

# Social Similarity and Influence

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# Social Influence

- The behavioral change of a person because of the perceived relationship with other people, organizations and society in general
- Statistical Measures of Social influence → Node measures (Degree, closeness, betweenness and Eigen vector centrality), Tie Strength (Strong and Weak ties and Edge Betweenness), Structural holes
- **Issue → understanding the interplay between similarity and social ties**

## In the context of the structure of the social network:

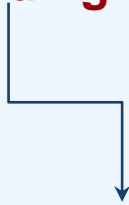
- What is the effect of the surrounding context in network formation?
- Do similarities and compatibilities between two people influence the formation of a link in the network?

# Homophily

- One of the basic notions governing the structure of the social networks
- Basic principle → **tending towards similar friends in the network**
- What are the similar characteristics of yours friends that resulted in the formation of a network?

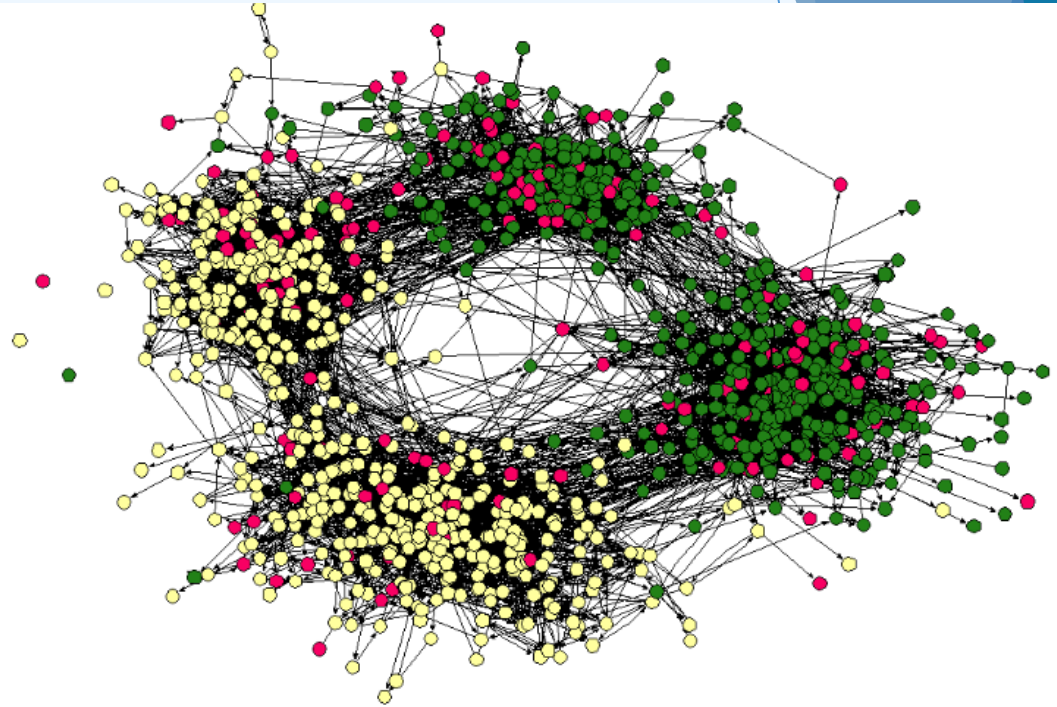
# Homophily

- Provides fundamental illustration → how a network's **surrounding contexts** can drive the formation of its links.



Those factors that exist outside the nodes and edges of a network - affect how the network's structure evolves.

## Birds of a feather flock together



**Figure 4.1.** Homophily can divide a social network into densely connected, homogeneous parts that are weakly connected to each other. In this social network from a town's middle school and high school, two such divisions in the network are apparent: one based on race (with students of different races drawn as differently colored circles) and the other based on friendships in the middle and high schools, respectively [304]. (Image from the University of Chicago Press.)

# Are these two friendship networks same?

**Case 1:** A friendship that forms because two people are introduced through a common friend.

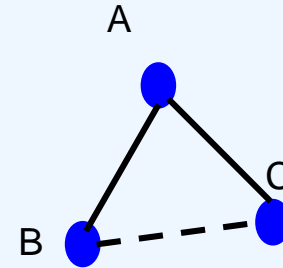
**Case 2:** Another friendship that forms because two people attend the same school or work for the same company.

