GENEVA GRADUATE INSTITUTE
INSTITUT DE HAUTES ÉTUDES INTERNATIONALES ET DU DÉVELOPPEMENT
GRADUATE INSTITUTE OF INTERNATIONAL AND DEVELOPMENT STUDIES

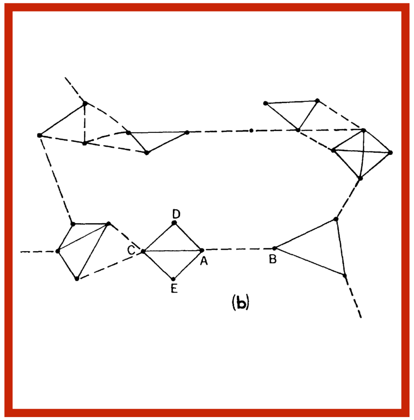
# Position

## Introduction to Social Networks

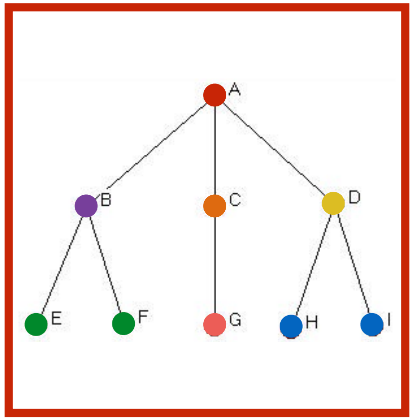
James Hollway

# Position

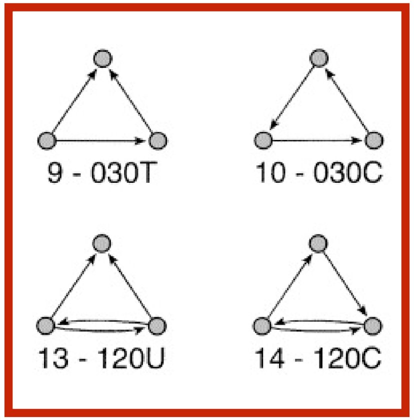
## Structural Holes



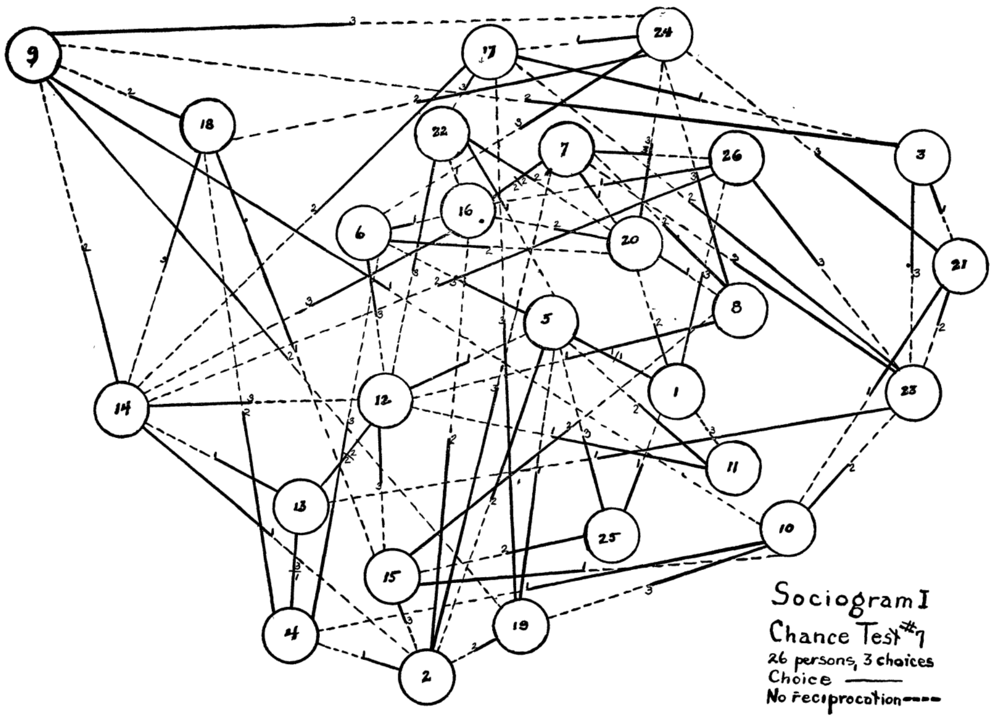

## Structural Equivalence




## Regular Equivalence



# Network positions




- Idea that one can learn about the nodes in a network by how they are connected to the rest of the network

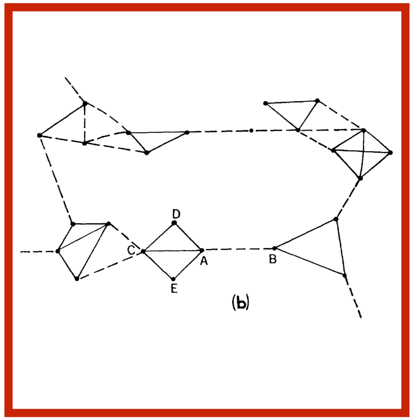
- Georg Simmel described society as interconnected and position within overlapping social circles key to individual identity (Simmel 1890, The web of group-affiliations)

- First to actually gather empirical data though were Jacob Moreno (1932, Application of the group method to classification) and Helen Jennings (see e.g. Moreno and Jennings 1938)

- In this random graph, each node has three outgoing links, which they compared with an empirical network "in which two dominating individuals are strongly united both directly and indirectly through other individuals" (according to Freeman), demonstrating cohesiveness ("strongly united") and social roles ("dominating individuals").

# Position

## Structural Holes




## Structural Equivalence




## Regular Equivalence

# How to get a job?

# How do people find jobs?

- PhD topic of Mark Granovetter (1970)
- He surveyed a few hundred people from a mid-sized US town and hypothesised:
  - H1: highly educated people use these qualifications to compete for jobs in the formal labour market
  - H2: less educated people have fewer distinguishing features, so rely on social contacts, especially close family and friends, because they will try very hard to get them a job

# He was wrong…

- …and wrote the most cited article in social science about it

# The results of the study

- For manual labourers, the proportion of jobs found through social contacts was minimal

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- For manual labourers, the proportion of jobs found through social contacts was minimal
- But most high-paying, high-skilled jobs were obtained through social contacts…
- …and these social contacts were mainly distant acquaintances
- Why?


I KNOW A GUY WHO KNOWS A GUY
WHO KNOWS A GUY
STRENGTH OF WEAK TIES

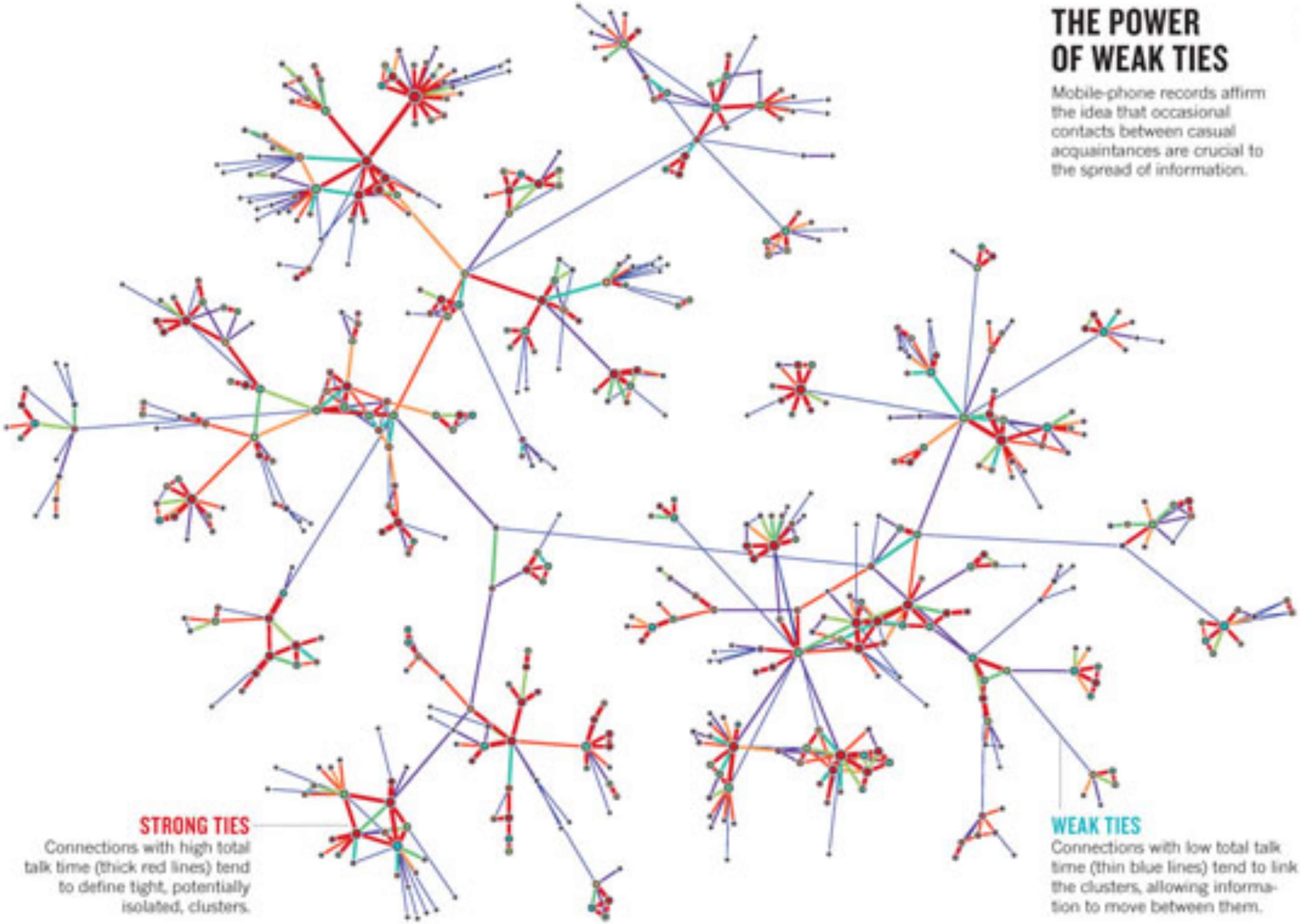
| Friends and family | Acquaintances |
|---|---|
| Reciprocal | Asymmetric |
| Multiplex | Simplex |
| Much trust | Little trust |
| Emotional | Instrumental |
| Intimate | Distant |
| Daily | Infrequent |
| Persistent | Ephemeral |
| Shared experiences | Different experiences |
| Same information | Novel information |
| Private information | Public information |

See Granovetter 1973, Marsden & Hurlbert 1988, Wellman & Worthley 1990: 581, Albert & David 2001, Angelusz & Tardos 1991: 82, Angelusz 2009, Gyarmati 2009: 55

# THE POWER OF WEAK TIES

REF. 7

Mobile-phone records affirm the idea that occasional contacts between casual acquaintances are crucial to the spread of information.



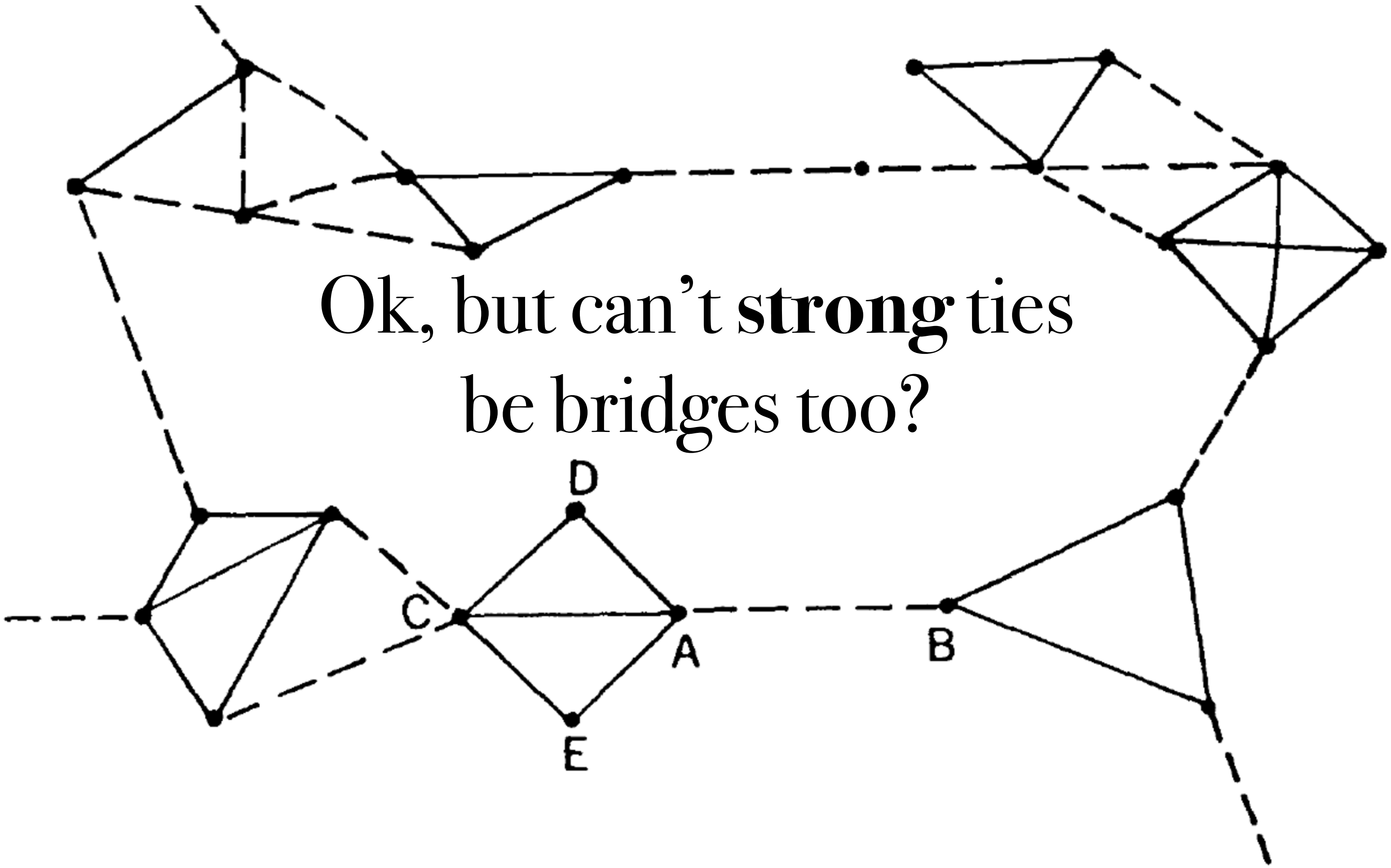
**STRONG TIES**

Connections with high total talk time (thick red lines) tend to define tight, potentially isolated, clusters.

