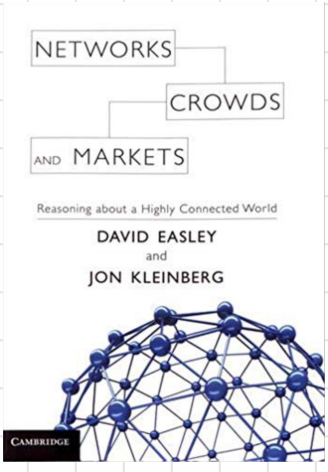
Lecture 4

Network Science

Strong and Weak ties

Today's Topics

- Introduction
- Triadic Closure
- "the strength of week ties"
- Tie Strength and Network Structure in Large Scale Data
- Tie Strength, Social Media, and Passive Engagement



Chapter 3

"Strong and Weak Ties"

From Local to Global

Complexity

socio-psychological behavior

structural property
in the network

Granovetter's hypothesis

Motivating Question

1960s – Granovetter's PhD

1. people found a job through a contact
2. "strength" of said contact had an impact on job-seeking

Surprising

acquaintances (weak ties) were more useful than "real friend" (strong ties) to receive fresher information during job-seeking.

Granovetter's hypothesis

Why?

G. proposed two different perspectives

1. Structural persp.: focus on how friendships span across different portions of your social network

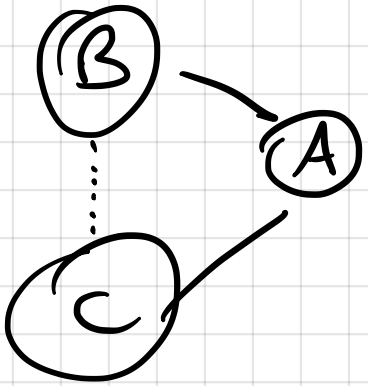
2. interpersonal: focus on purely local consequences that follow from a friendship (week or strong)

Evolution of a Network in Time

We have also nodes that join the netw. and also leave the netw.

and also links that are formed (or deleted) between two nodes

Rapoport, 1953



t : —

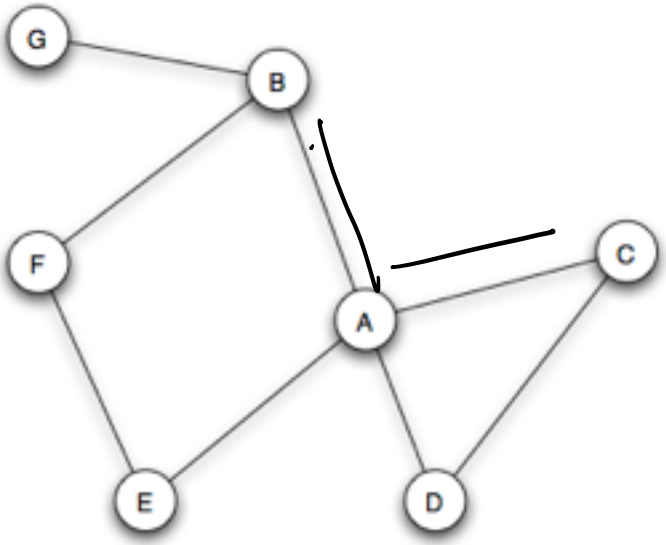
$t+\varepsilon$: ....

triadic closure

Triadic Closure

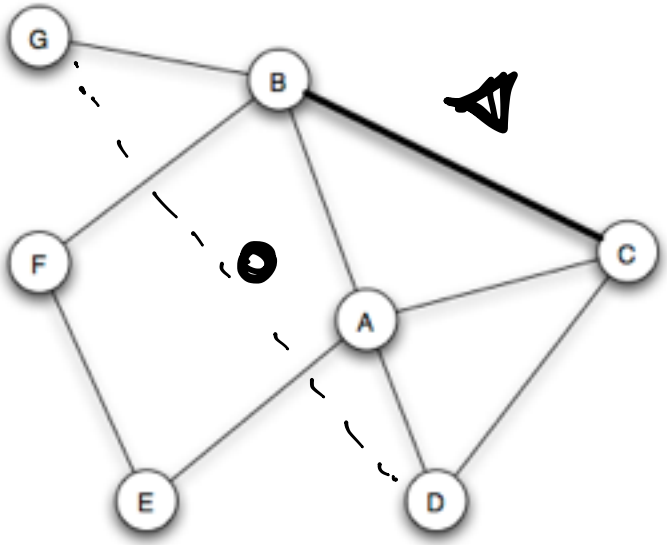
Δ is more likely than

t



(a) *Before B-C edge forms.*

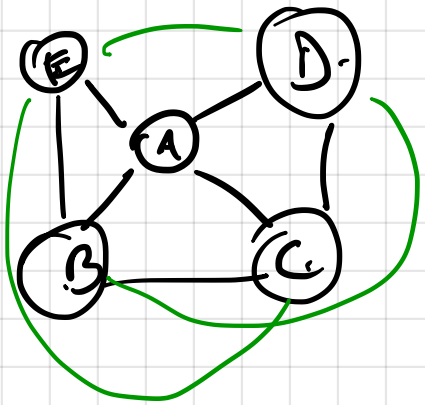
$t + \varepsilon$



(b) *After B-C edge forms.*

Relation with the Clustering Coefficient (cc)