Case 1 → Inclusion of a new link into the network → **intrinsic**

Case 2 → It arises for an equally **known natural reason** -  
consider the contextual factors beyond the network

# Triadic closure

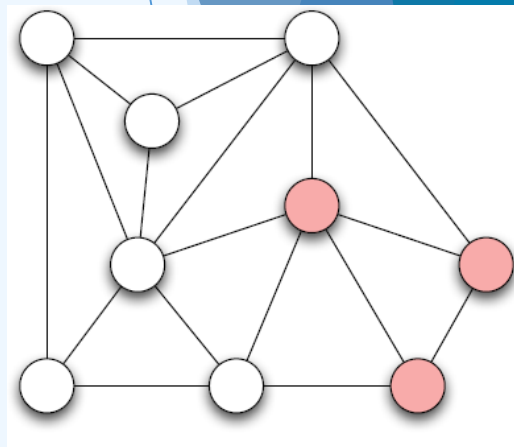
- Having common friends
  - Homophily
- Triadic closure
- Example:
  - Suppose B and C have a common friend A  $\Rightarrow$  increased opportunity of B and C becoming friends  $\Rightarrow$  Triadic Closure
  - There exists the ties A-B and A-C  $\Rightarrow$  by the principle of homophily  $\Rightarrow$  B and C are likely to be similar to each other  $\Rightarrow$  formation of the friendship B-C





# Measuring Homophily

- Requires some characteristic to be specified
- Example:  
Age, Gender, Native, etc.
- Motivation to measure homophily
  - Consider a friendship network of some children in an elementary school
  - The White Circles → Boys and Pink colored circles → Girls
  - To check if this network exhibit homophily?
  - **What would it mean for a network not to exhibit homophily by gender?**



## Measuring Homophily (contd.)

**Extreme case of homophily** → **No-homophily** in the network  
⇒ Friendships are formed by random mixing across the given characteristic

## Measuring Homophily (contd.)

**How to measure develop the numerical measure based on one characteristic i.e. gender (boy/ girl) in this example?**

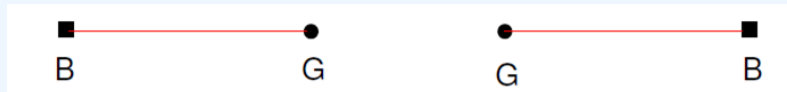
$p \rightarrow$  probability that male gender

$q \rightarrow$  probability that female gender

$p^2 \rightarrow$  probability that both ends of the edge will be male

$q^2 \rightarrow$  probability that both ends of the edge will be female

$2pq \rightarrow$  probability that the first end of the edge is male and the second end is female, or vice versa, i.e. a cross-gender edge



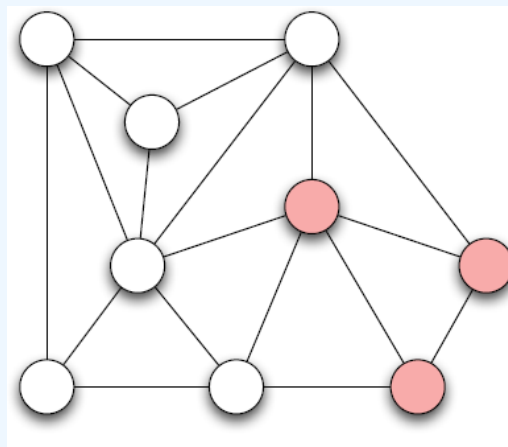
## Measuring Homophily (contd.)

For the assumed problem,

- No. of students = 9
- No. of boys = 6
- No. of girls = 3
- Total number of edges = 18
- No. of cross edges = 5
- Cross-edge fraction =  $5/18 = 0.27$
- $p = 6/9 = 2/3$
- $q = 3/9 = 1/3$

- $2pq = 4/9 = 0.44$
- Actual cross-edge fraction  $< 2pq$
- $0.27 < 0.44$

**Conclusion: The network exhibits homophily**



**Homophily Test:** If the fraction of cross-gender edges is significantly less than  $2pq$ , then there is evidence for homophily.

## Solve the problem : Extreme Gender Homophily

Consider a class of elementary school students consisting of 9 boys and 12 girls. Suppose a social network on this group exhibits extreme gender homophily; that is, it has no cross-gender edges. Compute the maximum number of possible edges in the social network.