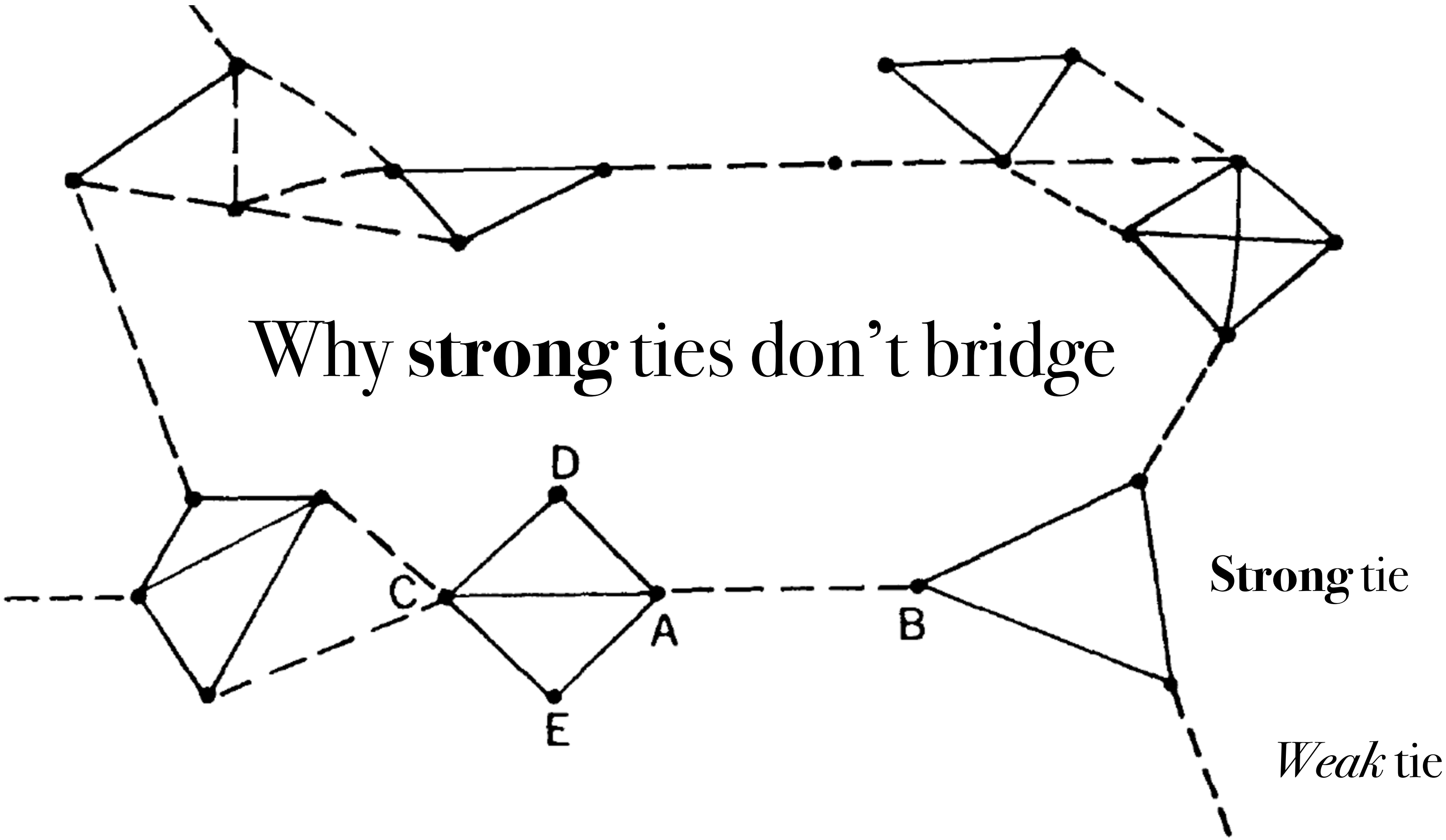
**WEAK TIES**

Connections with low total talk time (thin blue lines) tend to link the clusters, allowing information to move between them.

Ok, but can't **strong** ties be bridges too?



# Why **strong** ties don't bridge



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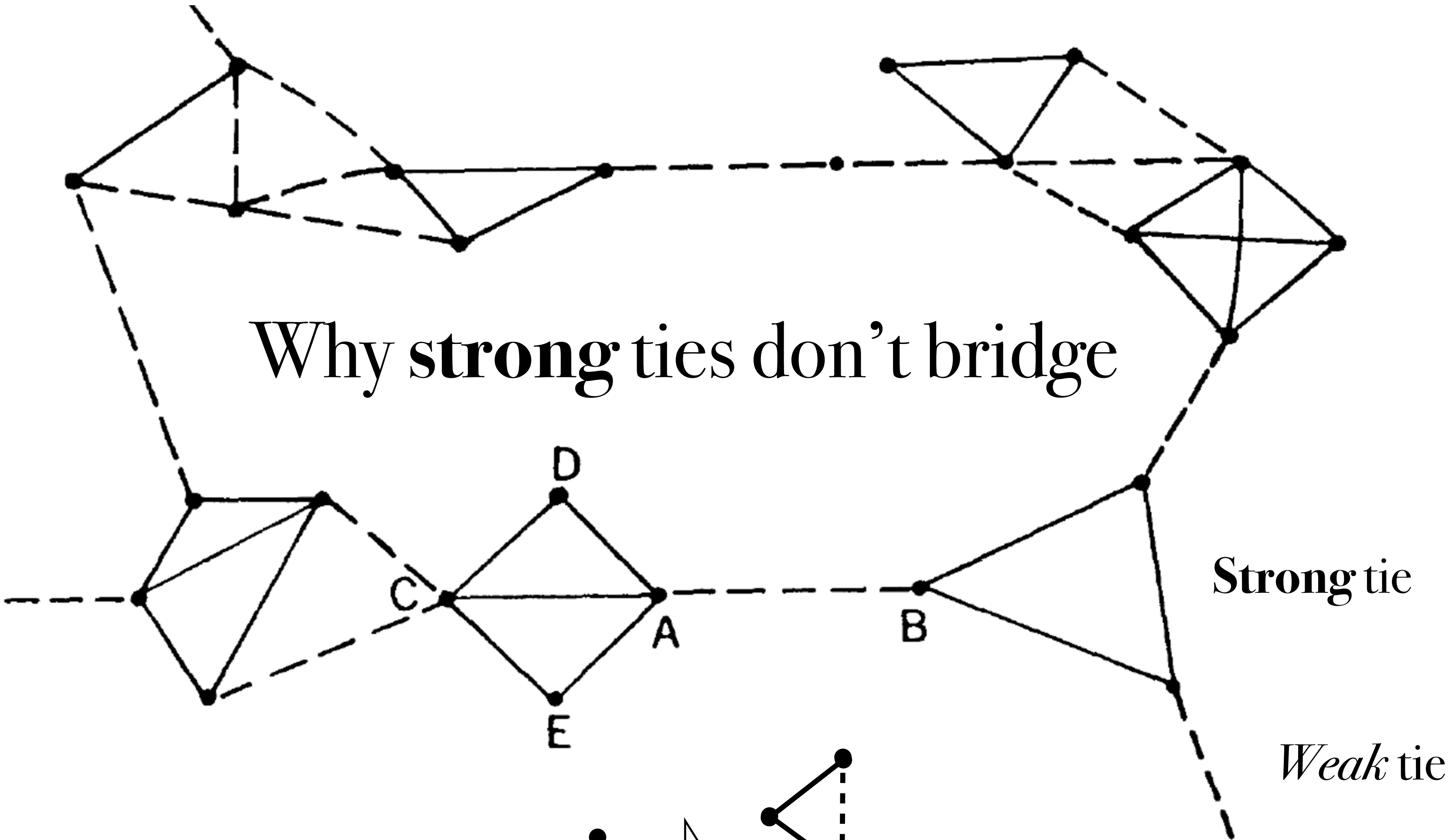
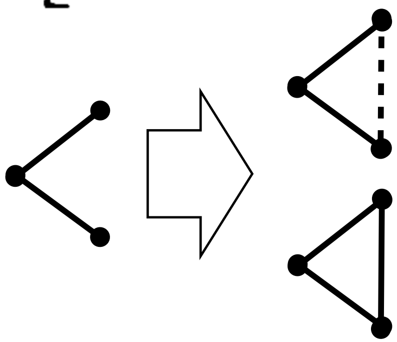



“Forbidden Triad”
because balance,
homophily, and time



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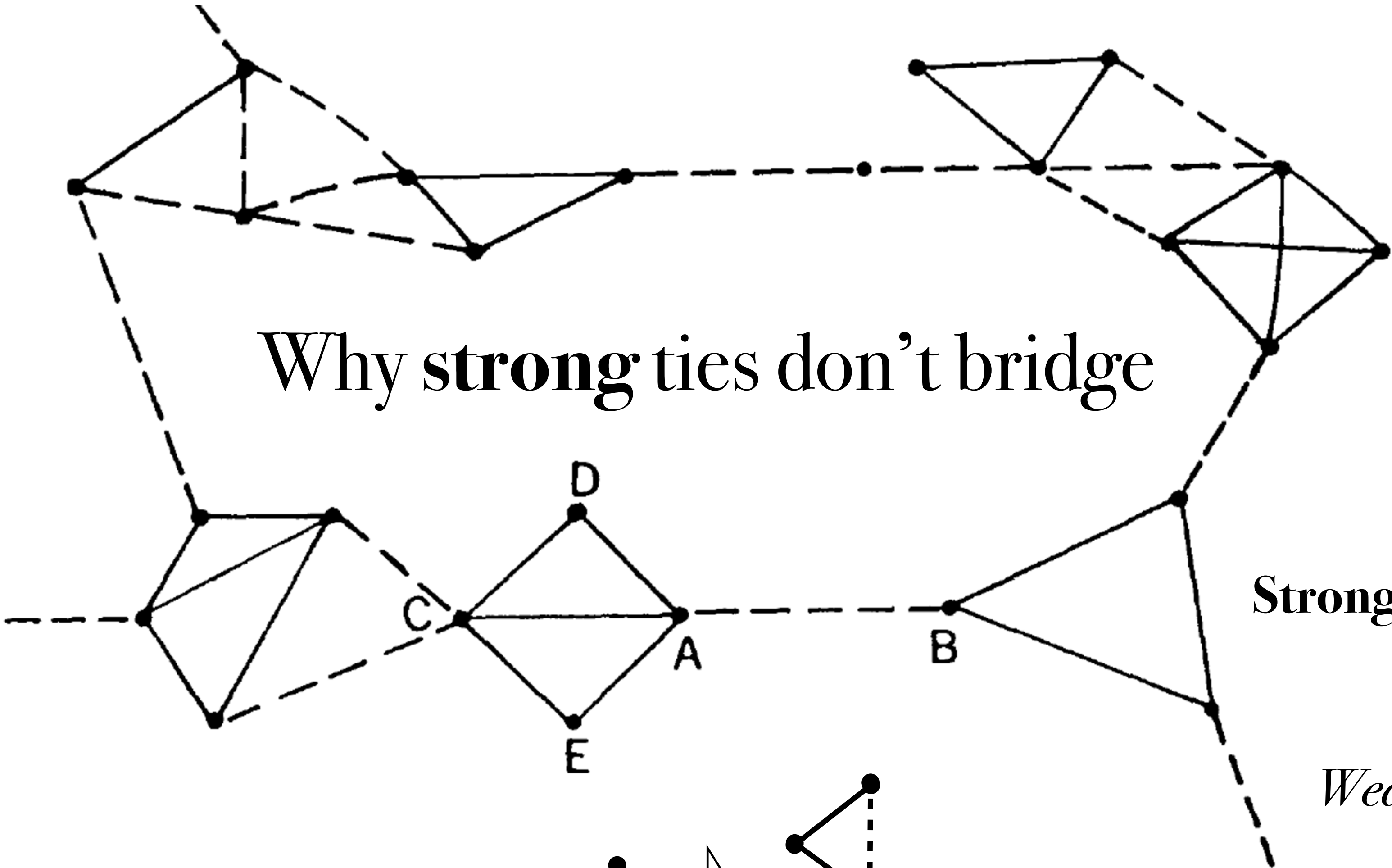
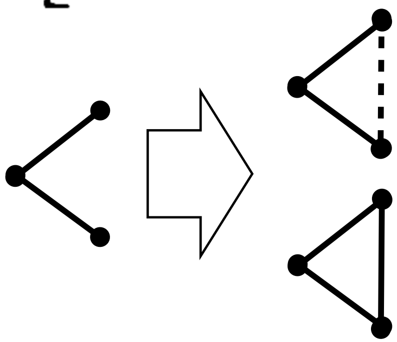



