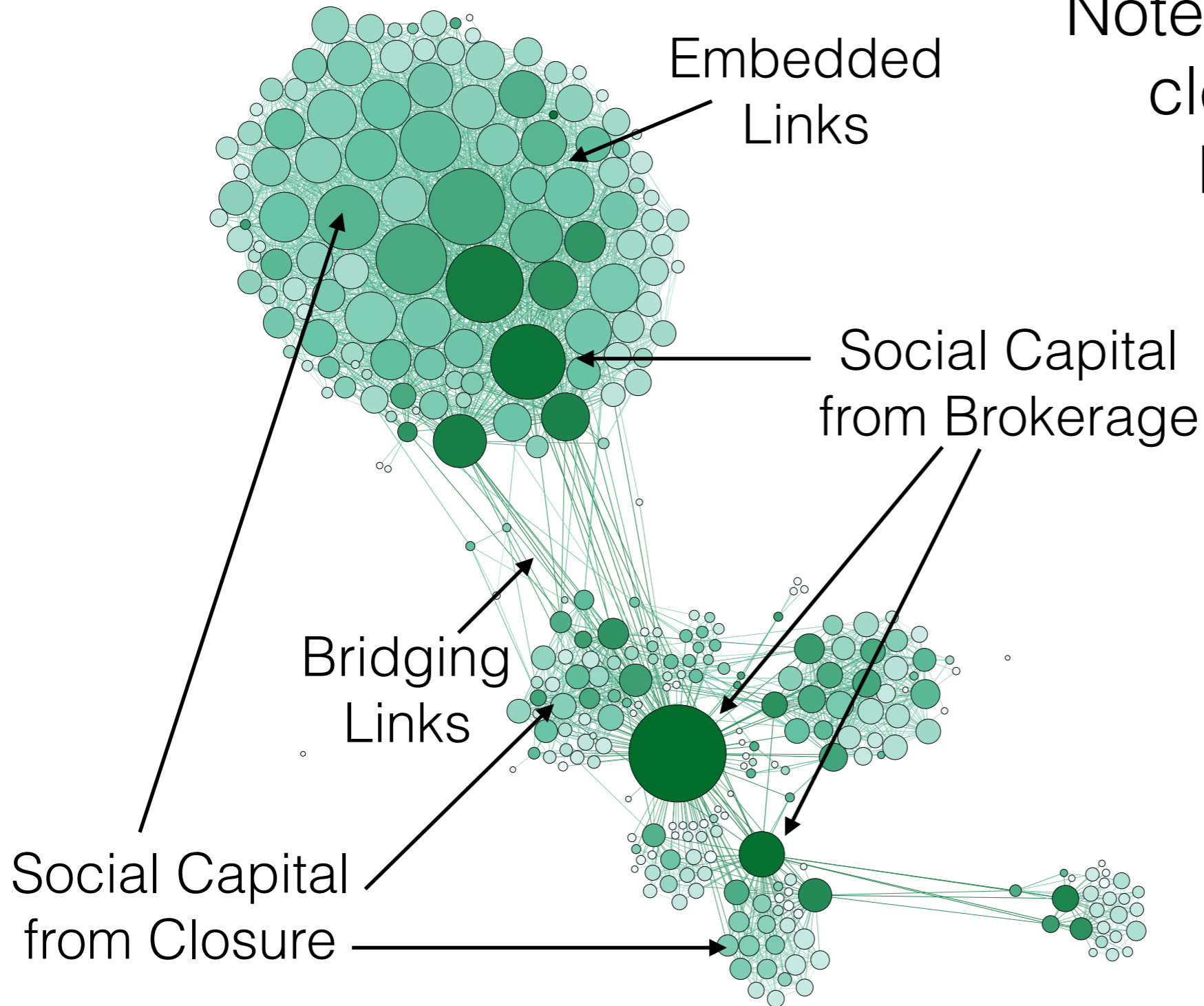
In an assortative network, disease spreads quickly, but spreads to a small fraction of the network

In a disassortative network, disease spreads slowly, but may reach a larger fraction of the nodes

More on that later...