# Mechanisms Underlying Homophily

- Underlying behaviour that can be observed
- Sociologists → How to understand the mechanism leading to homophily?
- Two mechanisms → Selection and Socialization or social influence

## **Selection:**

- Operate at different levels and scales and intentionality
- Nodes exhibiting immutable characteristics  
Example: People working in an organization/ studying in same school

## **Socialization or Social Influence:**

- Nodes exhibiting mutable characteristics
- People modify themselves to get aligned with their friends

# Selection and Socialization

- Social influence → reverse of selection
  - Selection → Individual characteristics ⇒ formation of the link
  - Socialization/ Social Influence → Existing links ⇒ shapes people's characteristics
- Interplay of selection and socialization → Have the people in the network adapted their behaviors to become more like their friends, or have they sought out people who were already like them?
  - **Longitudinal studies of the social network** → the social connections and the behaviors within a group are both tracked over a period of time.
  - Examples :
    - A study on homophily in the network of illicit use of drugs
    - Effect of social networks on health-related outcomes – A study by Christakis and Fowler

Read the example of research addressing this subtle interplay of factors is the work of Christakis and Fowler on the effect of social networks on health-related outcomes.

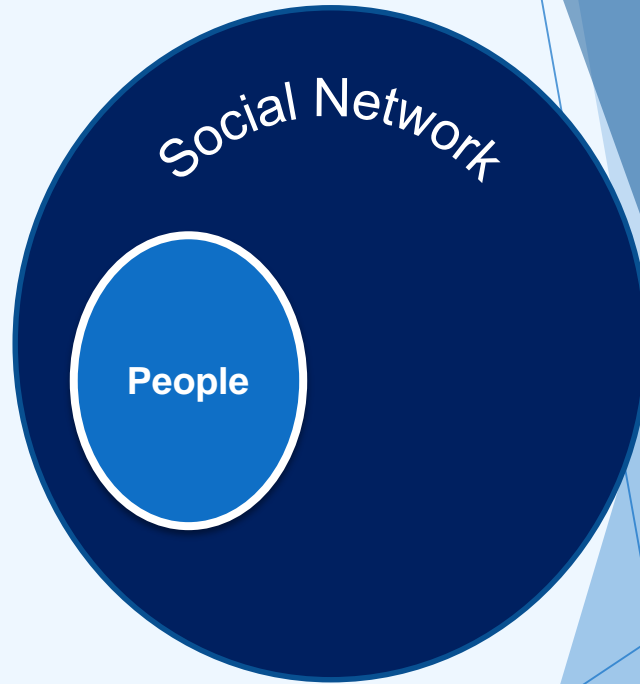
(Book by Easley & Kleinberg - Chapter 4 - Section 4.2)

- Why the people tend to be similar to their neighbour in a social network?
- The study of homophily is not an end point.