**Strong** tie

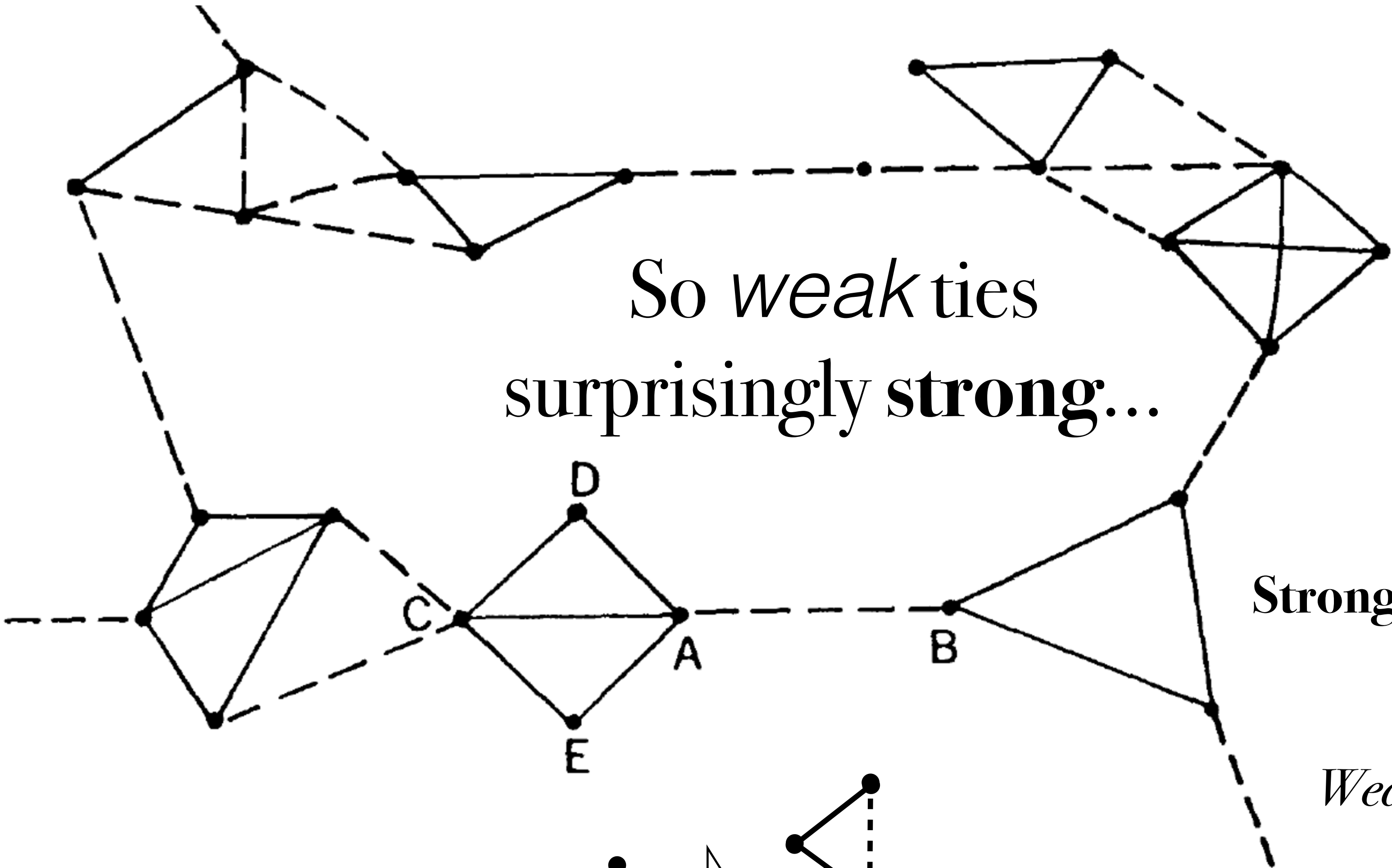
*Weak* tie

"Forbidden Triad"
because balance,
homophily, and time



Strong bridges would
create many
forbidden triads

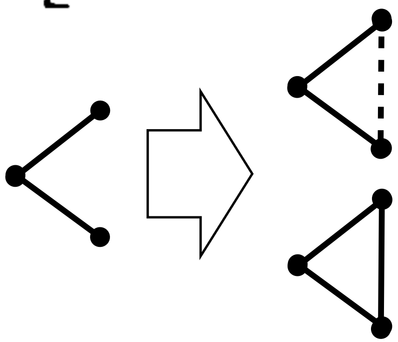
# So *weak* ties surprisingly **strong**…




**Strong** tie

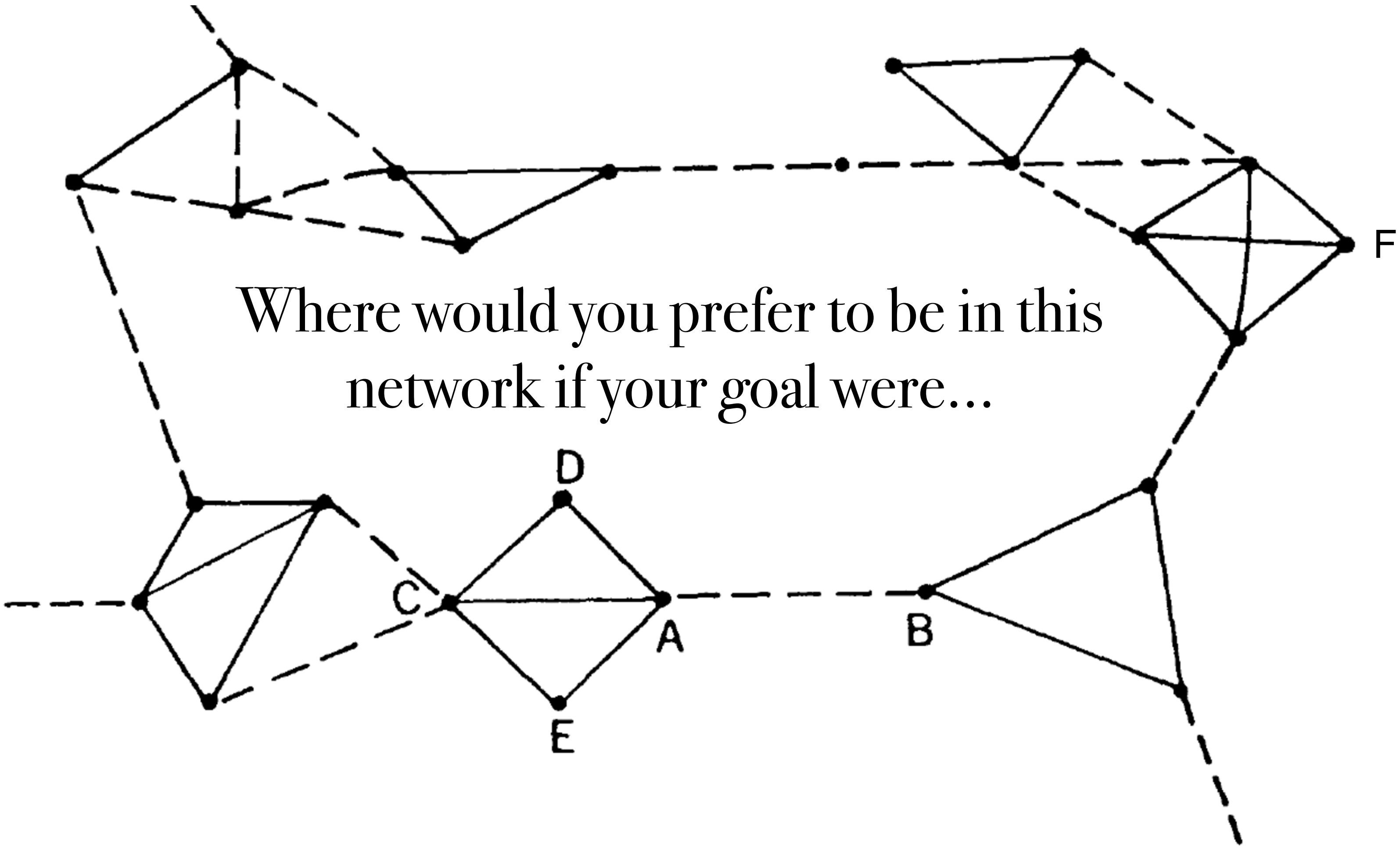
*Weak* tie

"Forbidden Triad" because balance, homophily, and time



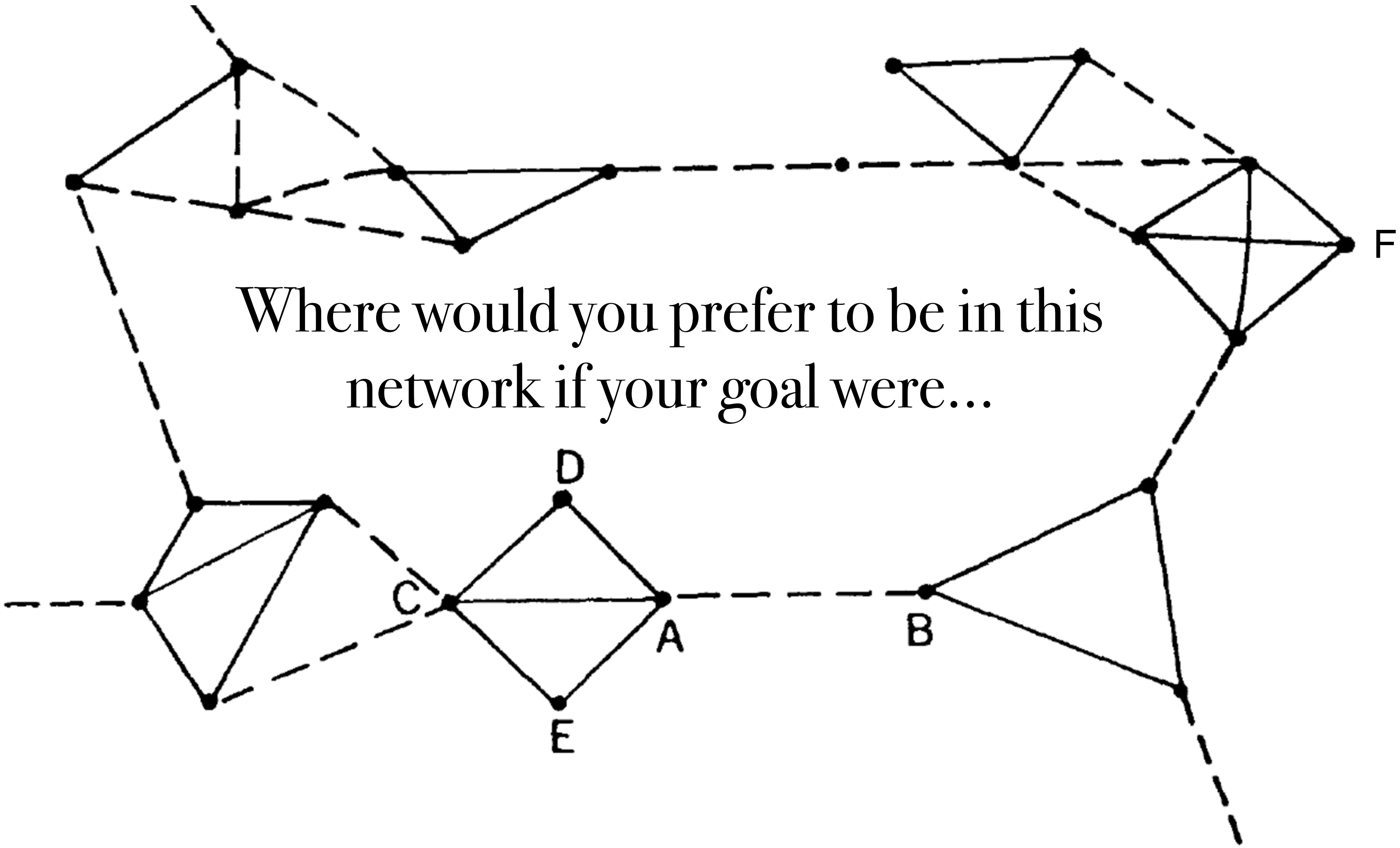
Strong bridges would create many forbidden triads

Where would you prefer to be in this network if your goal were…




Safety?

Effectance?

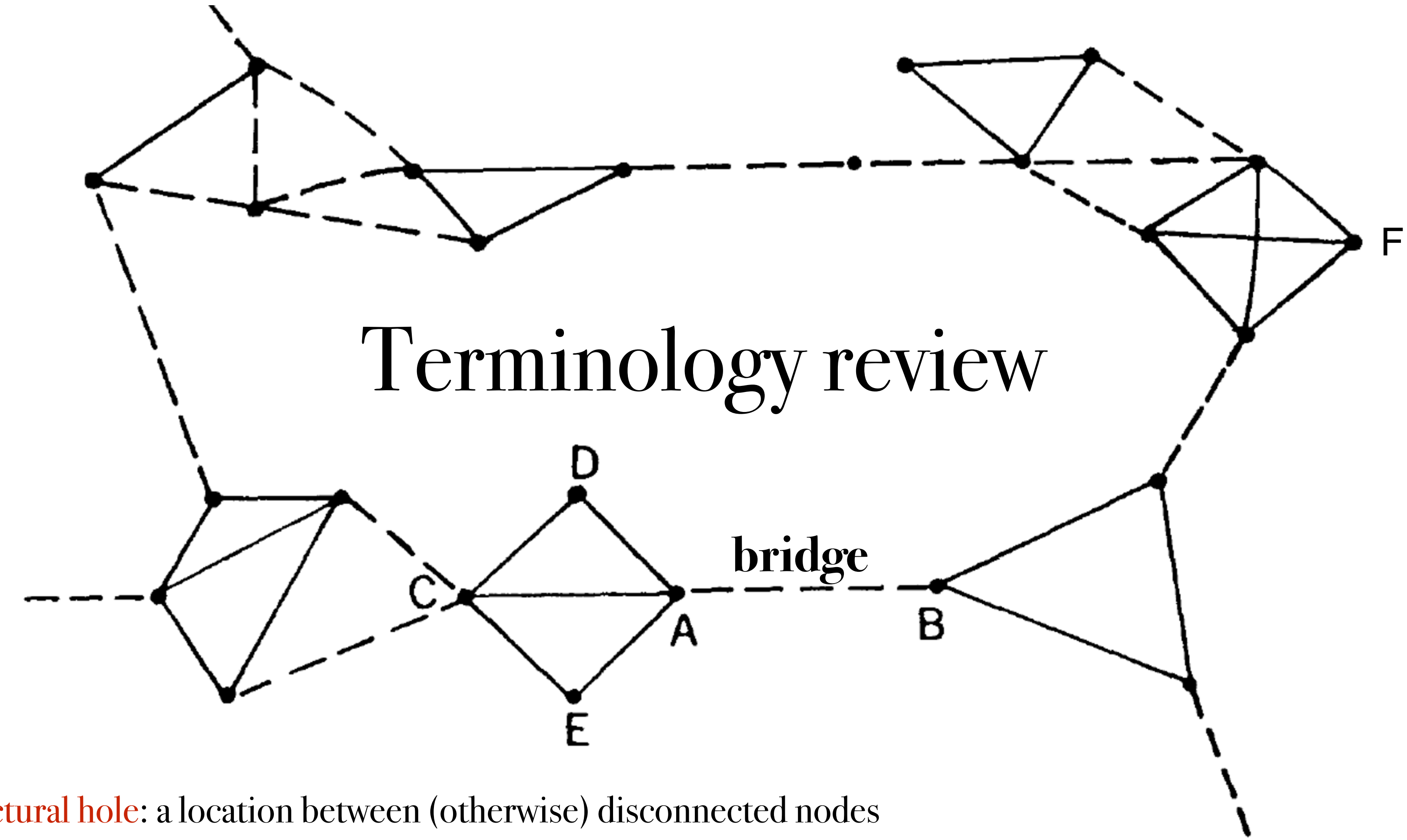



Where would you prefer to be in this network if your goal were…

Effectance? → "Structural Hole"

Safety? → "Embedded"

# Terminology review



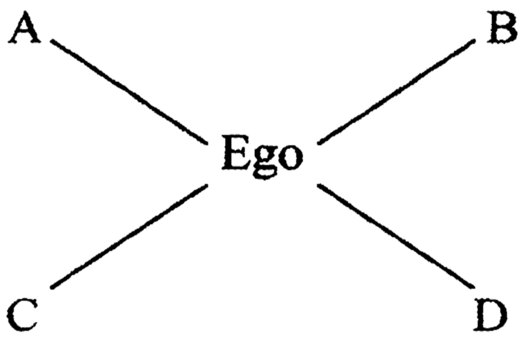

- Structural hole: a location between (otherwise) disconnected nodes
- Broker: a position *in* a structural hole
- Bridge: a tie *across* a structural hole