Closure, Brokerage, and Social Capital

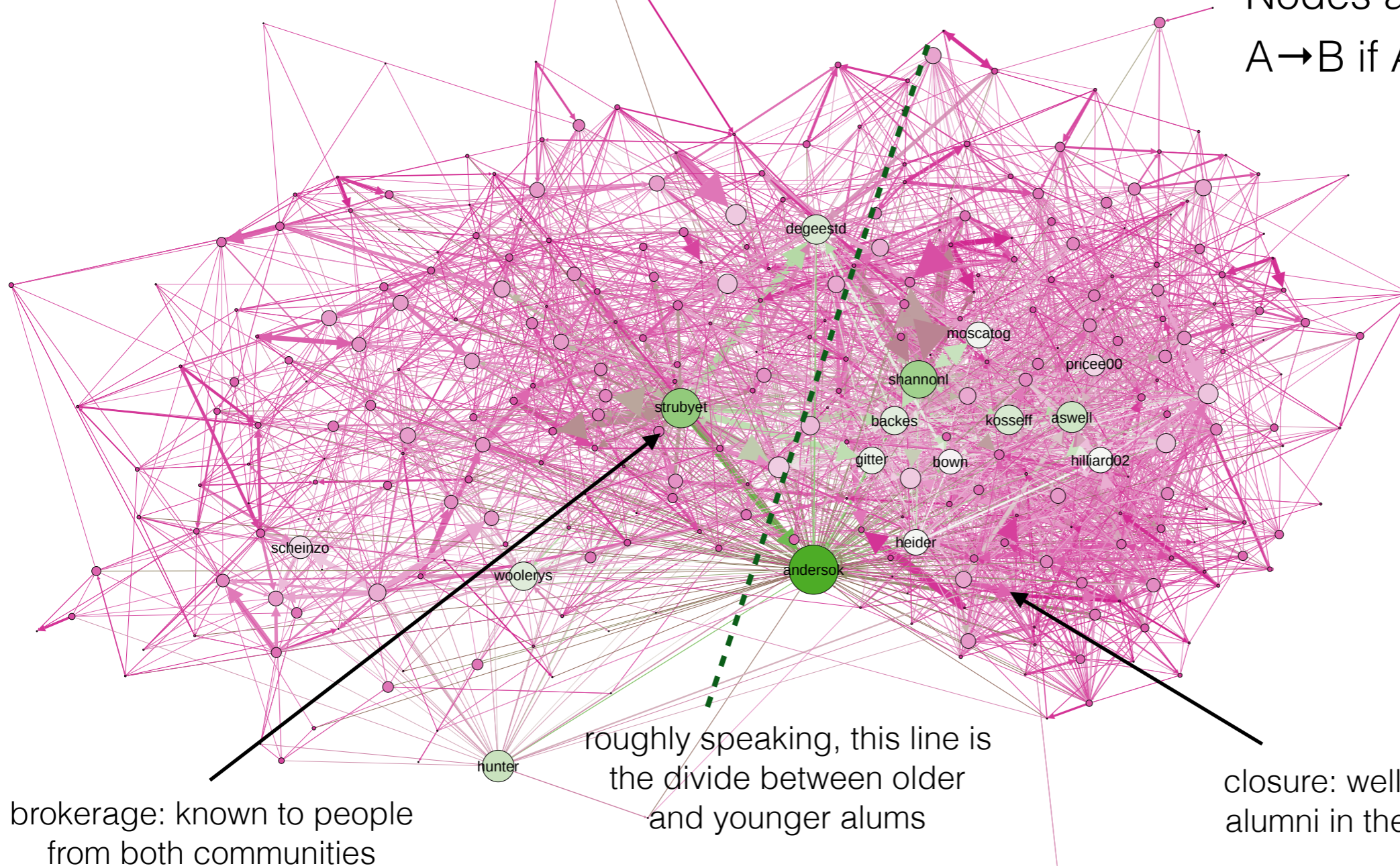
Note that brokerage is clearly related to betweenness



Closure, Brokerage, and Social Capital

Those who have high closure provide a sense of community. Those with brokerage connect the communities together...

Online alumni social network:
Nodes are alumni.
 $A \rightarrow B$ if A's page links to B's



The Big Picture

An individual's position on the social network confers both costs and benefits

- Social Capital: Brokerage and Closure
- High Degree and High Betweenness

Links between individuals are local, but they can have far-reaching effects:

- Local and Global Bridges affect the span of the network and the social capital of individuals
- Deleting a link potentially affects not just the nodes it connects, but the other nodes in the network