cc is a property of a node

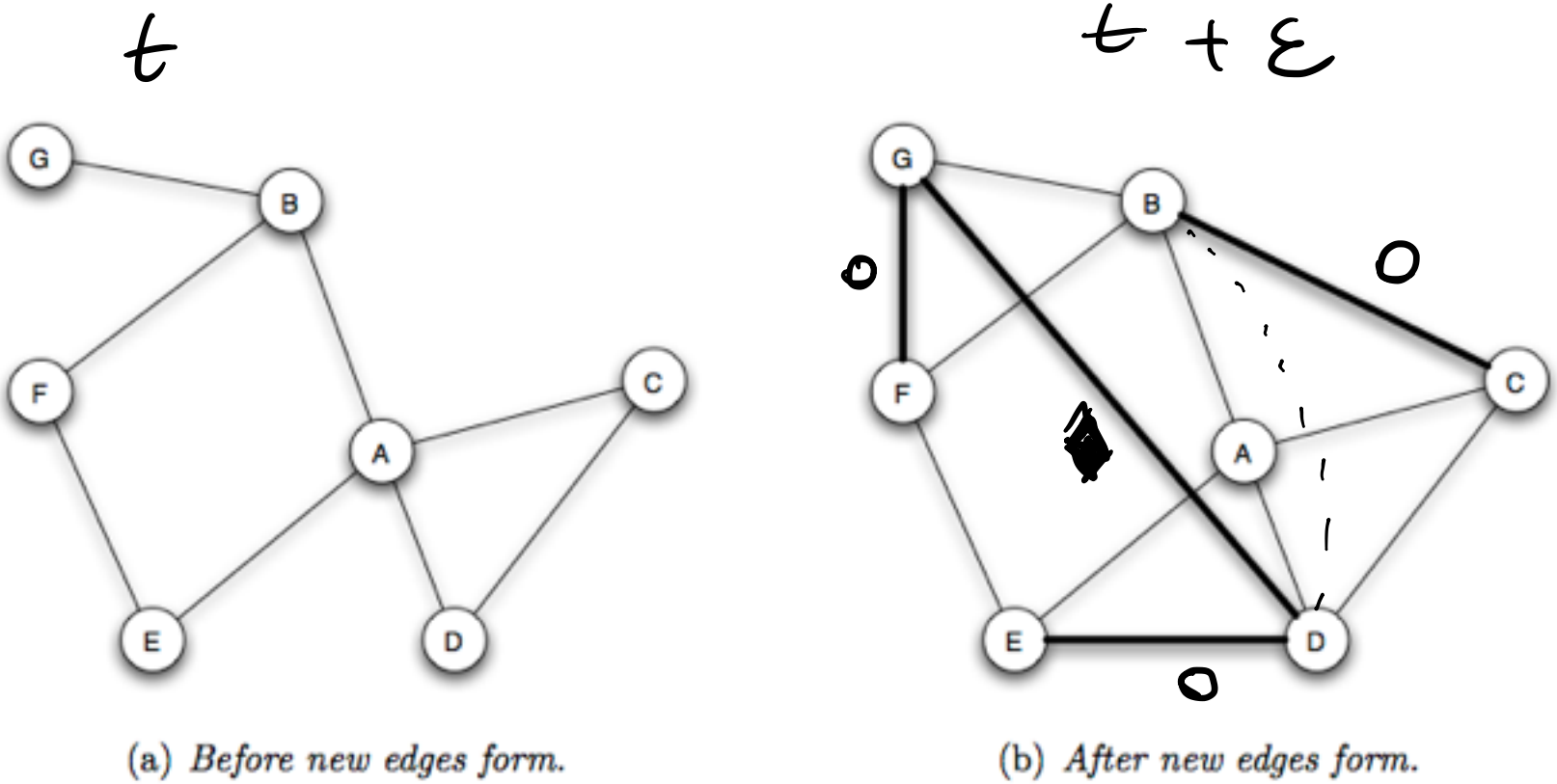


$$cc(A) = \frac{2 \cdot 3}{4 \cdot 3} = \frac{1}{2}$$

cc: the probability that friends of A are connected to each other

triadic closure is connected with the definition of c.c.

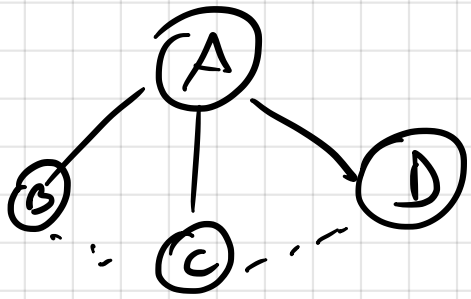
After a given span of time…



(a) *Before new edges form.*

(b) *After new edges form.*

Closing Triangles



the more strongly triadic closure is operating in the neighborhood of the node, the higher the c.c. will tend to be.

Side Note on clustering coefficient

high cc: extremely frequent in social netw.

low cc: in a random graph

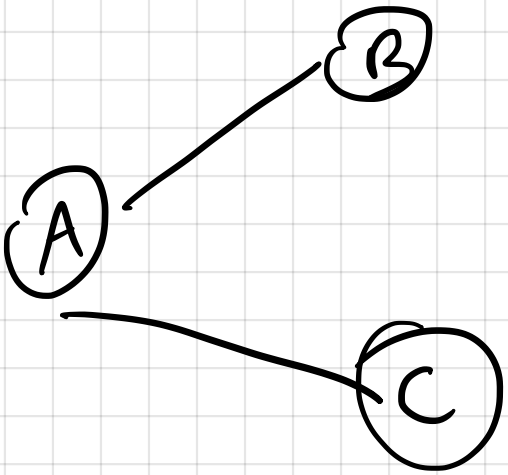
$$cc(G_R) << cc(G)$$

social network

"equivalent" random version of G

Reasons for triadic Closure

Opportunity
trusting
Incentive



Heider, 1958

Side note on "incentive"