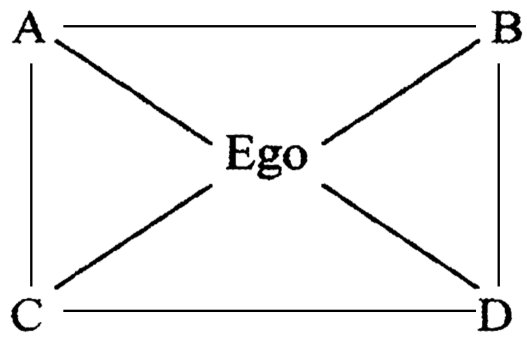
# Constraint and other measures

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

where $p_{ij} = z_{ij} / \sum_q z_{iq}$

- `node_bridges()`: sum of bridges to which each node is adjacent.
- `node_redundancy()`: average degree of ego's alters not counting their tie to ego.
- `node_effsize()`: size of ego's local network minus redundancy.
- `node_efficiency()`: number of non-redundant contacts.
- `node_hierarchy()`: nodes' exposure to hierarchy, where only one or two contacts are the source of closure.




so **not** the same as betweenness centrality

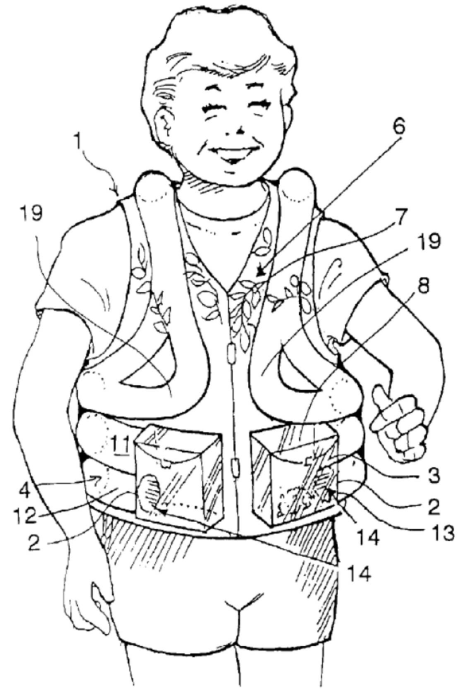
# Structural Holes and *Good* Ideas

- Being in a structural hole associated with creativity, power, innovation, middleman, etc.

- The position likely to expose you to different views that you can translate or combine and introduce productively

- Returns to network brokerage are a probability, not a certainty… access to structural holes merely "increases the risk of productive accident"

- But still behaviouralist issue: structural holes associated with taking of opportunities…

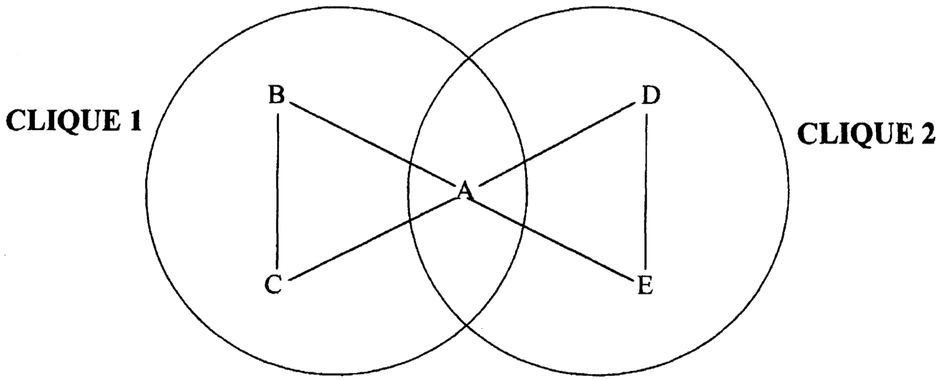



from Brice Belisle, "Pet display clothing"
US Patent 5,901,666 granted May 11, 1999).

# Ties that Torture

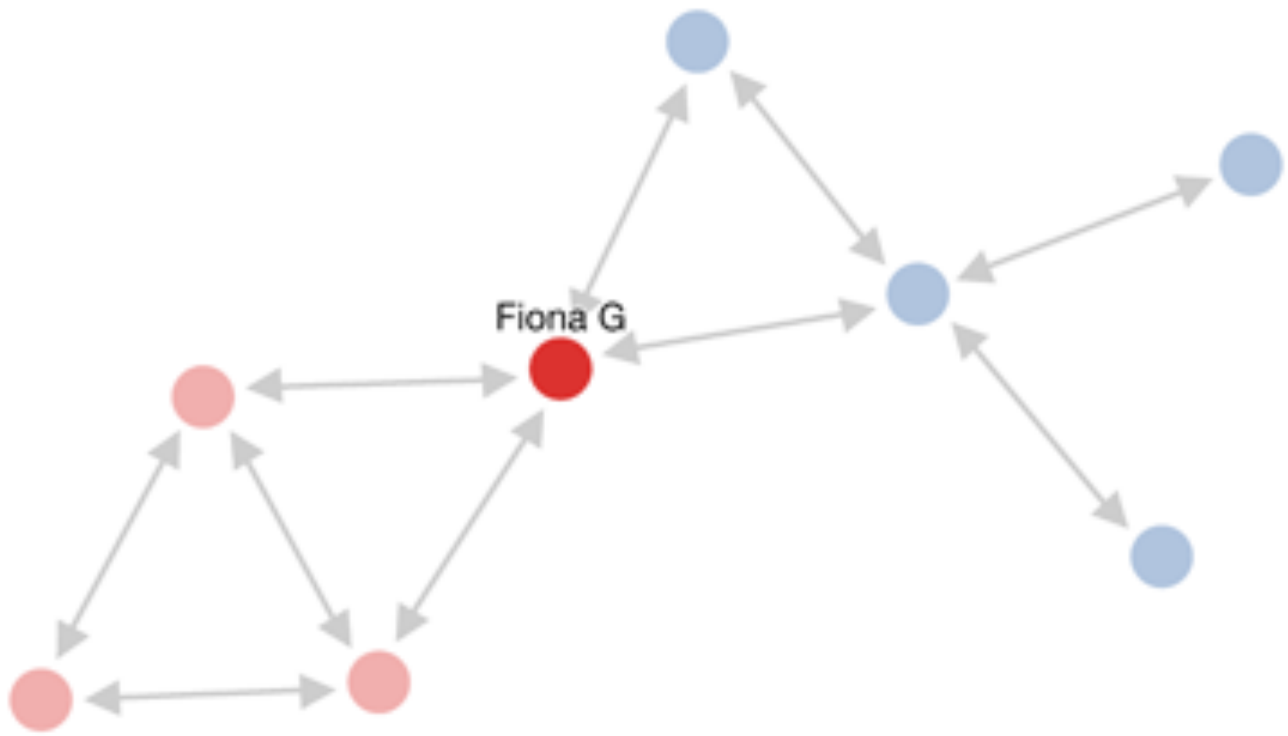
- Being in a structural hole between **Simmelian ties** can be disadvantageous though…
  - Simmelian ties are embedded in cliques

- Individual A is constrained as a member by different cliques and has no freedom to act




Krackhardt (1999) "The Ties That Torture: Simmelian Tie Analysis in Organizations"

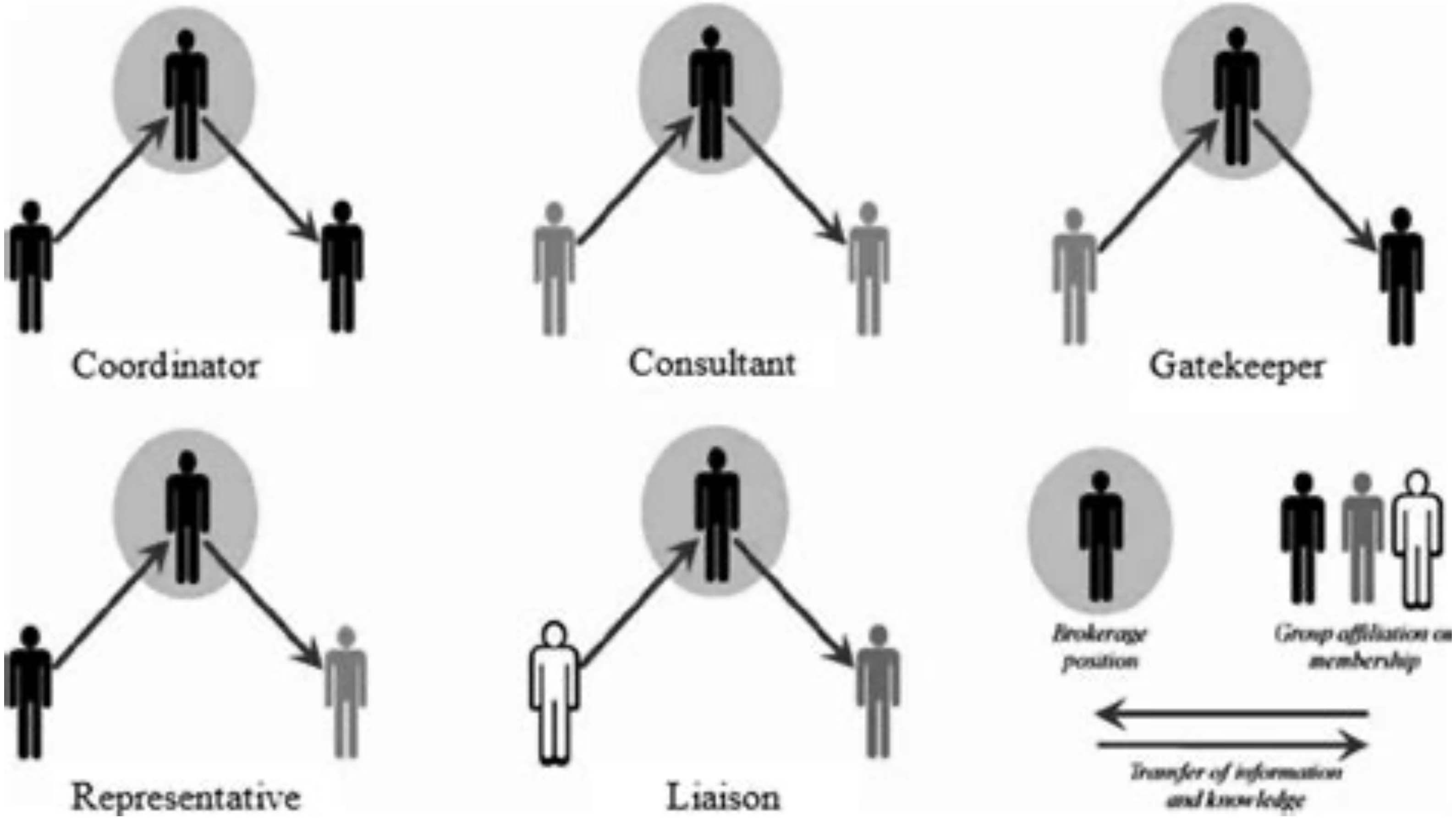
# Or Structural Fold?




- Goes back to Simmel's (1922 [1955]) idea that individuality found in intersection of multiple social circles

- Vedres and Stark (2010) argue that those in a structural fold are multiple insiders, combining familiarity and reputation with diversity

# Gould and Fernandez (2006)



# Lesson #1

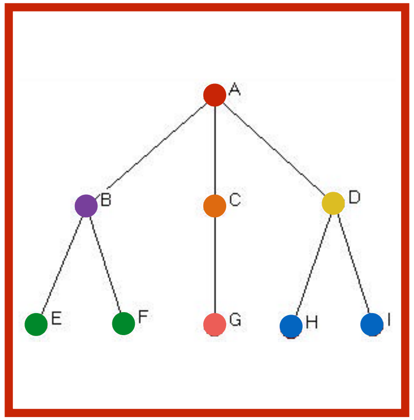
Make statements that can be wrong

# Position

Structural Holes




Structural Equivalence




Regular Equivalence


- While some nodes brokers, other nodes adopt *other* positions in the network
  - **Positions**: collection of individuals who are similarly embedded in networks of relations (aka *class*)
  - **Roles**: patterns of relations that obtain between actors or between positions

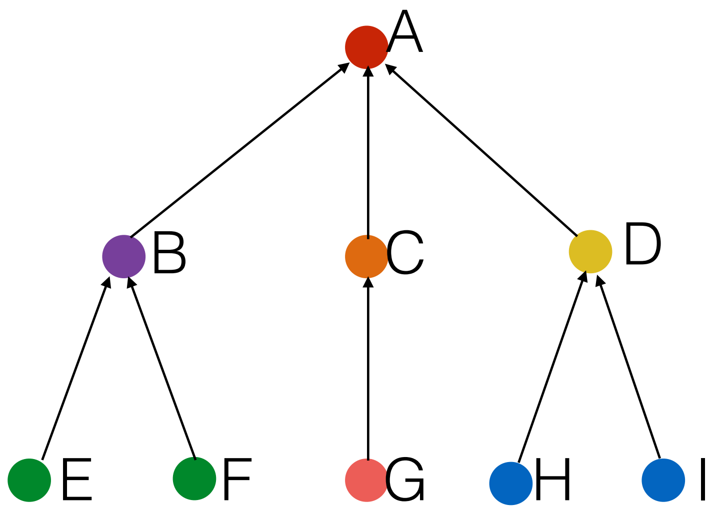
Wasserman and Faust 1994: 348


- Roles imply rights/duties with respect to 'role compliments' they interact with
- Like with "class" analysis, sometimes not interested in individuals but rather patterns of positions and roles
- Positions defined when patterns of relations **equivalent** (or at least similar enough…)
- So what does equivalence/similar mean?