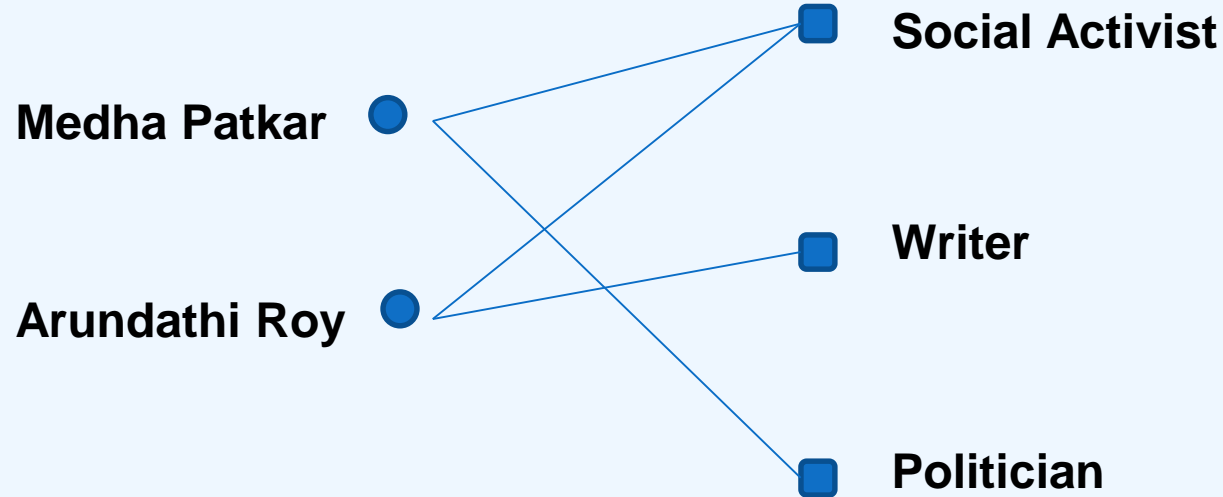
# Affiliation Network

- The surrounding context → exist **outside** the network
- Introduce **activities** or **focal points (foci)** as nodes in the network, leading to a more general form of the network
- Focal points → Interests, Hobbies, Nature of work, etc.



Context

## Example of Affiliation Network



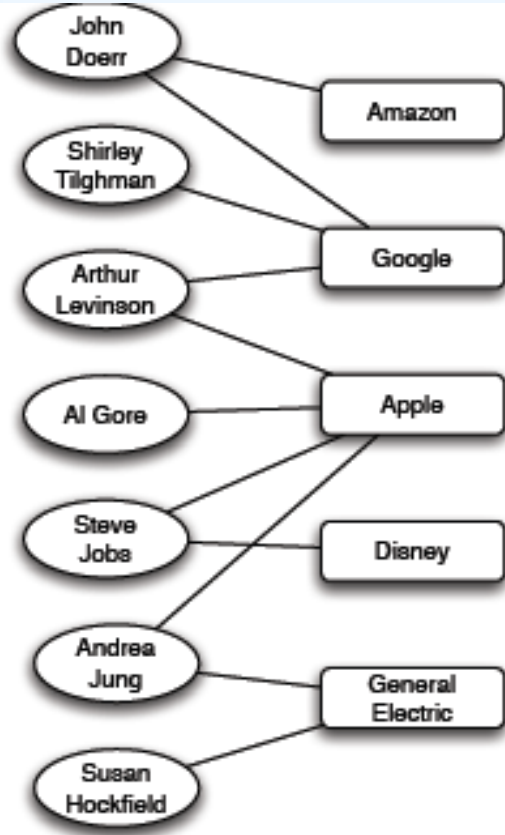
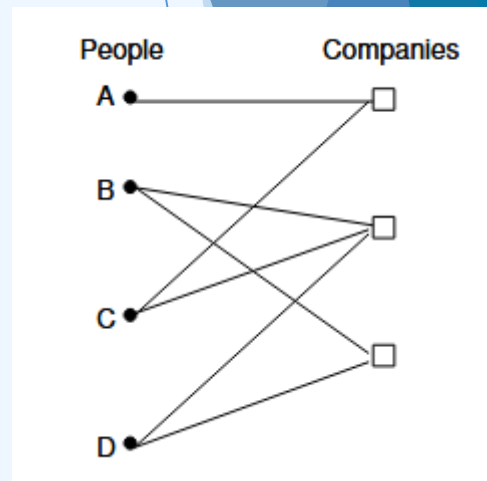


Figure 4.4: One type of affiliation network that has been widely studied is the memberships of people on corporate boards of directors [301]. A very small portion of this network (as of mid-2009) is shown here. The structural pattern of memberships can reveal subtleties in the interactions among both the board members and the companies.

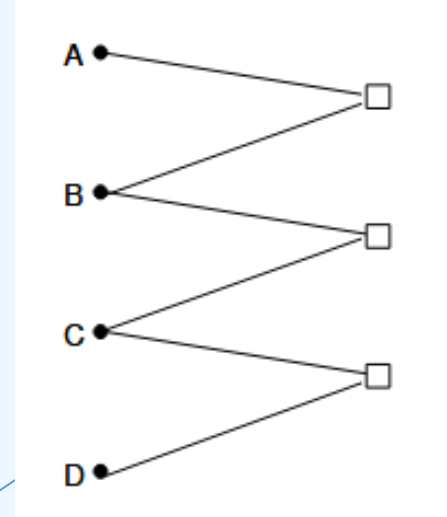
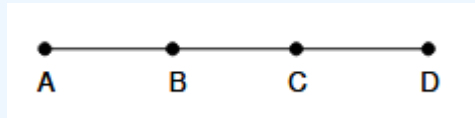
# Affiliation Network as a Bipartite Graph

