Social Networking

الشبكات الاجتماعية

ITMC 413

إعداد

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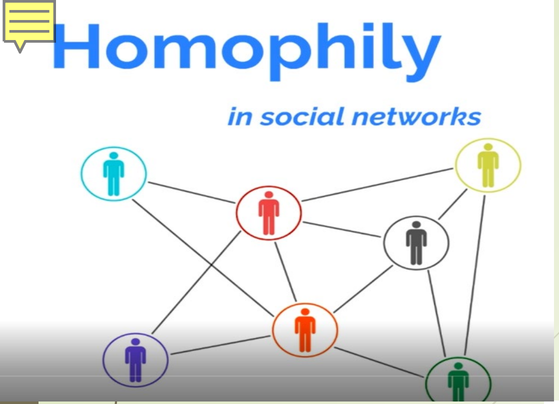
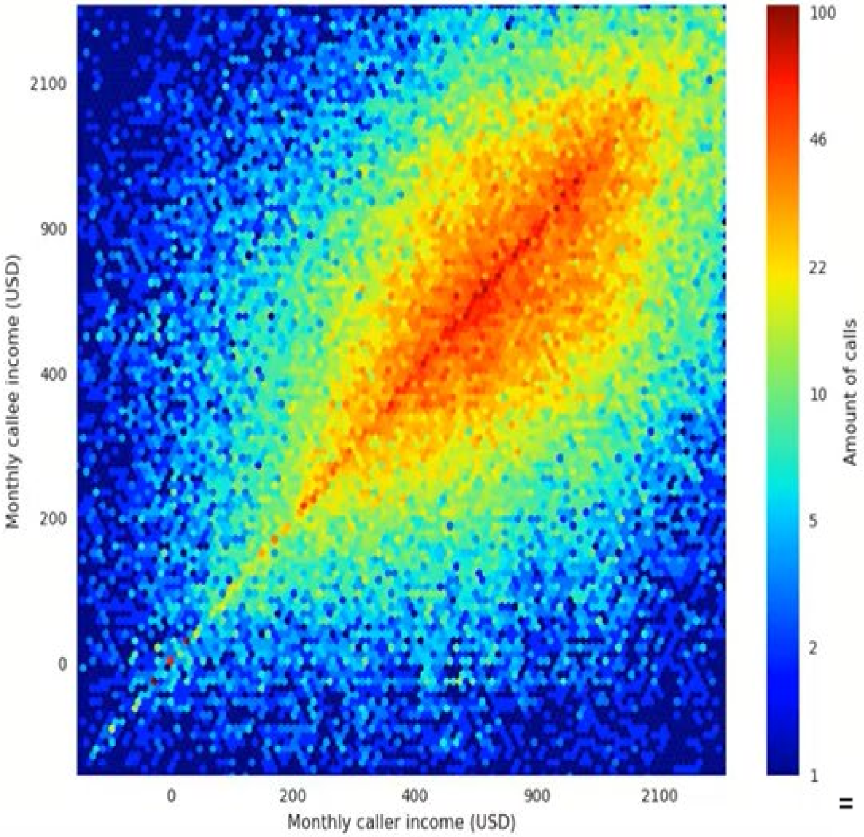


Homphily and Triadic Closure

- Triadic closure: When two individuals share a common friend, a friendship between the two is more likely to occur
- Homophily suggests two individuals are more alike because of common friend, so link may occur even if neither is aware of mutual friend!
- Difficult to attribute formation of link to any one factor

Measuring Homophily in Social Networks

- Homophily in social networks:
  - People have tendency to associate with others whom they perceive as being similar
  - *"Birds of a feather flock together"*