# Equivalencies

Nodes **structurally equivalent** if same/similar tie partners

7: {A} {B} {C} {D} {E,F} {G} {H,I}




Nodes **regularly equivalent** if same/similar pattern of ties

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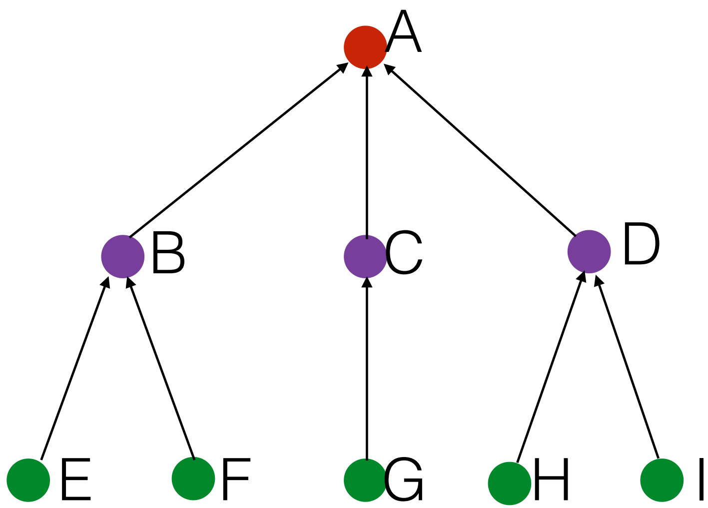

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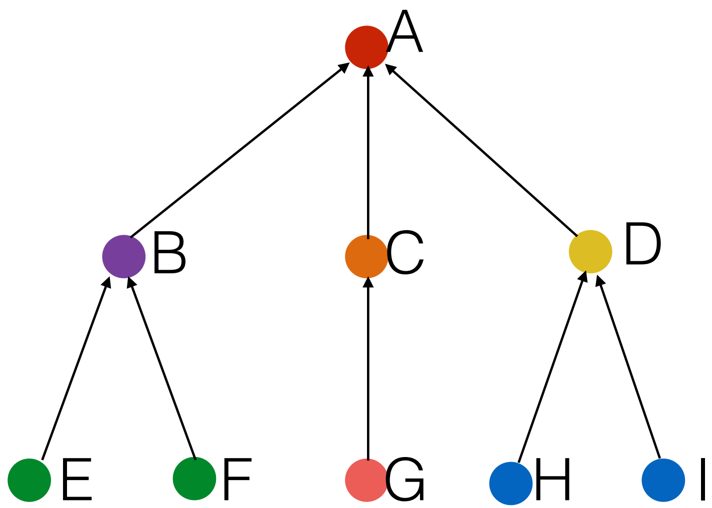
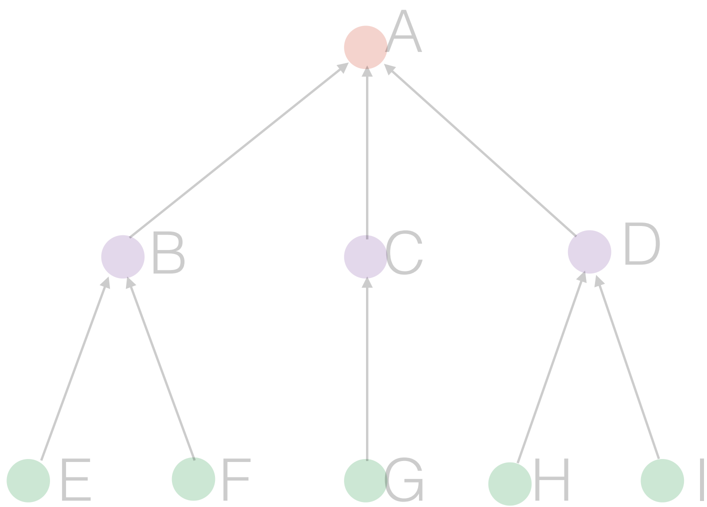


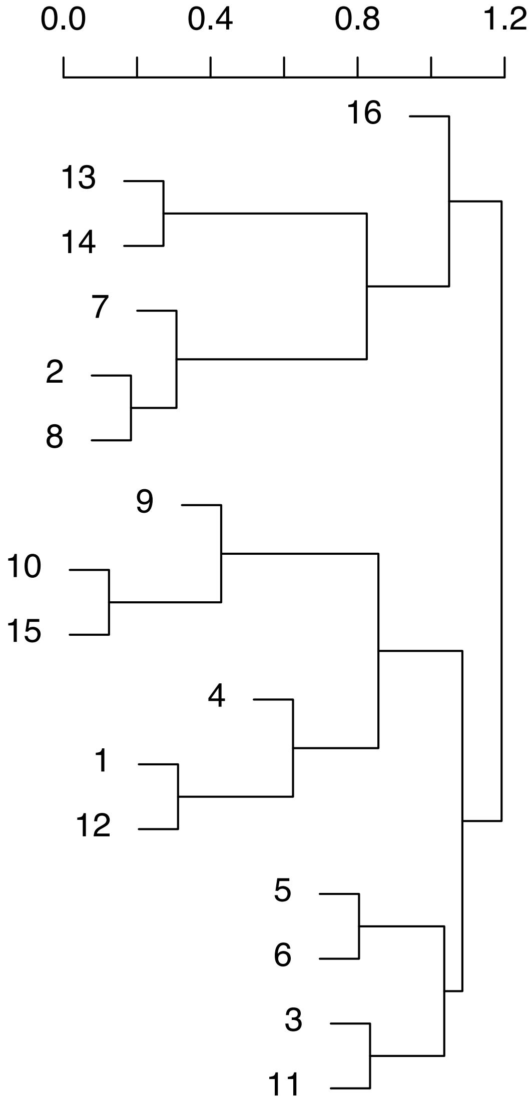

Structurally equivalent nodes thought to **compete** with one another, which can lead to **divergence or isomorphism**

# How can we measure similar partners?

Correlation ⟷ Distance

- For structural equivalence, we start with a simple correlation of partners
- We then invert this so that it is not the correlation (how similar they are) but the distance (how dissimilar they are from all others)
- This dissimilarity can be represented in the form of a dendrogram

# Dendrograms

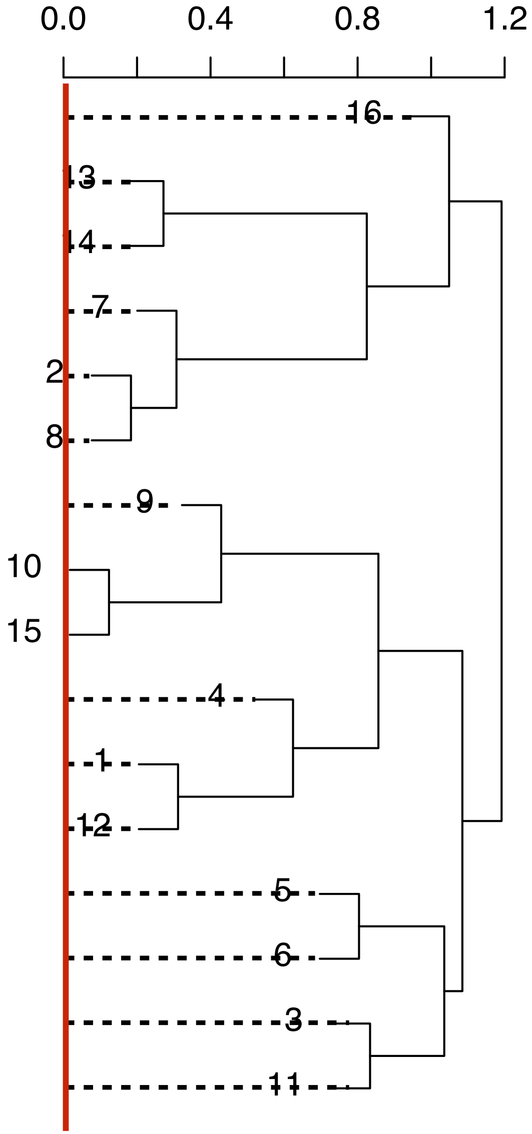



(Can be printed vertically/horizontally)

Scale at top usually some kind of distance measure

So 0 means no distance = same, or perfect, positive correlation

Each observation (node) has its own branch on this dendro-(it means tree)-gram



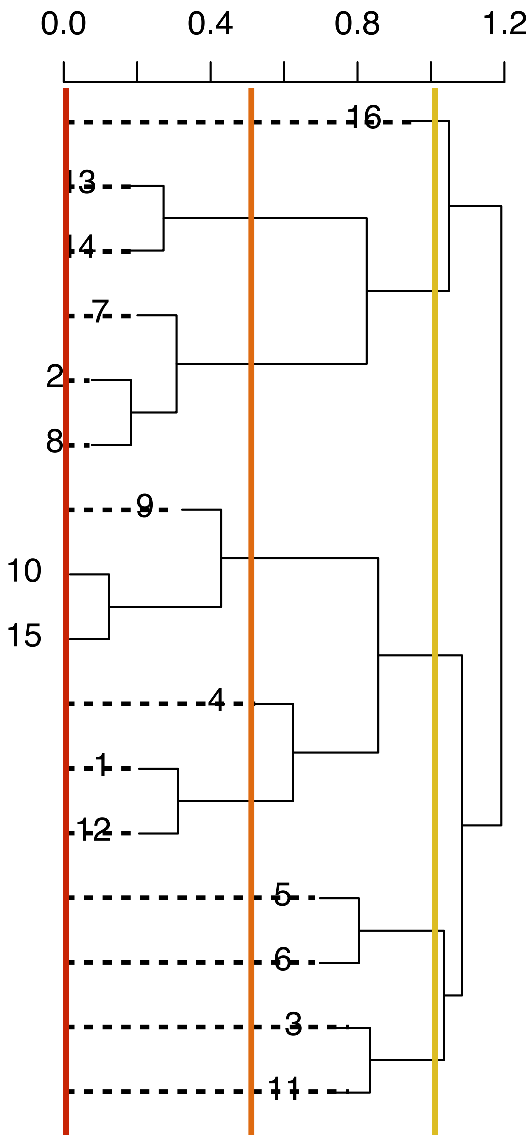

# Dendrograms

If you cut dendrogram at 0, intersects 16 separate lines

Means all 16 nodes have slightly different partner profiles, and at this (strict) interpretation of equivalence, we have 16 classes, each with a single node

But dendrogram also represents how clusters branch/ fork off at different levels of (dis)similarity

So we could relax the similarity threshold a bit, and find fewer clusters…

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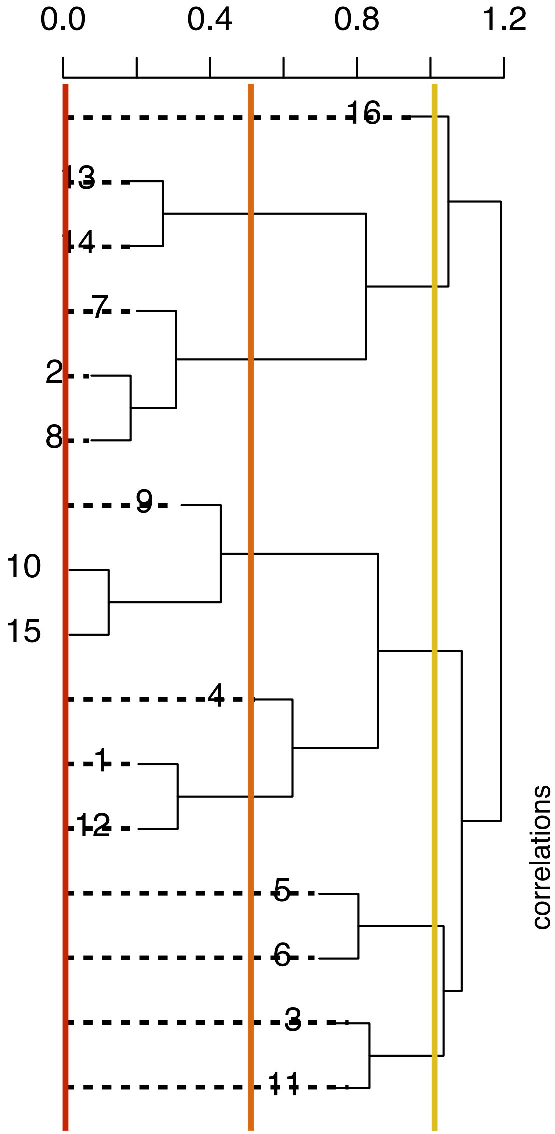
But where should we draw the line?



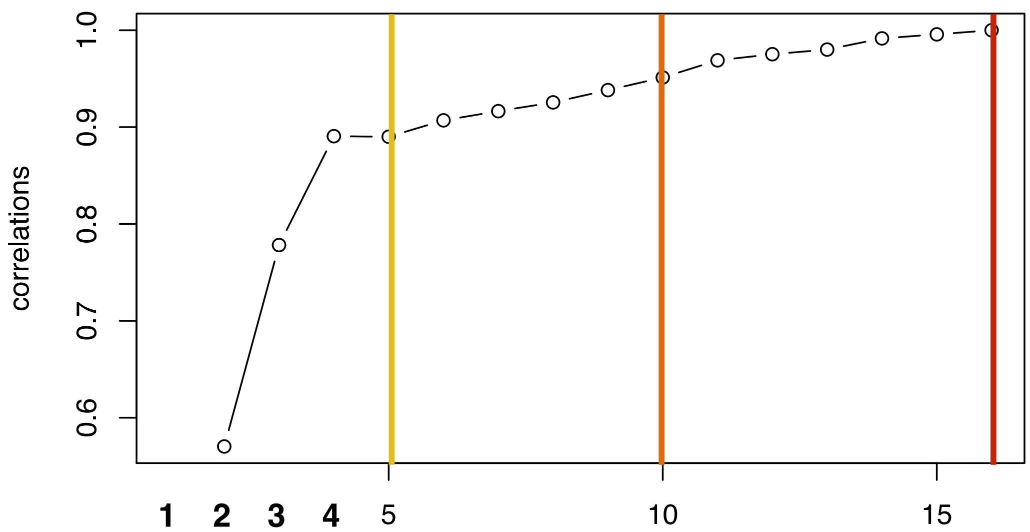

Plot below directly relates to the dendrogram

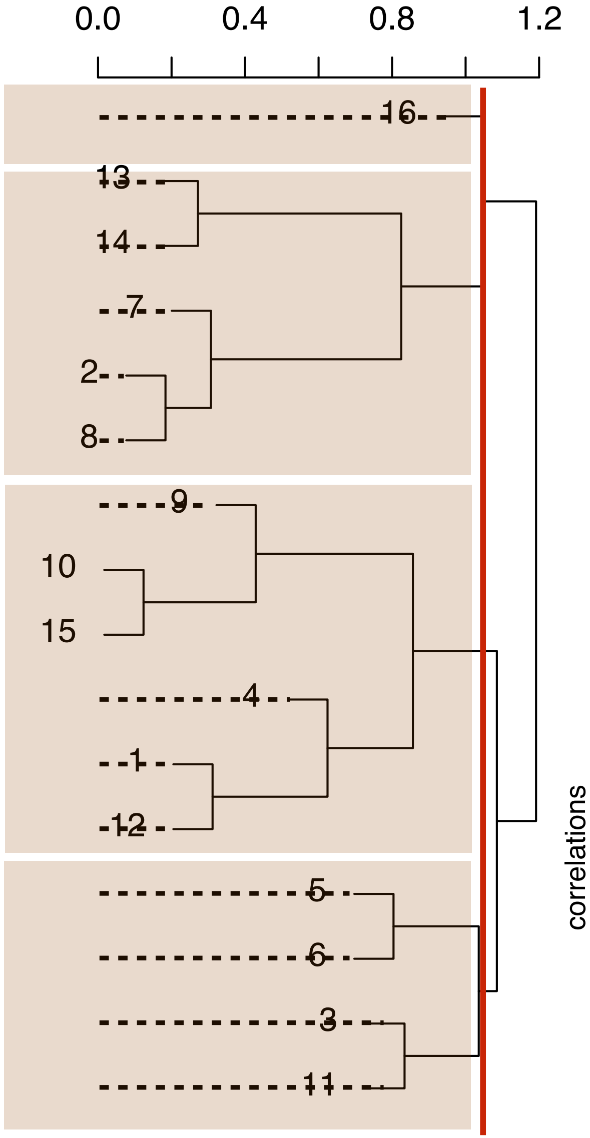
$x$ = number of clusters

$y$ = within cluster correlation

Tells us more about the tradeoff between many very similar clusters or fewer less similar clusters

Still, correlation always goes up with more clusters…
how many to choose?