- Affiliation network  $\rightarrow$  representation as Bipartite Graph
- One set of nodes  $\rightarrow$  people
- The other set of nodes  $\rightarrow$  Foci
- Each edge joins a node from one set to a node in the other set.
- No edge joins a pair of nodes in the same set.
- Affiliation networks  $\rightarrow$  studied to understand the pattern of participation of the people in structured activities
- A cycle in a bipartite graph  $\rightarrow$  even number of nodes and edges

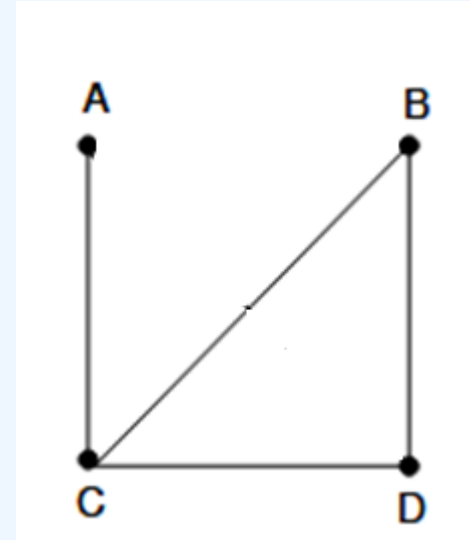
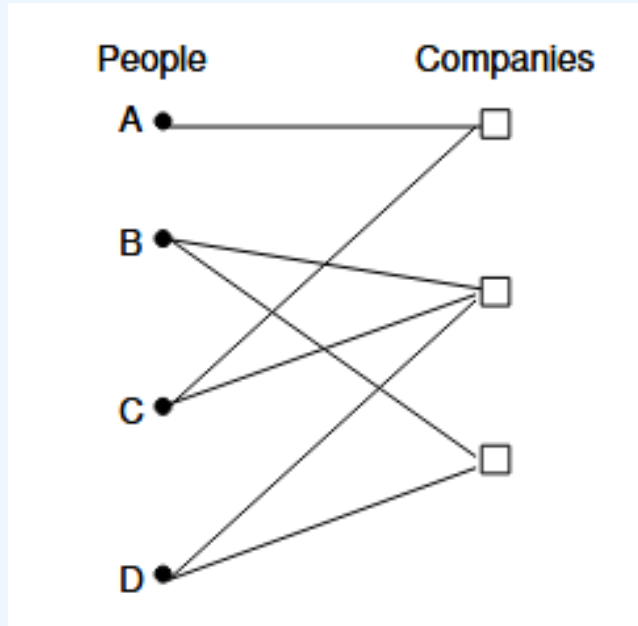


# Projected Networks of Affiliation Networks

- Projected graph / Projected Network → Network on the nodes representing people.
- There is an edge between two people if they both have edges to at least one common focal point.
- Example: The projected graph/network of the given graph is

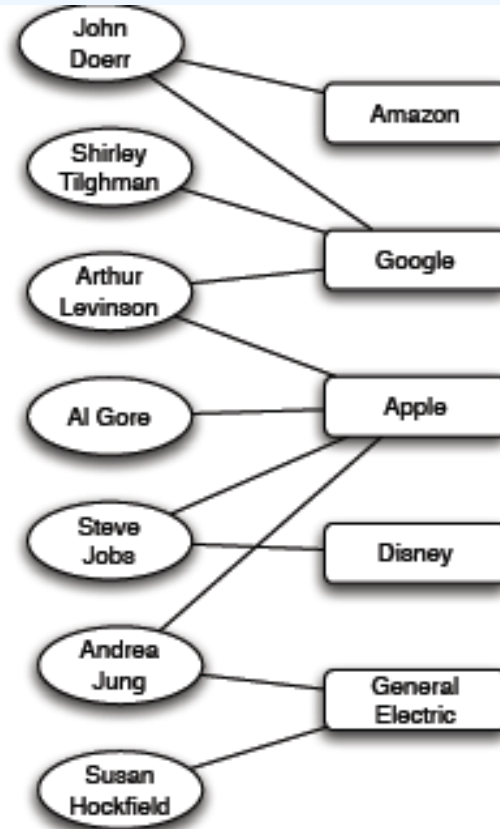


# Draw the Projected Graph of the given graph



## Draw the projected graph.

- Draw the projected graph for the example of memberships on corporate boards of directors from the given network. Here the nodes should be the seven people in the figure, and an edge should join any two who serve on a board of directors together.