a study on teenage girls found a correlation low C.C and suicide

the structure of social connections can be indicators for catastrophic events

Bearman and Moody, 2004

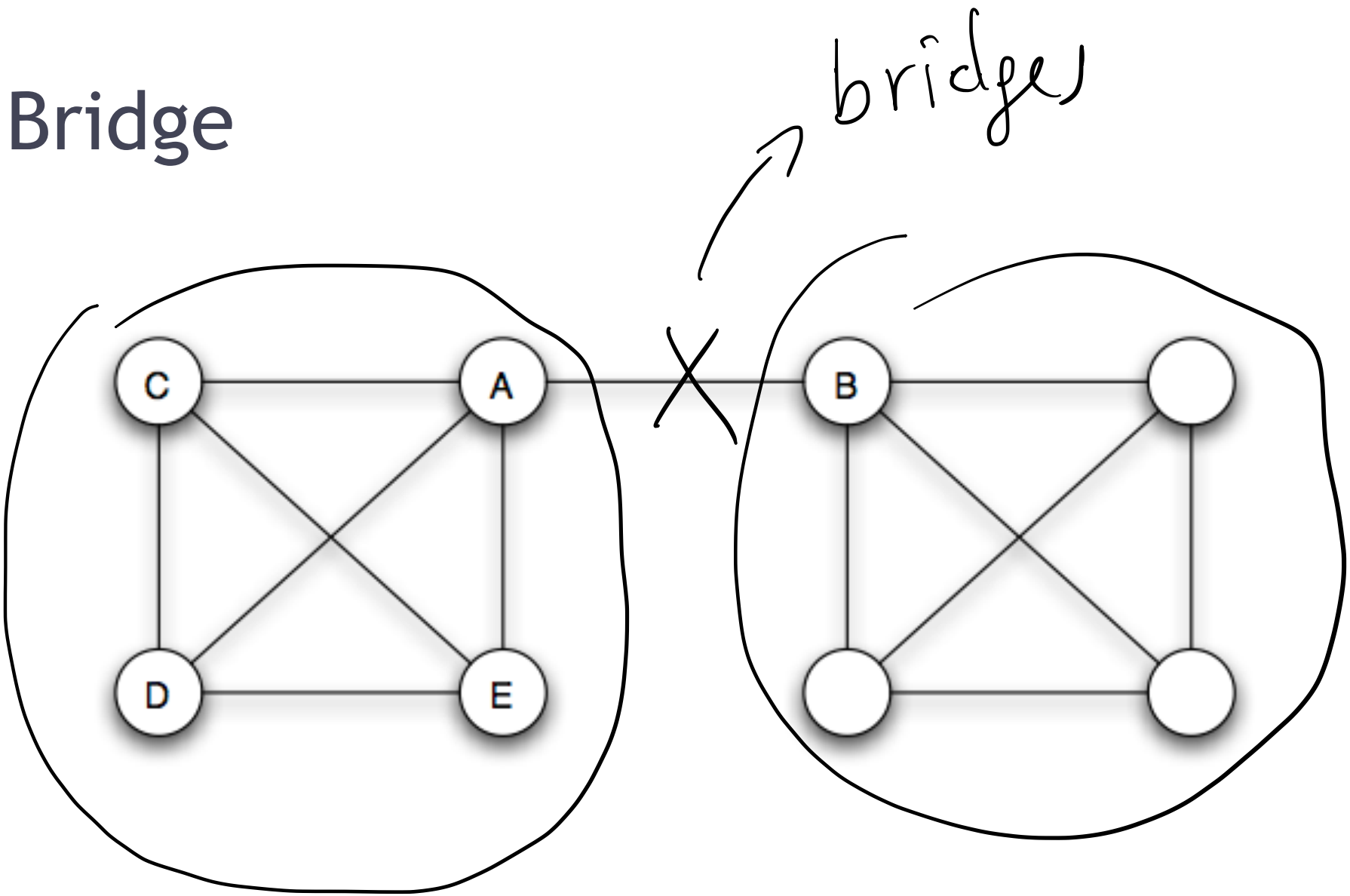
The Strength of Weak ties

interpersonal triadic closure

weak vs strong ties

weak ties have access to information that a node don't

Bridge



(strong) definition of e bridge

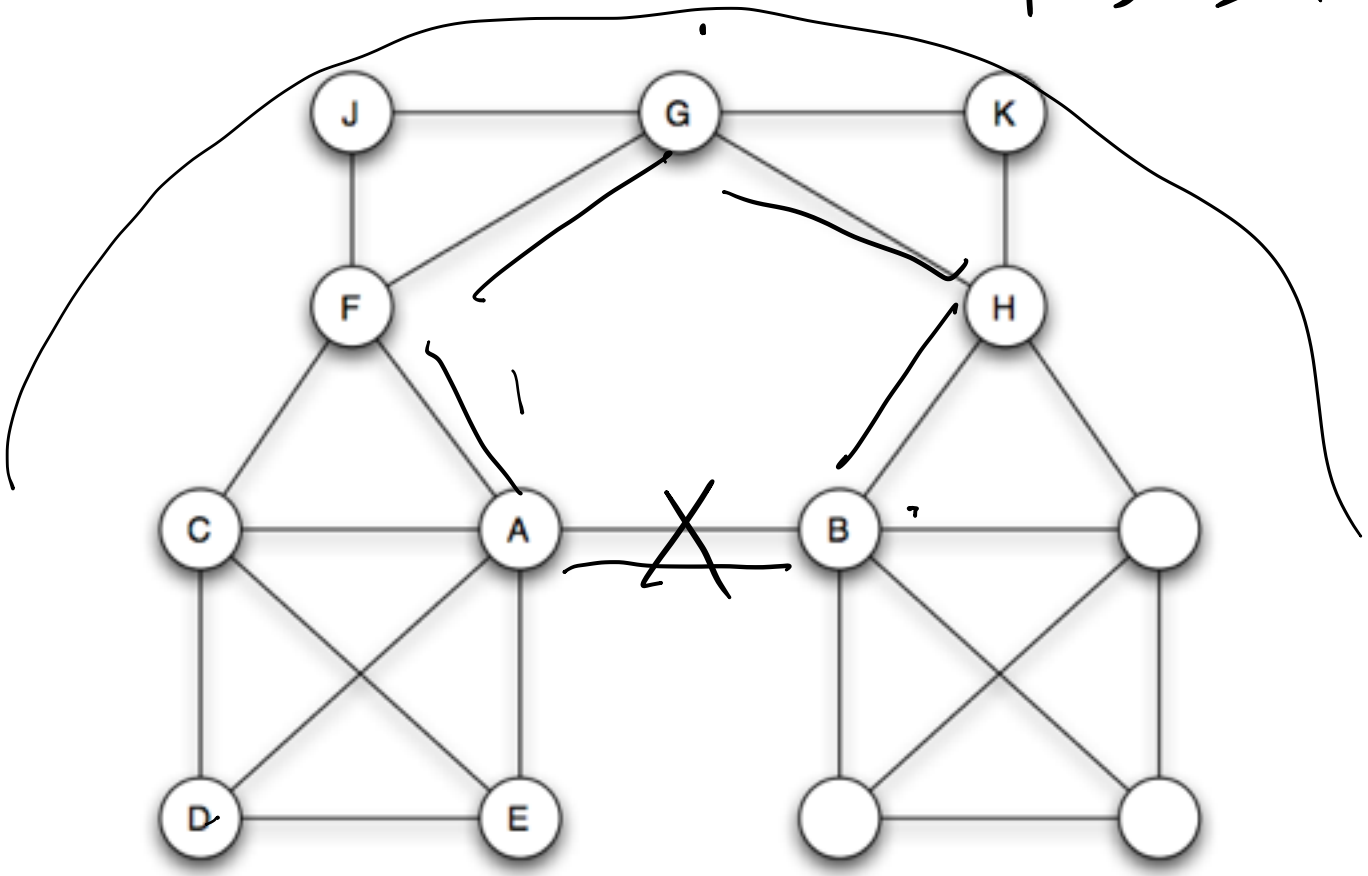
two vcles A B are connected by a bridge if deleting edge (A, B) the graph is divided in two different components

bridges are extremely rare in reef world

Longer paths

p(A, B)
→ length = 1

p(A, B) → 1 = 4



Definition of a local bridge

if we remove edge (A, B) it will take a significantly longer path to connect A and B.

"significantly" > 2

Span of a local bridge

Span : new distance between nodes A and B when (A, B) is removed

Span(A, B) = 4

in the prev. ex.

The role of a local bridge

endpoints in a local bridge can receive fresher information because of their position.

- local bridge play roughly the same role of a bridge
- endpoints are likely to receive fresh information from the group they do not belong to.