# Elbow Method

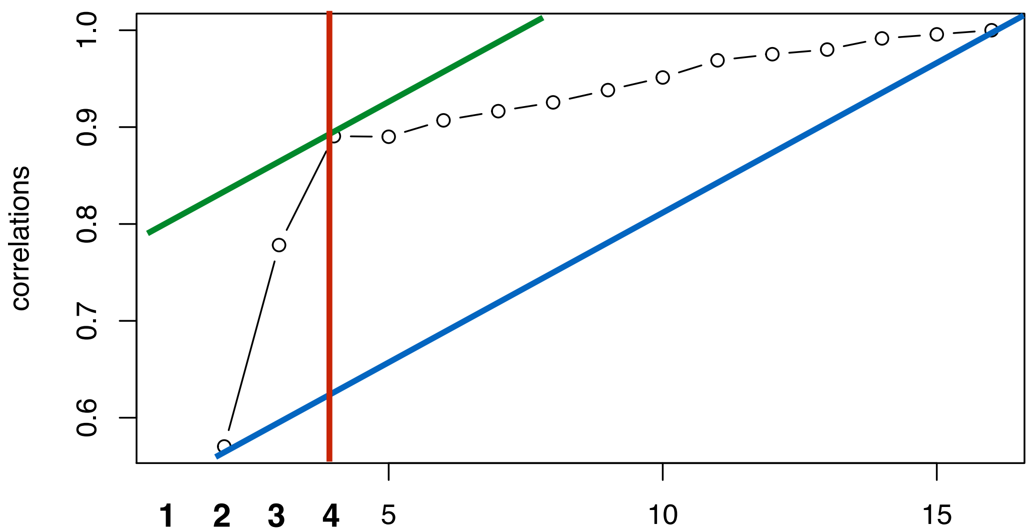
Introduced in a *hilarious* article by Thorndike (1953) that *starts*:

"I was sitting before my TV set, a while back, watching Captain Video…"

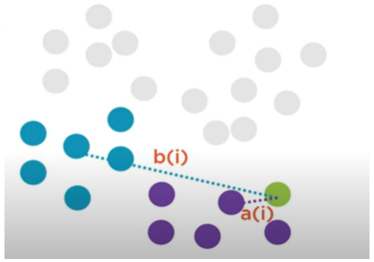
Basically just look for biggest inflection point

After this point, internal correlation only grows more gradually

A bit ad hoc and sometimes several points possible, but often easiest solution to really difficult problem…

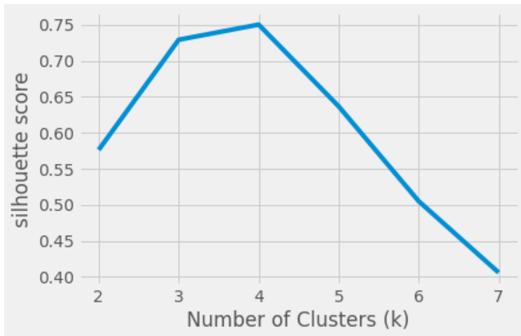


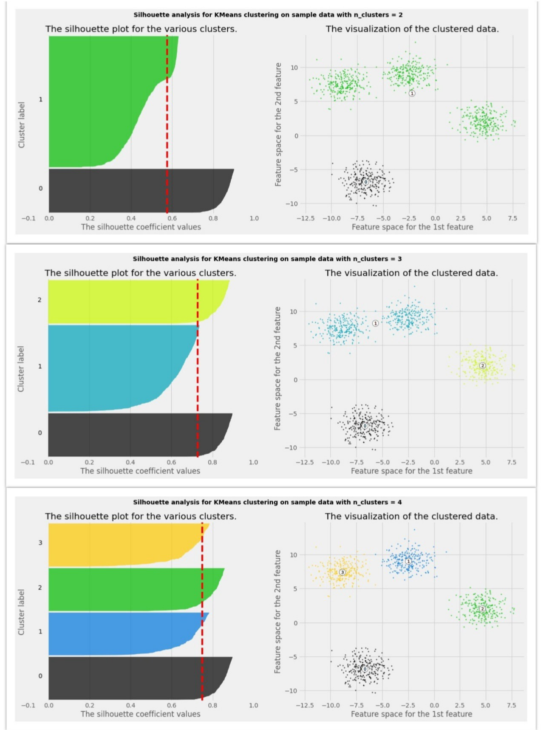

Thorndike 1953

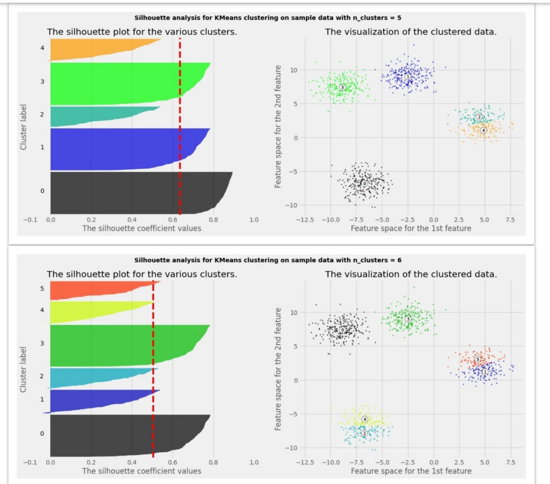



# Silhouette Method

- Idea is to measure how well each class/cluster assignment works for each observation compared to next nearest cluster
- $$s(i) = \frac{b(i) - a(i)}{max(b(i), a(i))}$$
- Where *a(i)* is average distance of *i* to other observations in same cluster, and *b(i)* average distance of *i* to other observations in the next nearest cluster
- Ranges between -1 and 1:
  - 1 is far away from neighbouring cluster
  - 0 is on the decision boundary between clusters
  - -1 suggests wrong assignment/outlier
- Aim to maximise silhouette score



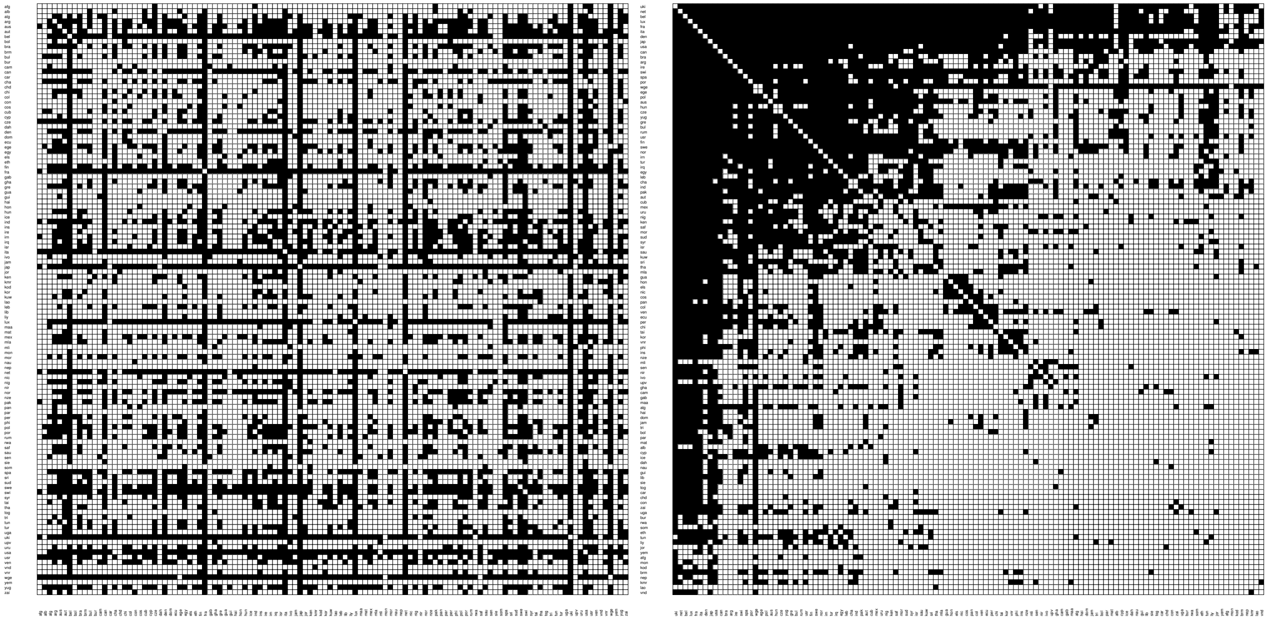



# Lesson #2

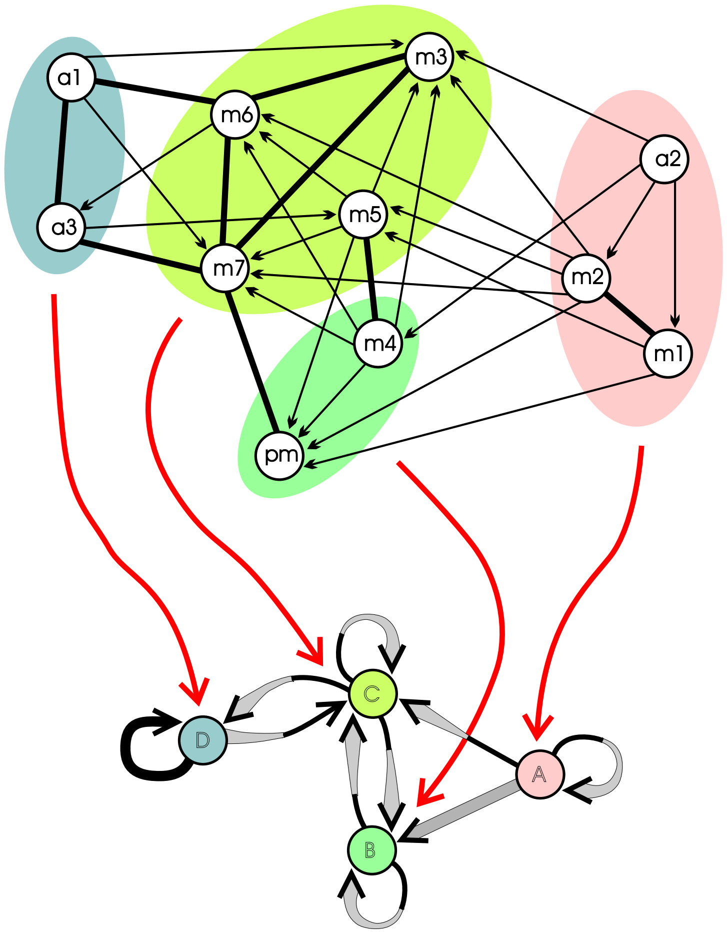
Similarity is relative

# Blockmodelling



- Once we have identified how many structurally equivalent classes we have, and which nodes belong to each class, what can we do with this information?
- We can explore the mesostructure of the network by considering the clusters/class as 'blocks' to give us a network of roles rather than a network of individuals
- Begins by resorting (permuting) rows and columns by cluster identity, and then optionally summarise tie weight/proportion within and between these blocks

# Reduced Graph




So now we can take the blocks and visualise them as a "reduced graph"

This reduced graph illustrates how different roles (not individuals) interact

This can be pretty useful when studying political, social, economic, legal, or historical networks...

# Lesson #3

## It’s networks all the way down

# Blockmodelling and Statebuilding

Building a stable state/organisation involves tension between:

- need to control and organise (boss role) and

- ability to build the legitimacy and recognition required for the institution to reproduce (judge role)

Padgett and Ansell study the state oligarchy structure of Medieval Florence, which we know stabilised after the rise of the Medici, including its marriage, economic, and patronage networks

Paradox of Cosimo de' Medici is that he didn't seem to fit the Machiavellian ideal of being decisive and goal-oriented

Padgett and Ansell resolve this by pointing to how Cosimo took a role with no clear meaning or obligation, allowing *multivocality* and *robust action*

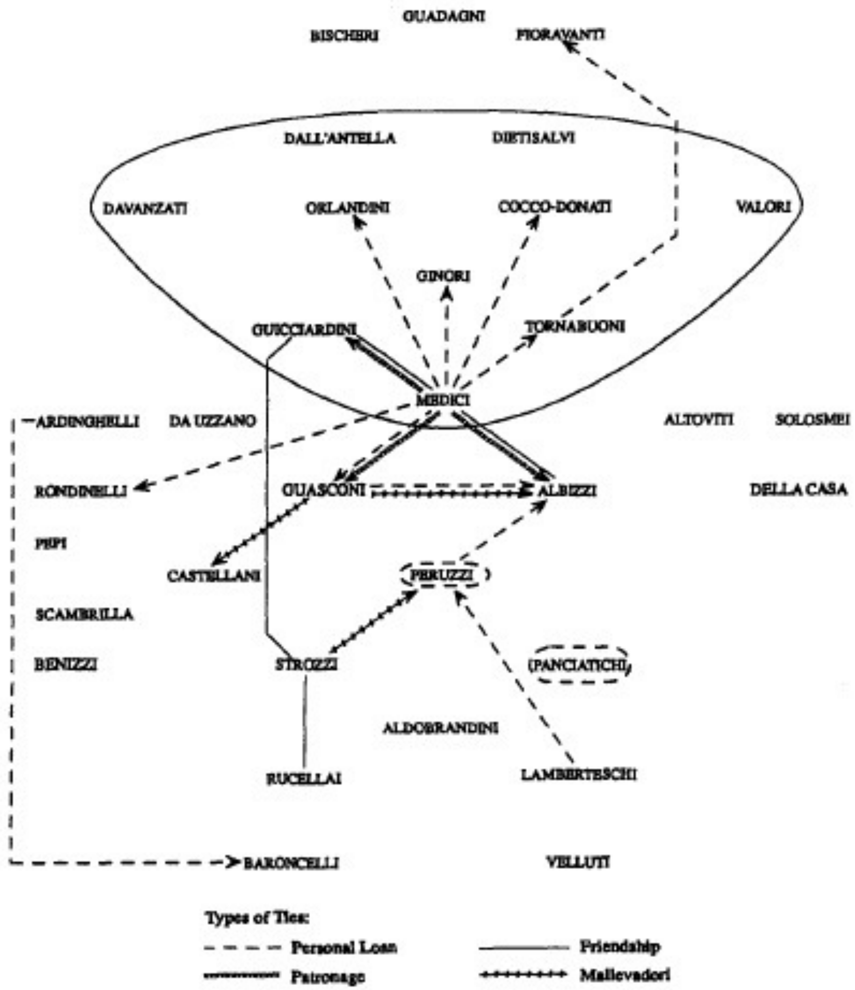



FIG. 2b.—"Political" and friendship blockmodel structure (92 elite families)