# Co-Evolution of Social and Affiliation Network

- New friendship links → people associated with new foci
- Co-evolution – interplay between selection and social-influence
- Principle behind co-evolution → If two people participate in a shared focus, they become friends;
- If two people are friends, one can influence the foci of the other's.
- Extension of affiliation network
- **Social-Affiliation Network**

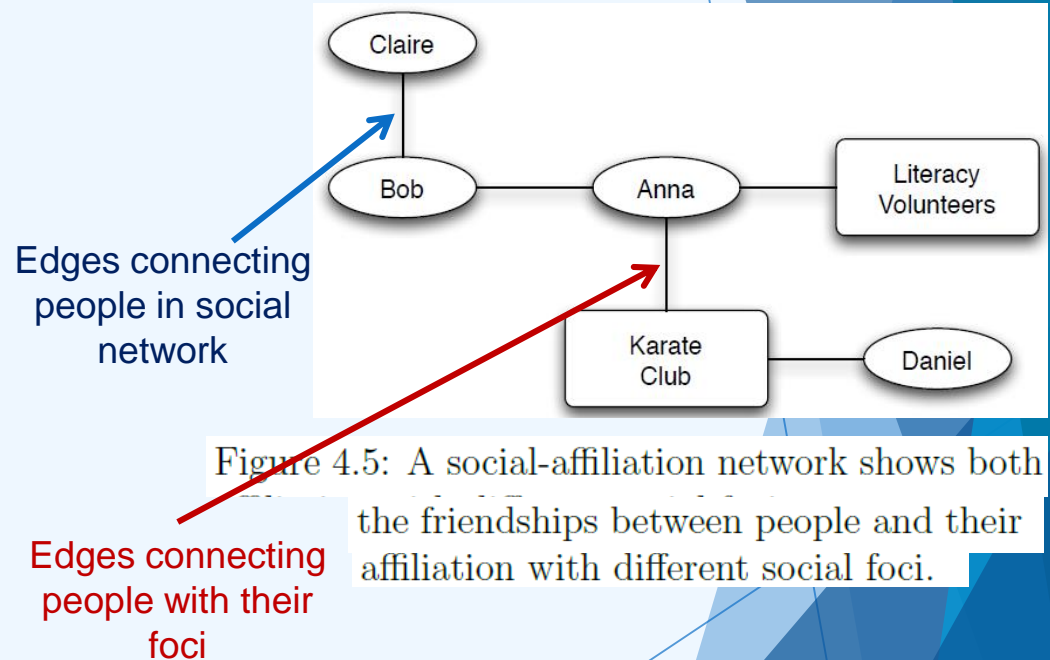
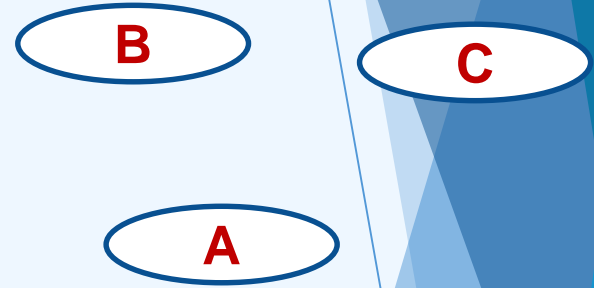


Figure 4.5: A social-affiliation network shows both the friendships between people and their affiliation with different social foci.