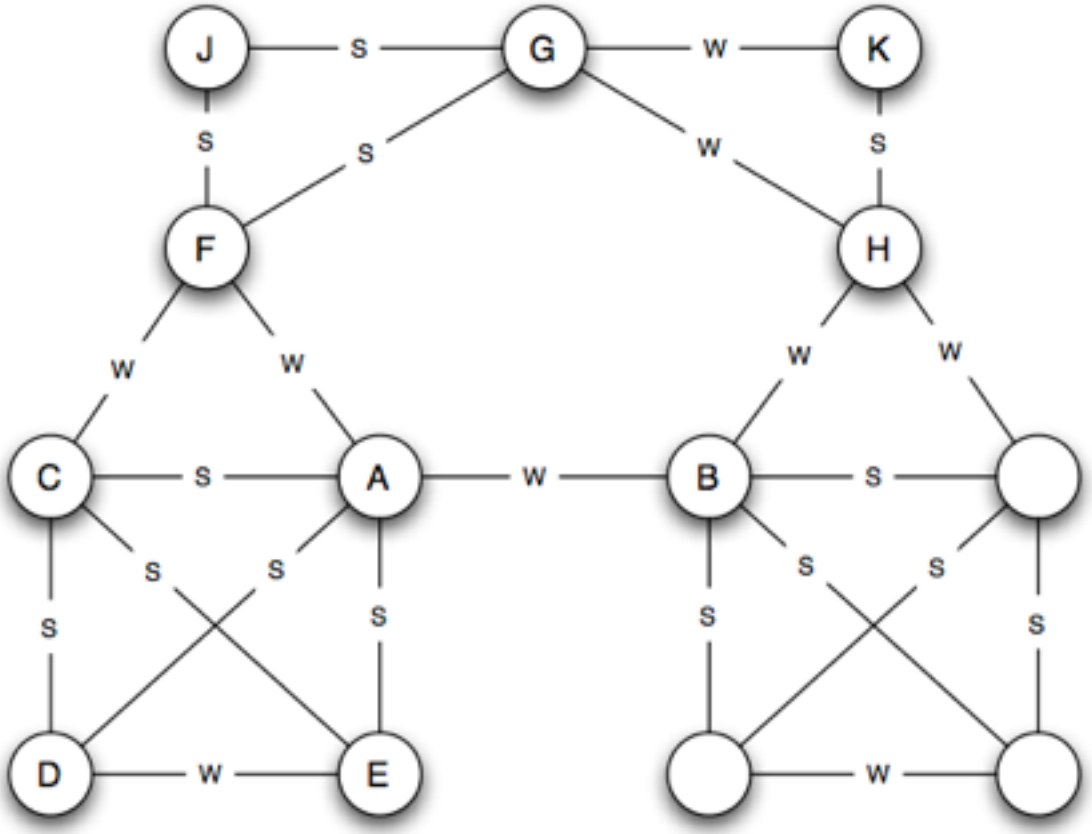
Different level of strength

Week ties → acquaintances

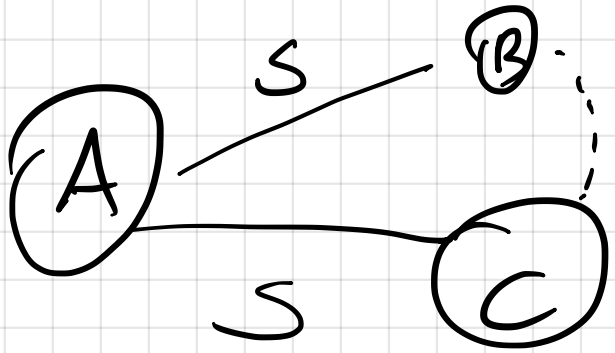
Strong ties → friend

{w, s} : labels for edges

Strong and weak ties annotations



Triadic closure and strength of ties



"[illegible] assumption"

Strong Triadic Closure

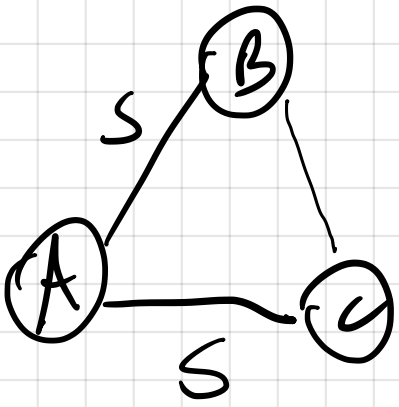
more concrete

STC property:

if A is connected to B

if $(A, C) \in L$

and



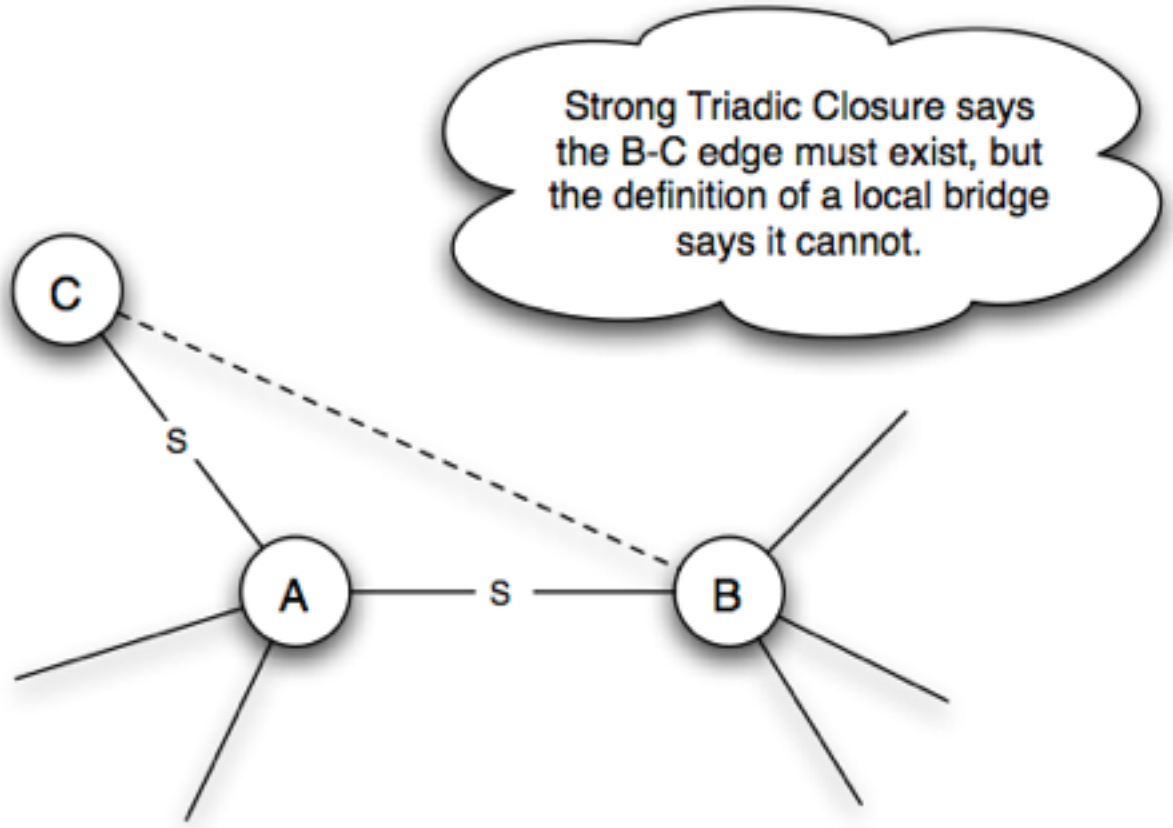
B and C will be connected in the future

then

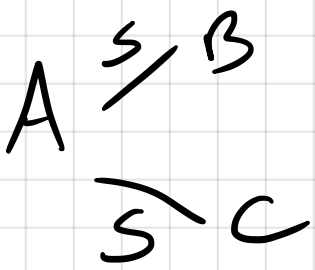
(A, B), (A, C) are both strong

Local Bridges and Weak Ties

if a node A in a network satisfies the STC property and it is involved in at least two strong ties, then any local bridge it is involved in must be a weak tie