# Position

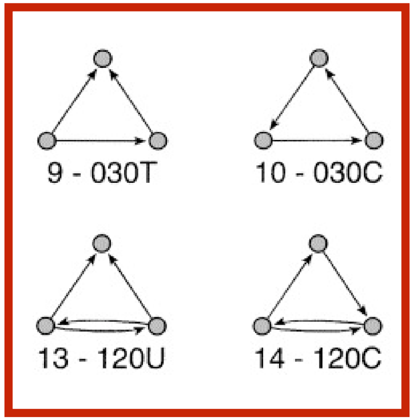
## Structural Holes




## Structural Equivalence




## Regular Equivalence



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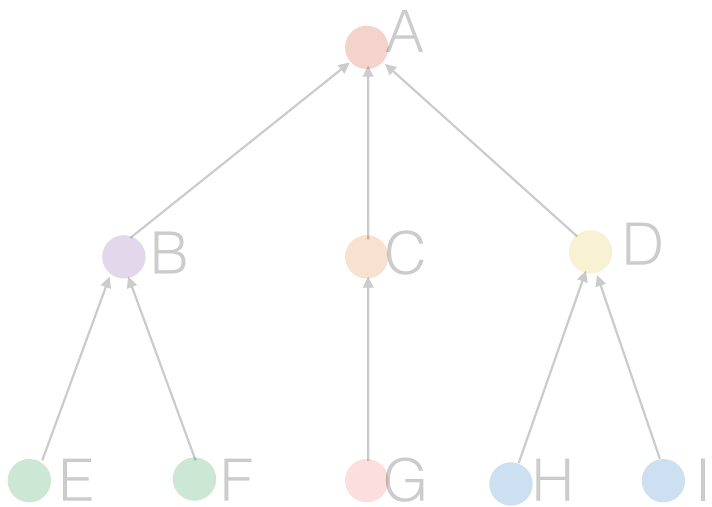


Nodes **regularly equivalent** if same/similar pattern of ties

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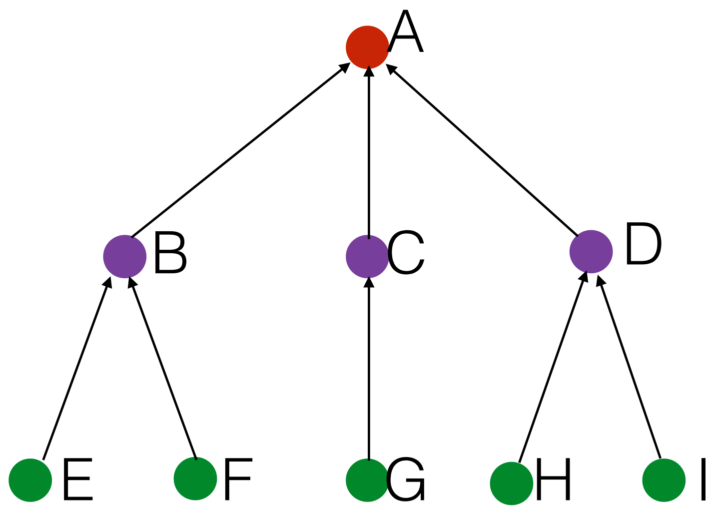



Regularly equivalent nodes in **class** with one another, which can also lead to **isomorphism**

# This guy again…

Granovetter, Mark S. 1985. “Economic Action and Social Structure: The Problem of Embeddedness.” *The American Journal of Sociology* 91 (3): 481–510.

# Embeddedness of Economic Action

- New institutional economics is *undersocialised*
  - Atomistic actors make free choices, and construct institutions to provide information and reduce other transaction costs as a functional substitute for trust

- Parsonian sociology is *oversocialised*
  - Actors just play roles in large social systems that structure or even determine all choices, a generalized reciprocity that does not explain intra-systemic variation

Granovetter, Mark S. 1985. "Economic Action and Social Structure: The Problem of Embeddedness." *The American Journal of Sociology* 91 (3): 481–510.

“[E]conomics is all about
how people make choices;
sociology is all about
how they don’t have any choices to make.”

–James Dusenberry (1960: 233)

# Embeddedness of Economic Action

- Because social ties generate trust necessary for economic action, argued economic action is embedded in social ties

Granovetter, Mark S. 1985. "Economic Action and Social Structure: The Problem of Embeddedness." *The American Journal of Sociology* 91 (3): 481–510.

# Embeddedness of Economic Action

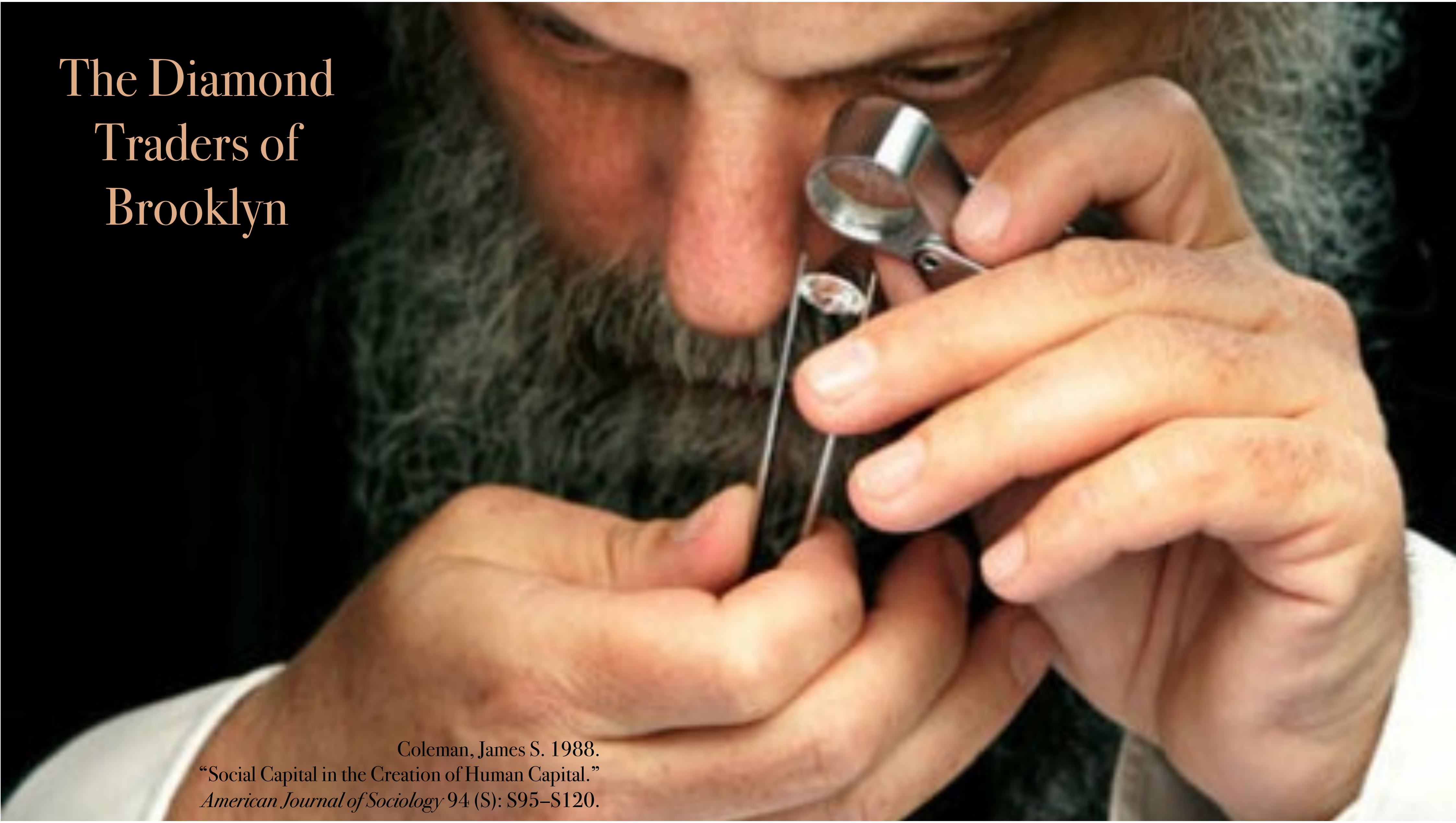
- Because social ties generate trust necessary for economic action, argued economic action is embedded in social ties

- Because patterns of social ties differ across the network, successful economic action can also vary across a network

- Because social ties and trust necessary for large-scale malfeasance too, can also enable fraud and corruption

Granovetter, Mark S. 1985. “Economic Action and Social Structure: The Problem of Embeddedness.” *The American Journal of Sociology* 91 (3): 481–510.

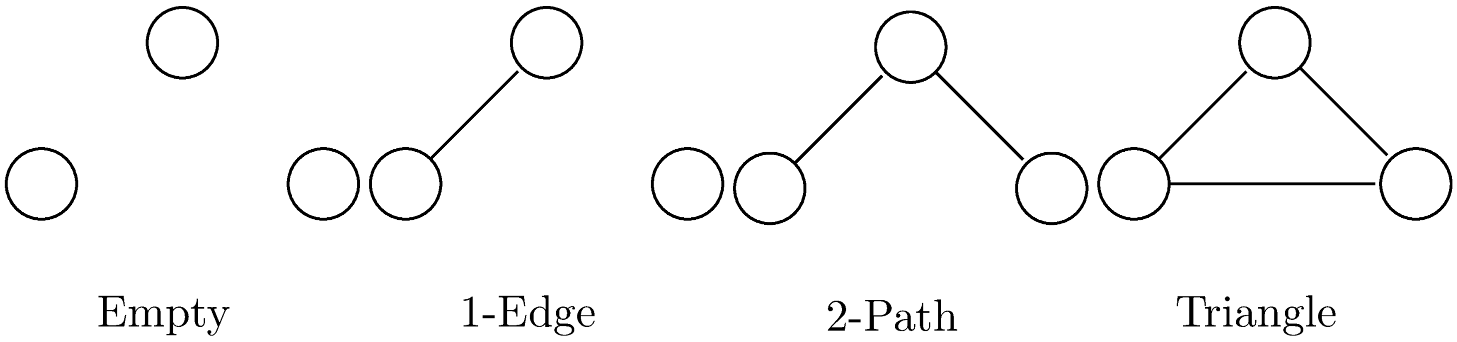
# The Diamond Traders of Brooklyn



Coleman, James S. 1988.
"Social Capital in the Creation of Human Capital."
*American Journal of Sociology* 94 (S): S95–S120.

Not all nodes are embedded to the same degree!?

# Local Structure Expressed In Triad Counts

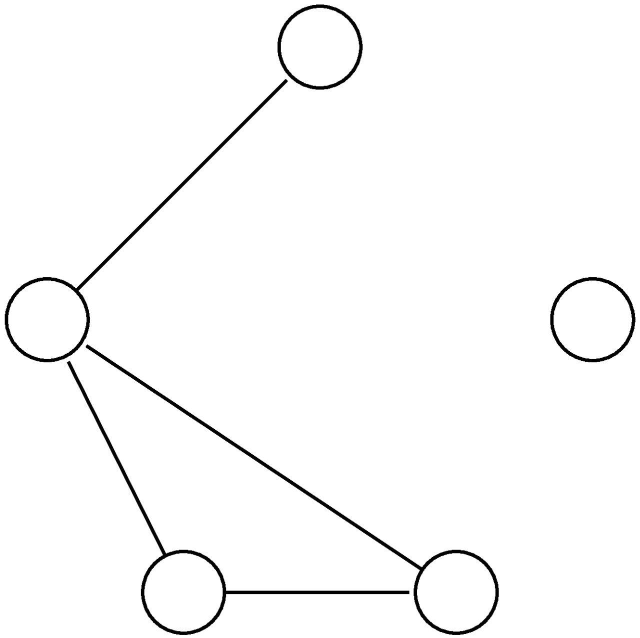



You write a triad census as a list like

(#0Empty, #1Edge, #2Path, #3Triangle)

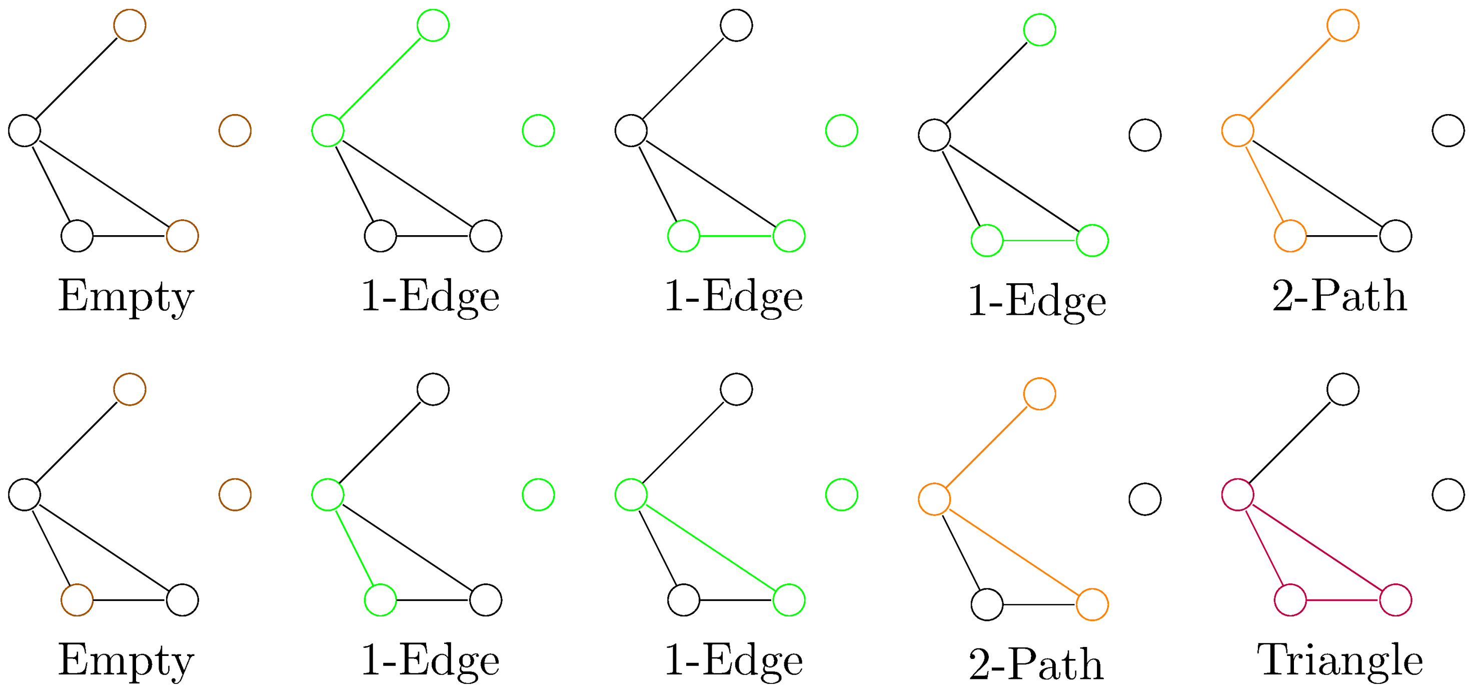
Holland and Leinhardt 1975

# What is this graph's triad count?



- Remember, you write a triad census like (#empty,#edge,#2path,#triangle)