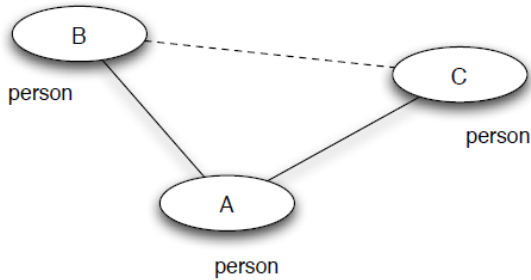


# Link formation in Social-Affiliation Network

- Link formation in social – affiliation network → ***closure process***
- ***Consider*** there are nodes B and C with a common neighbor A in the network, and suppose that an edge forms between B and C.
- ***What are the interpretation when A, B and C are people or foci?***

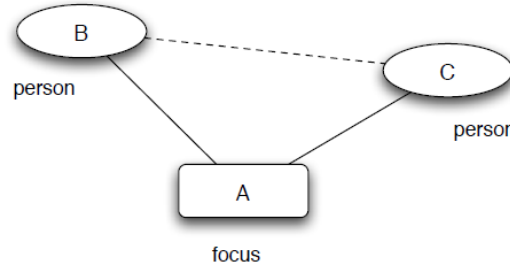


# Link formation in Social-Affiliation Network



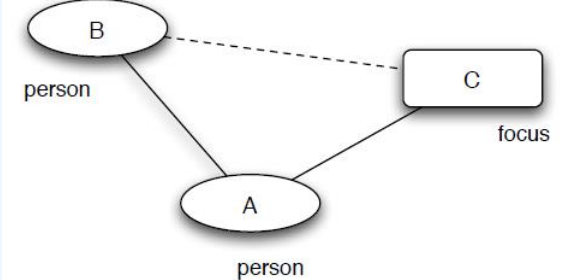
(a) *Triadic closure*

**Due to a common friend  
or homophily**



(b) *Focal closure*

**A new edge may form  
because of a common  
focal point (effect of  
homophily) - Principle  
of selection**



(c) *Membership closure*

**A new edge may form  
between a person  
and a focal point (also an  
effect of homophily) - Social  
influence**

# New link formation in the social-affiliation network

## Identify the principle behind the formation of the link

- Karate introduces Anna to Daniel -?
- Anna introduces Bob to Karate - ?
- Bob introduces Anna to Claire - ?

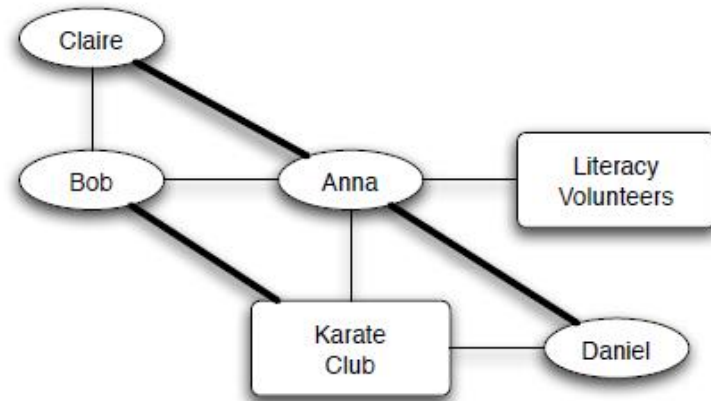


Figure 4.7: In a social-affiliation network containing both people and foci, edges can form under the effect of several different kinds of closure processes: two people with a friend in common, two people with a focus in common, or a person joining a focus that a friend is already involved in.

# Question for discussion

(Refer Book By Easley and Kleinberg - Chapter 4 - Exercise 4.6.1 – Pg. No.116)

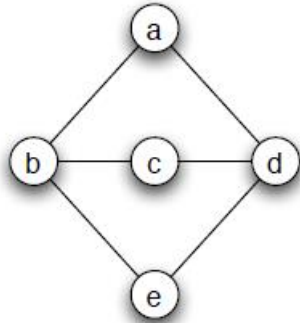


Figure 4.20: A social network where triadic closure may occur.

# Can we study the link formation issue in a quantitative fashion?

- Illustration → Study of Triadic Closure
  - Study done by Kossinets and Watts [2006].
  - Basic questions
    - How does the likelihood of the formation of a link increase when two people have one friend in common (compared to when they have no common friend)?
    - How does the likelihood increase when two people have two or more friends in common?