Strong Triadic Closure says the B-C edge must exist, but the definition of a local bridge says it cannot.
C
S
A
S
B

Proof by contradiction



(A, B): is a bad bridge

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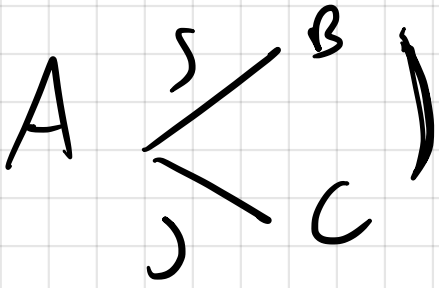
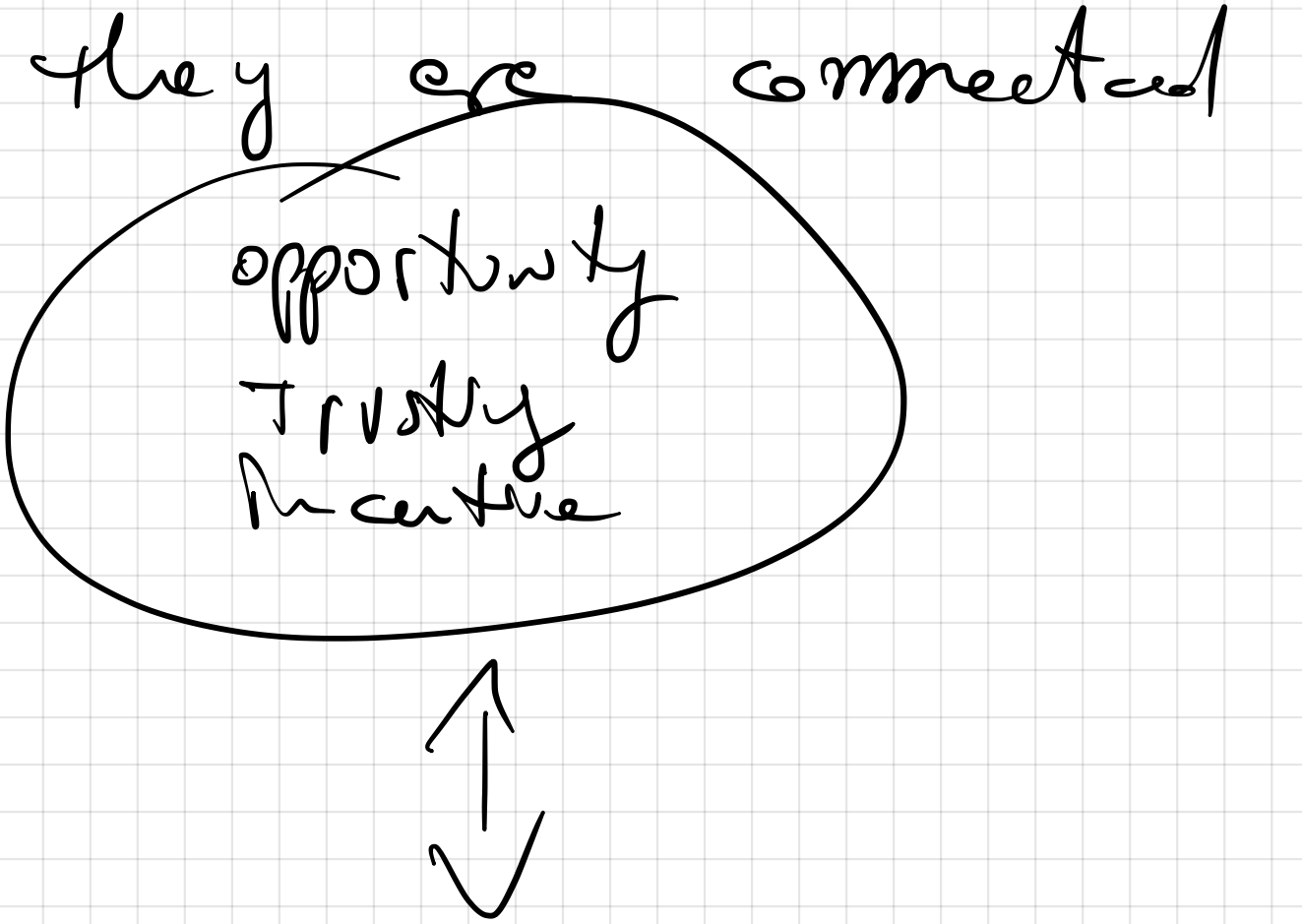
if STC property holds



→ (A B) is not a bad bridge

contradiction □

Interpersonal and structural properties



Strong Triadic Closure property: too STRONG?

real world is not broken

However we want to observe if bad bridge tend to be ≈ weak ties

Test or real Data

need to validate

- large population
- With an approximate measure to discriminate between local bridges and between weak and strong ties

