CS 103: Lecture 2 Strong and Weak Ties

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Plan for today

- Graph theory
  - Review definitions (exercise w/ partner)
  - Thought experiment (giant components)
  - Giant component video
- Strong and Weak ties

Granovetter (~1970): "Strength of Weak Ties"

- People get jobs by hearing about them through friends
- "Weak Ties": people are more likely to hear about their jobs from "acquantiances" than friends
- Why?

Overview of Approach

How can we explain this using graph theory?

Claim: If a node A in a network satisfies the **Strong Triadic Closure** property and is involved in at least two **strong ties**, then any **local bridge** it is involved in must be a **weak tie**.

What??

Overview of Approach

Not apparent that this (hard-to-understand) statement has anything to do with Granovetter's observation

Mathematical model

- Simplification of real world
- Try to make a precise statement that is predictive of what we observe
- OK to make the "right" simplifications

Overview of Approach

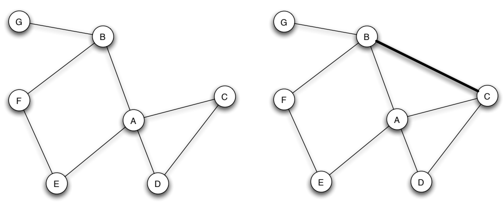
Map of ideas

- **Triadic Closure**: observed structural property of real social networks
- **Bridges / Local Bridges**: mathematical definitions for edges that connect disparate parts of graph
- **Strong and Weak Ties**: social notion

Mathematical statement about networks that corroborates Granovetter's observations.

Triadic Closure

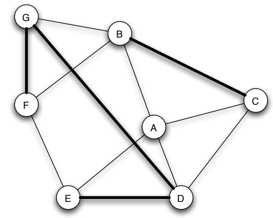
If A is friends with B and C, then B and C are likely to become friends



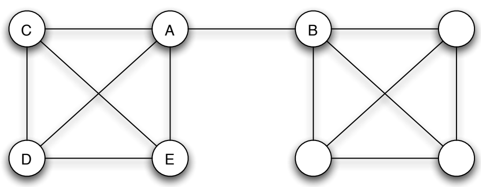
- Opportunity
- Trust
- Incentive

Triadic Closure

When we take a snapshot of a network, we are likely to see many "triangles".



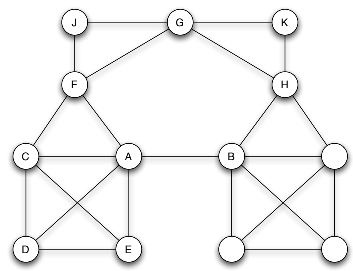
Bridges and Local Bridges



- edge from A to B seems more valuable than edges to C, D, E
- C, D, E know same things as A

Definition: edge A-B is a **bridge** if, when removed, the network becomes disconnected

Bridges and Local Bridges



Definition (local bridge): edge A-B is a **local bridge** if, when removed, the distance between A and B becomes 3 or more. Equivalently:

- A and B have no friends in common
- Edge A-B is not part of any triangles

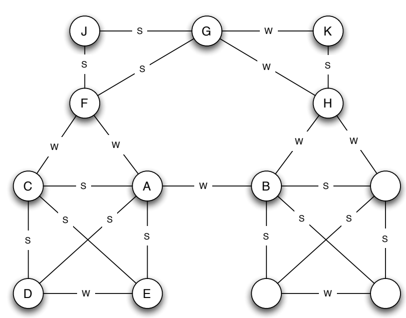
Exercises

Identify bridges and local bridges in an example graph.

Strong and Weak Ties

Back to Granovetter: need a way to differentiate between friends and acquaintances.

Supose each edge in the graph is classified as "strong" (S) or "weak" (W)



Strong Triadic Closure

Hypothesis: If A has *strong* edges to B and C, then the B-C edge is very likely to form

Definition (Strong Triadic Closure)

Example on board

- Node A *violates* the Strong Triadic Closure property if it has strong ties to any two nodes B and C, but B and C are not connected (by either a strong or weak tie).
- Node A *satisfies* the Strong Triadic Closure property if it does not violate it.

Exercise

Identify nodes that do and do not satisfy the Strong Triadic Closure property in an example graph.

Local Bridges and Weak Ties

Now we can make a precise mathematical statement

Claim: If a node A in a network satisfies the **Strong Triadic Closure** property and is involved in at least two **strong ties**, then any **local bridge** it is involved in must be a **weak tie**.

Paraphrased: if "Triadic Closure," then "local bridge" ==> "weak tie"

If we assume the structural property of triadic closure (that is usually observed in social networks), then any edge that connects disparate parts of the network (according to the mathematical definition of a local bridge) is a weak tie.

Proof! (on board)

Empirical Support

Cell phone "who-talks-to-whom" network (Onnela et al.)

- Tie strength
  - Minutes spent talking to each other
  - More refined than strong vs. weak
- Local bridges
  - Test if local bridges are are weaker
  - No, define more refined version
  - Compare "local-bridgedness" to tie strength

Empirical Support

Define Neighborhood overlap of A-B (local bridgedness)

```
# nodes who are neighbors of both A and B
---------------------------------------------------
# nodes who are neighbors of at least one of A
   or B
```

Example on board

Empirical support

Plot "Local-bridgedness" vs tie strength. What will it look like?