# Answer: (2,5,2,1)
# with 10 triads in total



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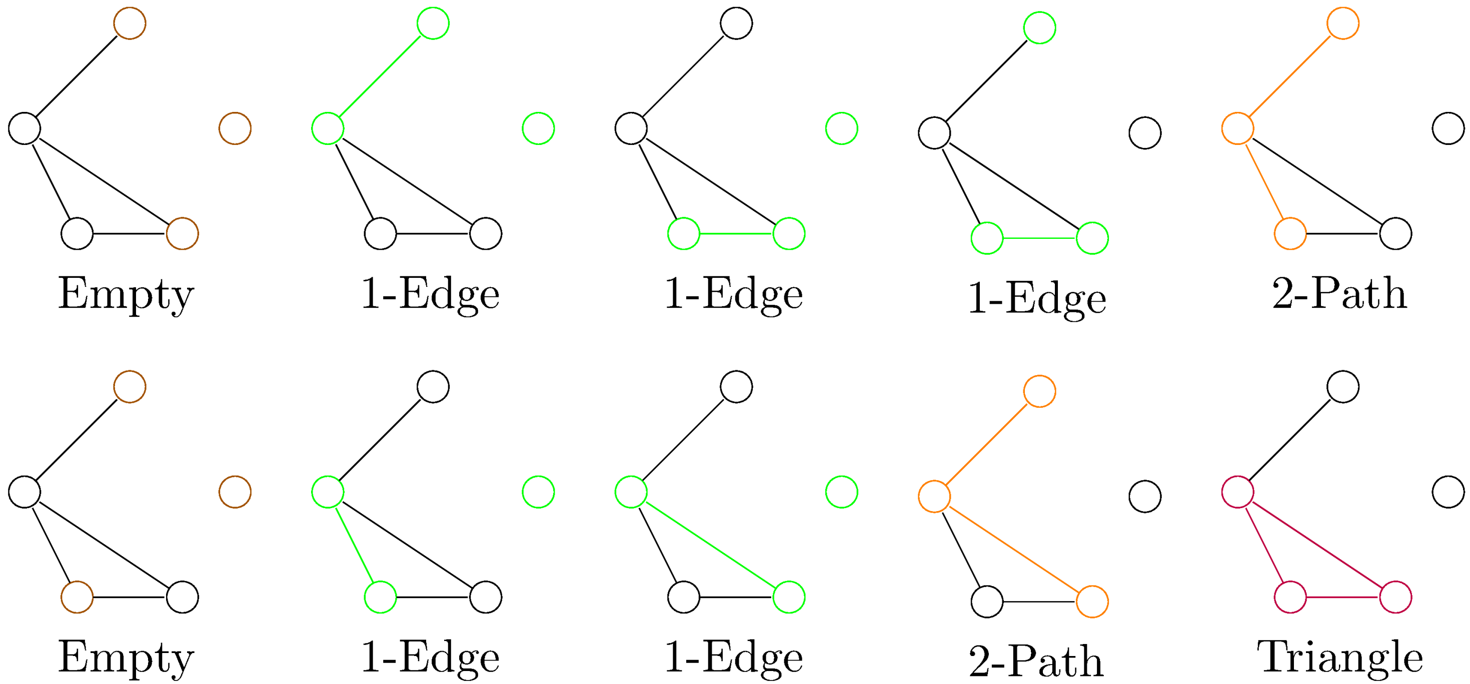
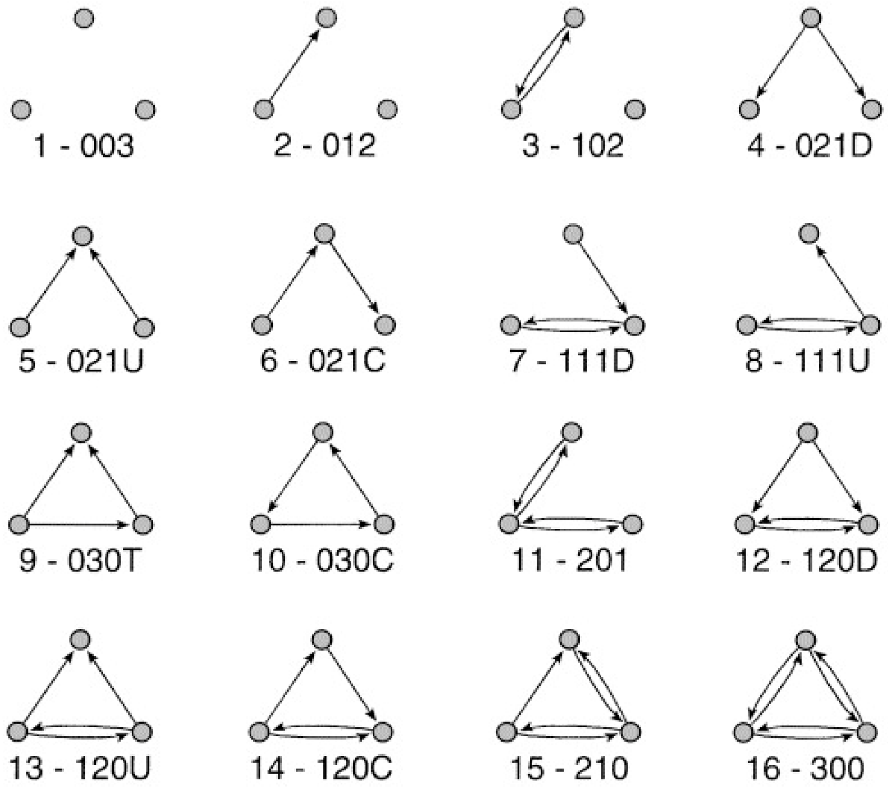



- If 4 *types* of triads for a simple undirected graph, how many for a simple *directed* graph?

# Directed Motifs

- Each triad represented by three numbers for the number of:
  - Mutual dyads
  - Asymmetric dyads
  - Null dyads
- ...and a letter, where necessary, for direction:
  - Down
  - Up
  - Transitive
  - Cycle




Wasserman and Faust 1994, Ch. 14

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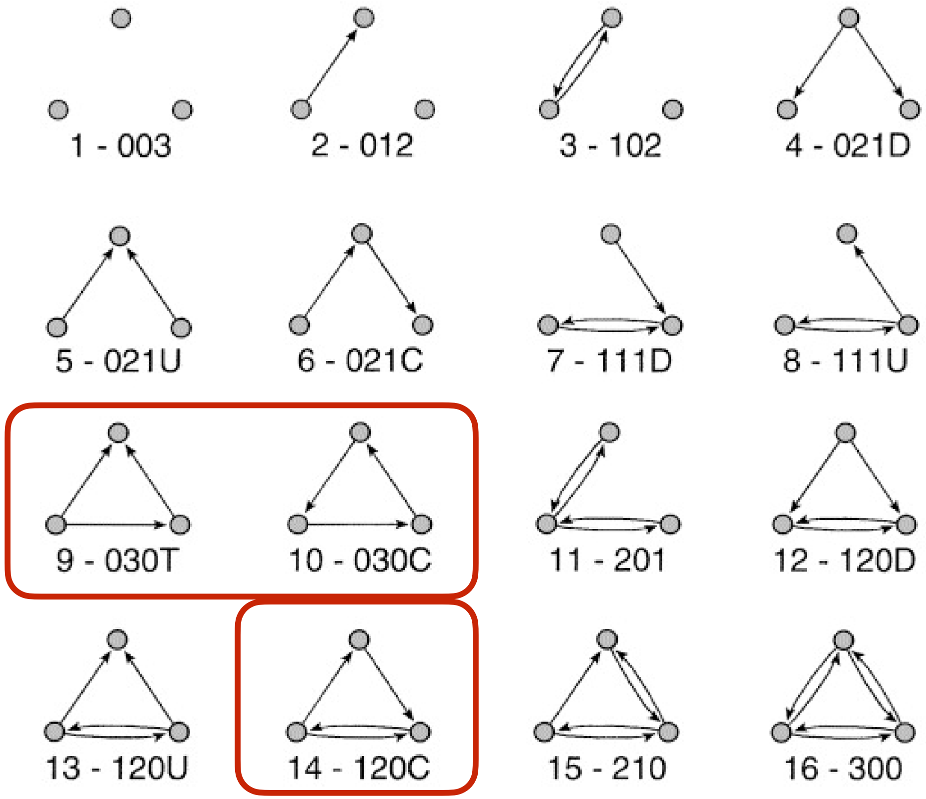
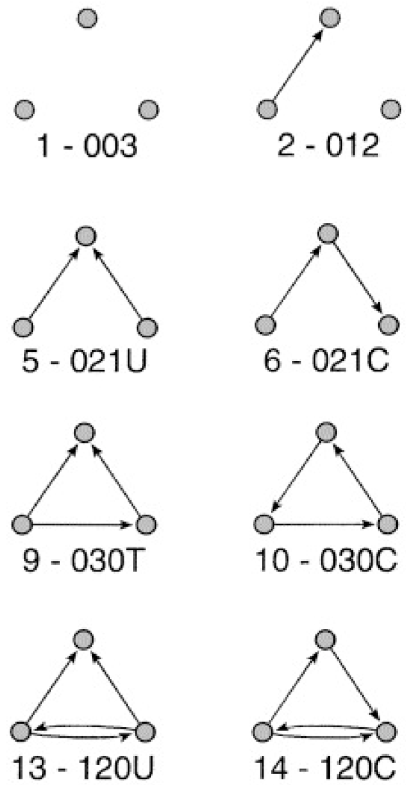



Wasserman and Faust 1994, Ch. 14

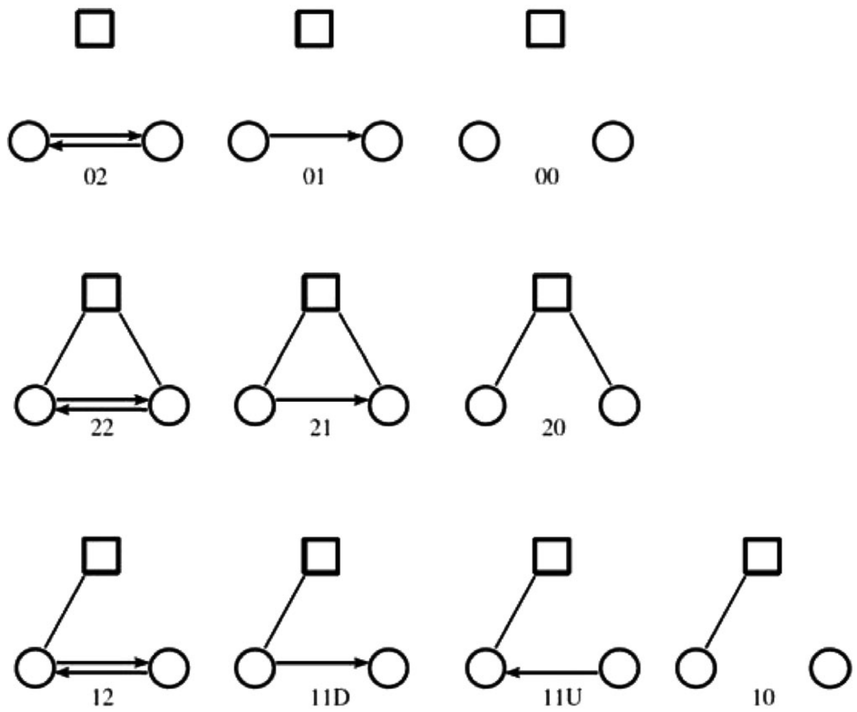
# Triads to Profiles

- Triad counts summarise local configurations nodes embedded in
  - Where nodes have similar triad counts they have similar tie profiles, irrespective of whether those profiles are to same others
  - Therefore they play similar roles in the network (i.e. in the middle of a group, between groups, isolated, etc)

- We can thus use correlations between nodes' triad counts for blockmodelling!



# Multiplex and Multilevel Embeddedness



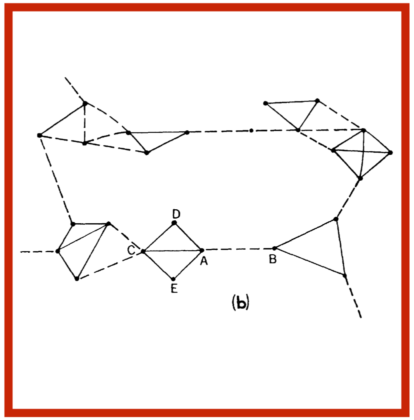

- Of course, profiles and embeddedness not only in single one-mode networks
- Triad counts across different one-mode networks (multiplex)
- Also two-mode, and even multilevel networks (see Hollway et al. 2017)

# Lesson #4

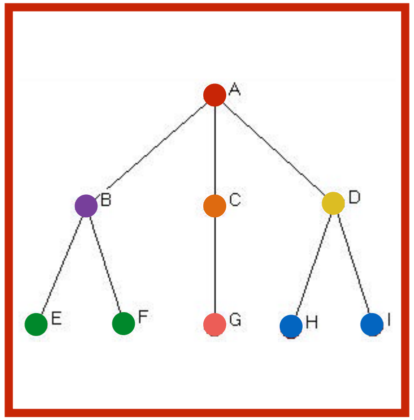
Network structure varies across the structure of the network

# Position

## Structural Holes




## Structural Equivalence




## Regular Equivalence