Concrete frame work

$$(w, s) = (0, 1)$$

we need different scales

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strength $\in [0, \infty)$

Digital Communication network

"who talks to whom"

network

$s \Leftrightarrow$ total time spent in mintg

The case of cell-phone network

Finnish telecom company

20% market share

Omele et al 2007

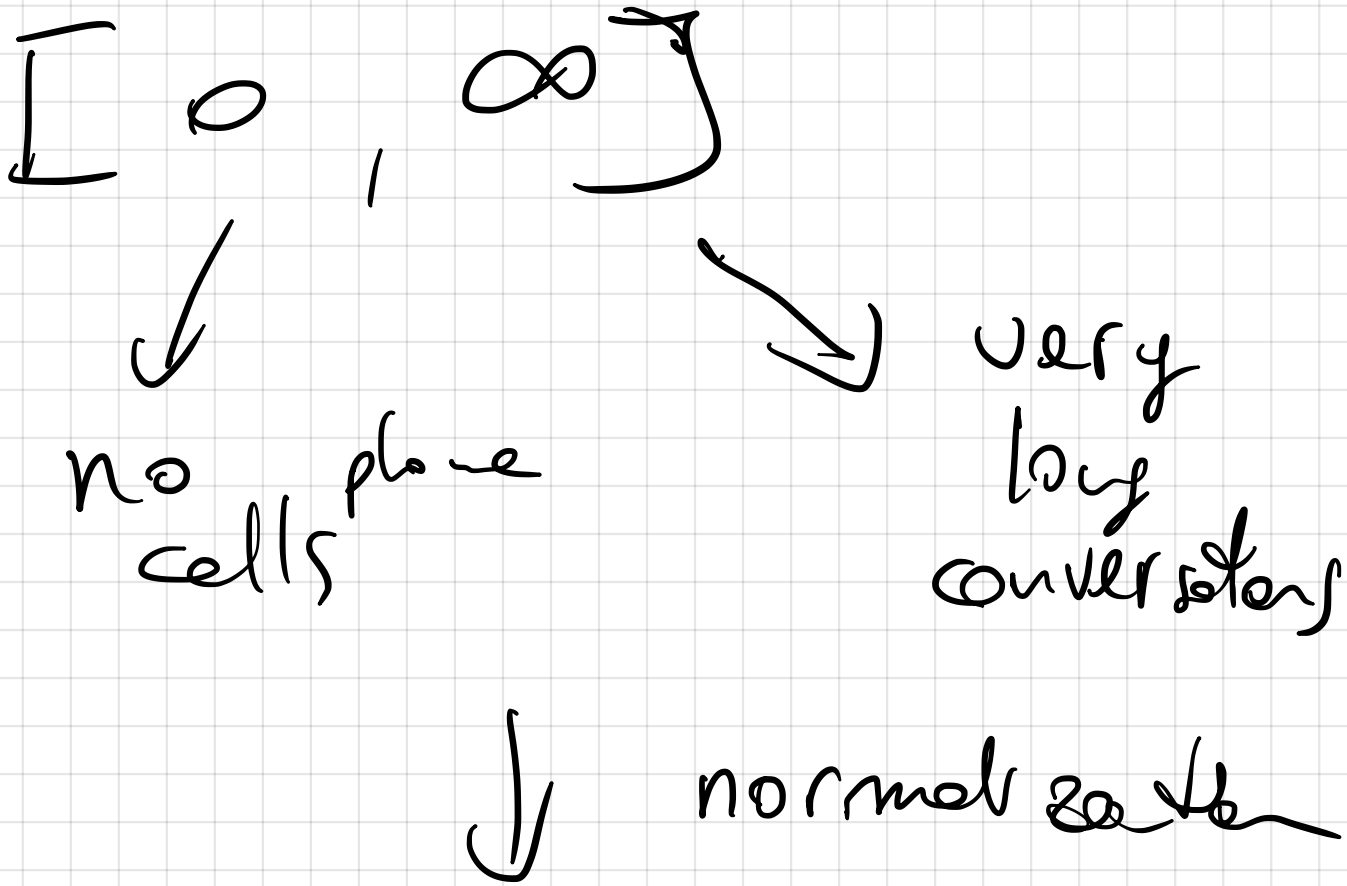
- observation period: 18 week
- (A, B): there was a call placed by A to B