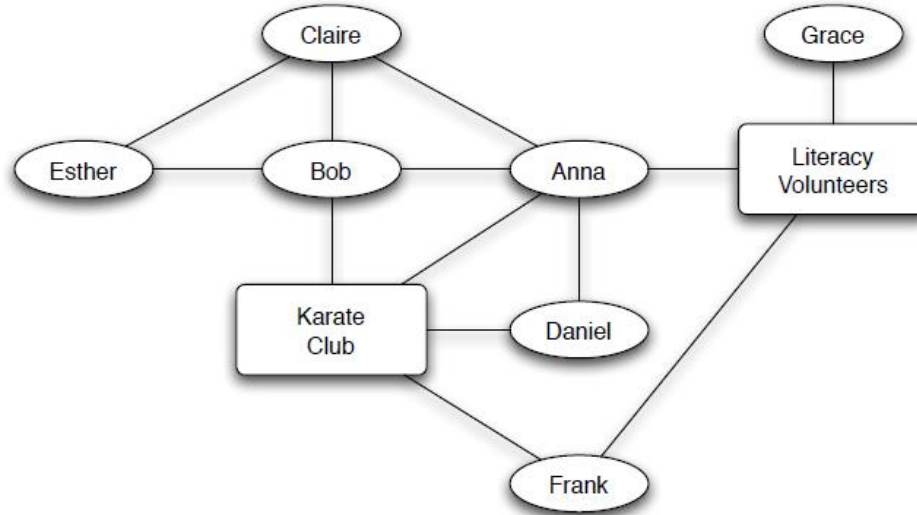


Figure 4.8: A larger network that contains the example from Figure 4.7. Pairs of people can have more than one friend (or more than one focus) in common; how does this increase the likelihood that an edge will form between them?

Read this case study under Tracking Link Formation in On-line Data (Book by Easley & Kleinberg - Chapter 4 - Section 4.4)

# A Spatial Model of Segregation

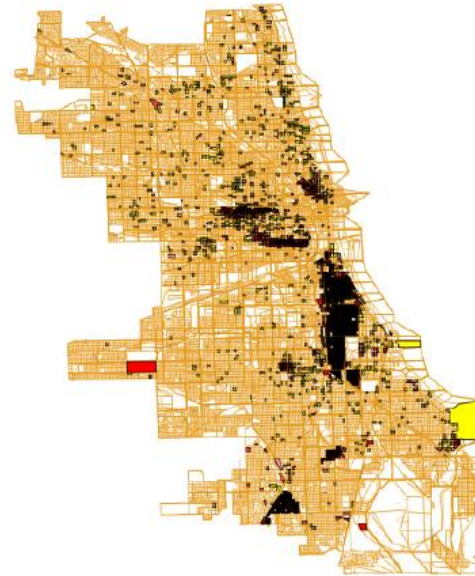
**African-Americans  
< 25%**

**Others >75%**

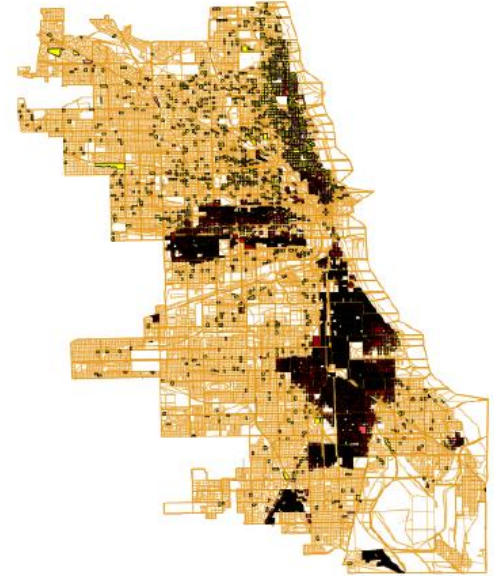
Read the Schelling's Model of Spatial Segregation - Effect of homophily  
(Book by Easley & Kleinberg - Chapter 4 - Section 4.5)

Link to simulation :

<http://nifty.stanford.edu/2014/mccown-schelling-model-segregation/>



(a) *Chicago, 1940*



(b) *Chicago, 1960*

Figure 4.14: The tendency of people to live in racially homogeneous neighborhoods produces spatial patterns of segregation that are apparent both in everyday life and when superimposed on a map — as here, in these maps of Chicago from 1940 and 1960 [302]. In blocks colored yellow and orange the percentage of African-Americans is below 25, while in blocks colored brown and black the percentage is above 75.

# Summary

- Similarity of nodes
- Homophily
  - Mechanisms → Selection and Socialization
  - Measuring homophily
- Affiliation Network
- Social-Affiliation Network
- Link formation in Social-Affiliation Network
  - Case Studies



# Structural Balance