First observation

Giant Component 84% nodes

Generalizing the notions of weak ties and local bridges

$[0, \infty]$



$[0, 1]$

Neighborhood Overlap

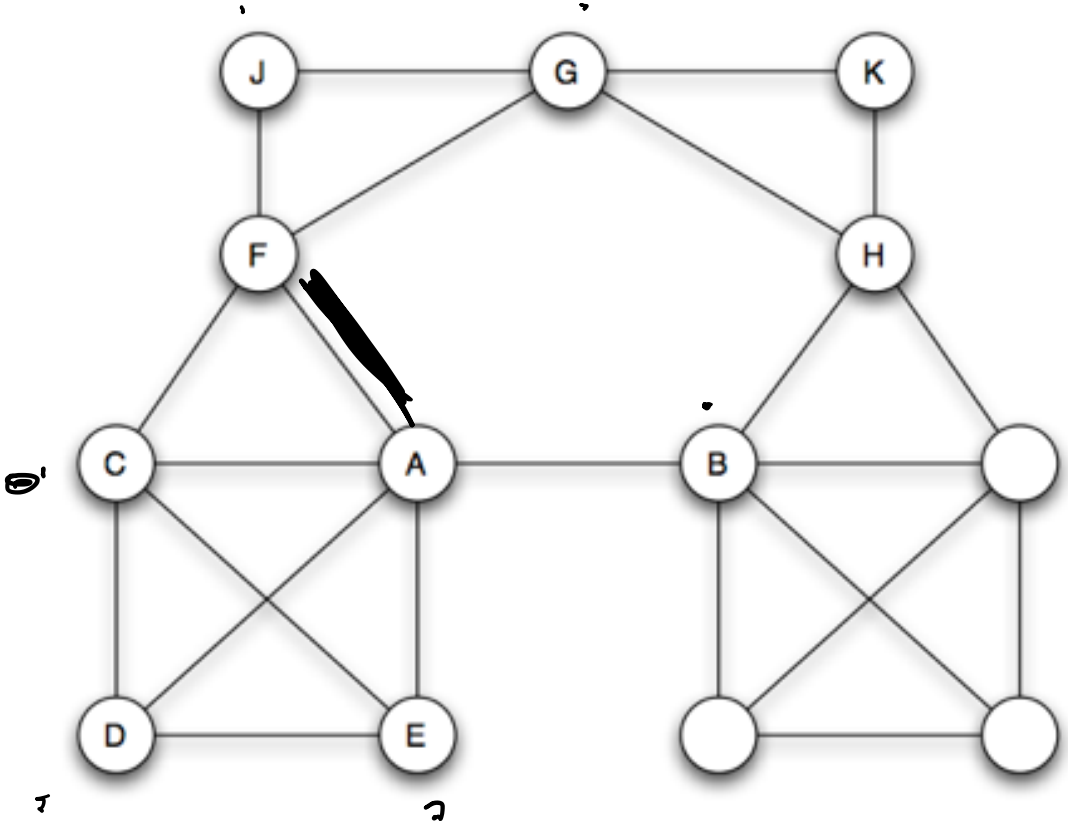
$N(A)$: Neighbors of A

$$O_{AB} = \frac{|N(A) \cap N(B)|}{|\{N(A) \cup N(B)\} \setminus \{A, B\}|}$$

O_{AB} : proxy for local bridge

$$\theta_{AF} = \frac{1}{6}$$

Example

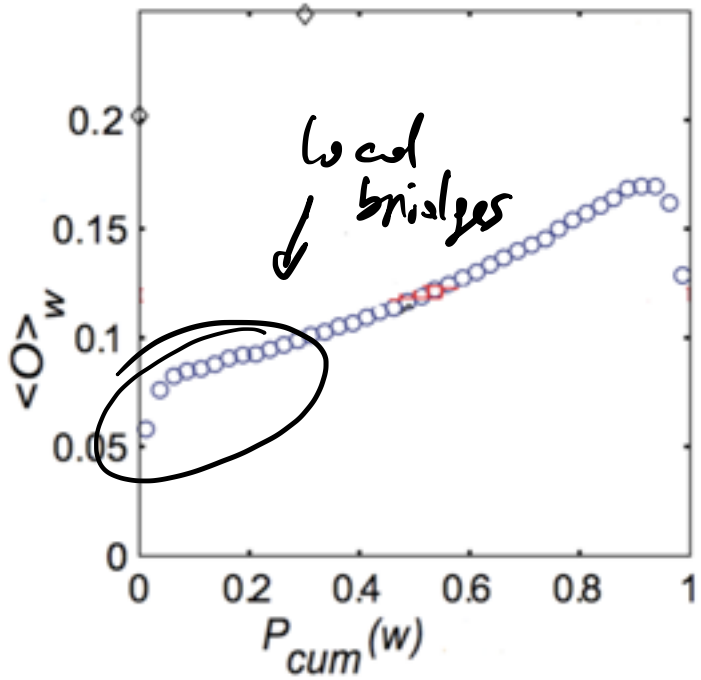


Key Feature

Local bridge definition is contained in NO definition

$$O_{AB} = 0 \iff (A, B) \text{ is a local bridge}$$

Plotting neighborhood overlap



Indirect Analysis

Dunne et al.

they started deleting edges

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two ways

+ randomly
+ sorting by "strength" and removing weakest ties first

the second approach led to faster disconnection of the whole network

Important!

this is just
a first step
to evaluate
sociological theory
to real world

Networks are important

to validate many
social theories
because they provide
a useful tool to deal
with big data

Tie Strength, Social Media and Passive Engagement

Social networking tools (Facebook, twitter, ...) help people maintain explicit information about their "social circles"

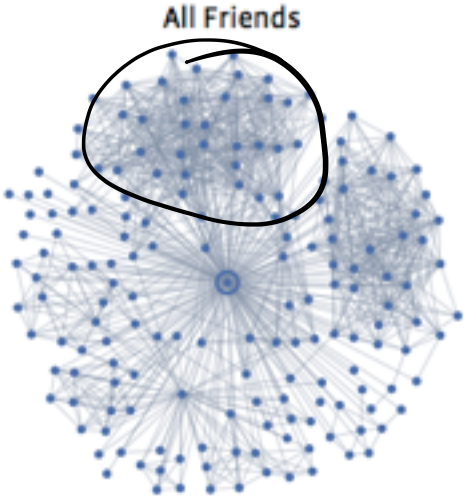
the strength of the ties can provide a useful perspective to better understand such circles formation

Case study: Facebook

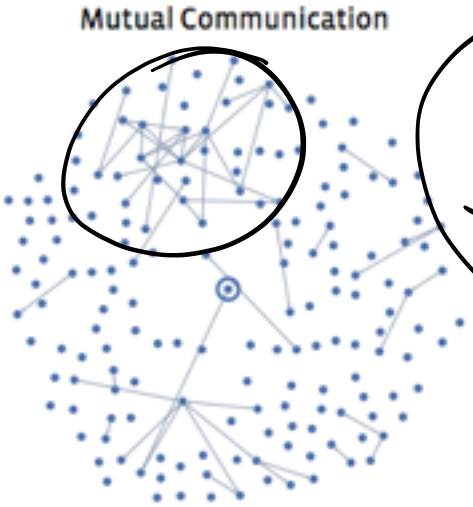
where are the strong ties among a user's friends ?

Tie Strength on Facebook

Weakest



"passive engagement"



S

Strongest

Marlow et al., 2009

Take home message