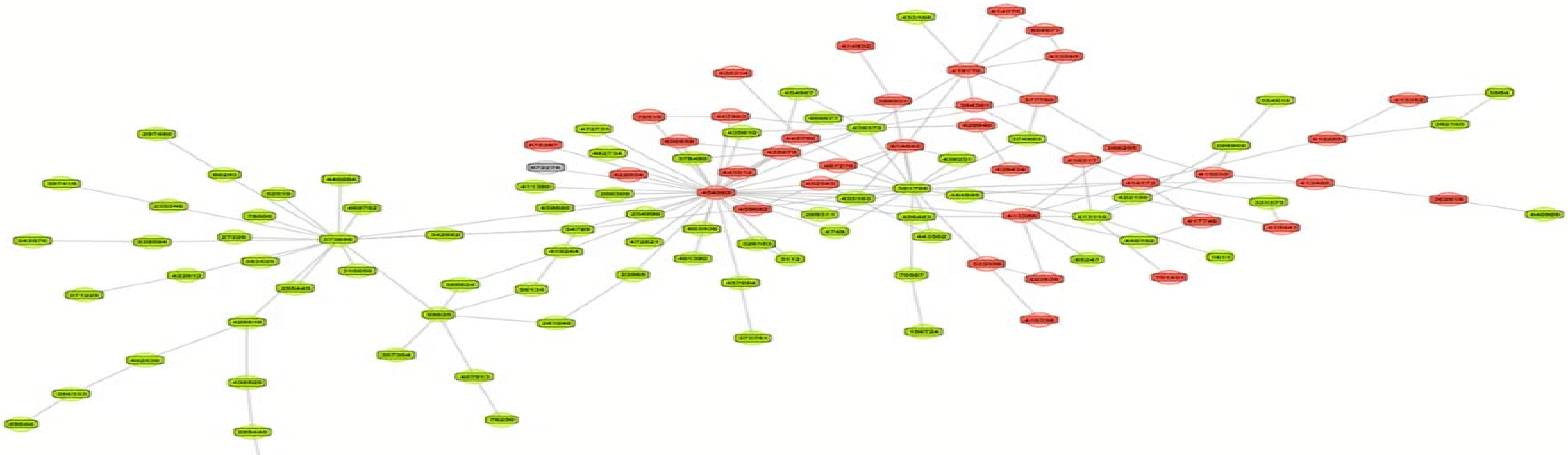


Homophily is a concept that stems from sociology where it usually described as "people have a strong tendency to associate with others whom they perceive as being similar to themselves in some way, e.g., live in same city, have same hobbies or interest".

= people **love those** who are **like themselves**

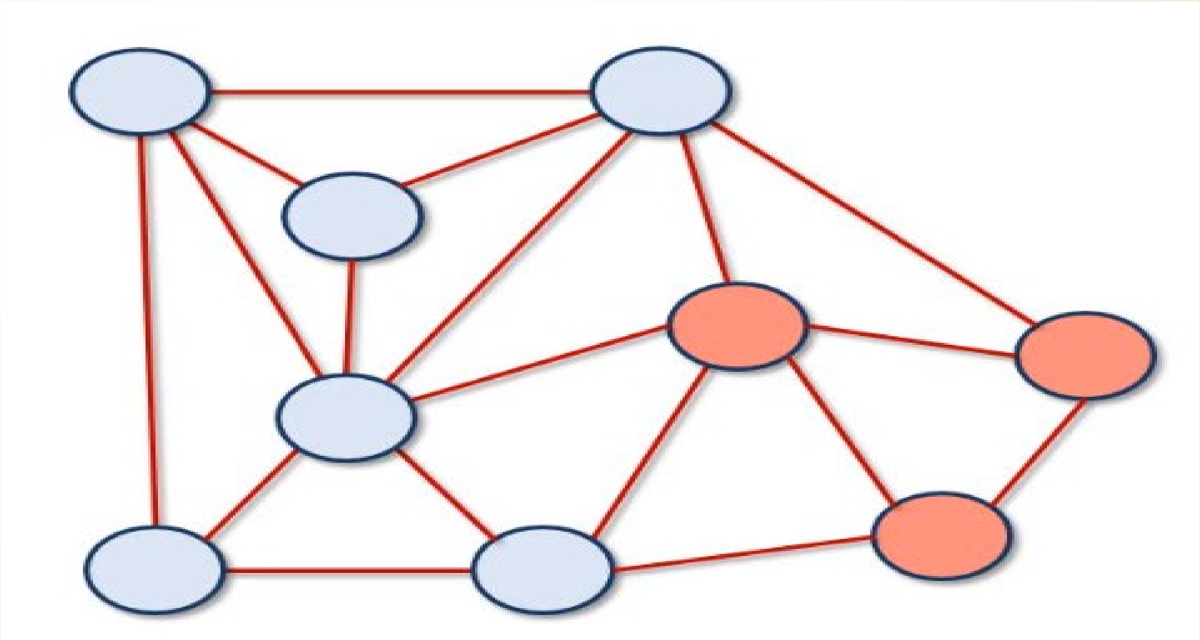
Homophily

- Homophily in fraud networks
  - Fraudsters are more likely to be connected to other fraudsters, and legitimate people are more likely to be connected to other legitimate people
- Depends on
  - Connectedness between nodes with same label
  - Connectedness between nodes with opposite label



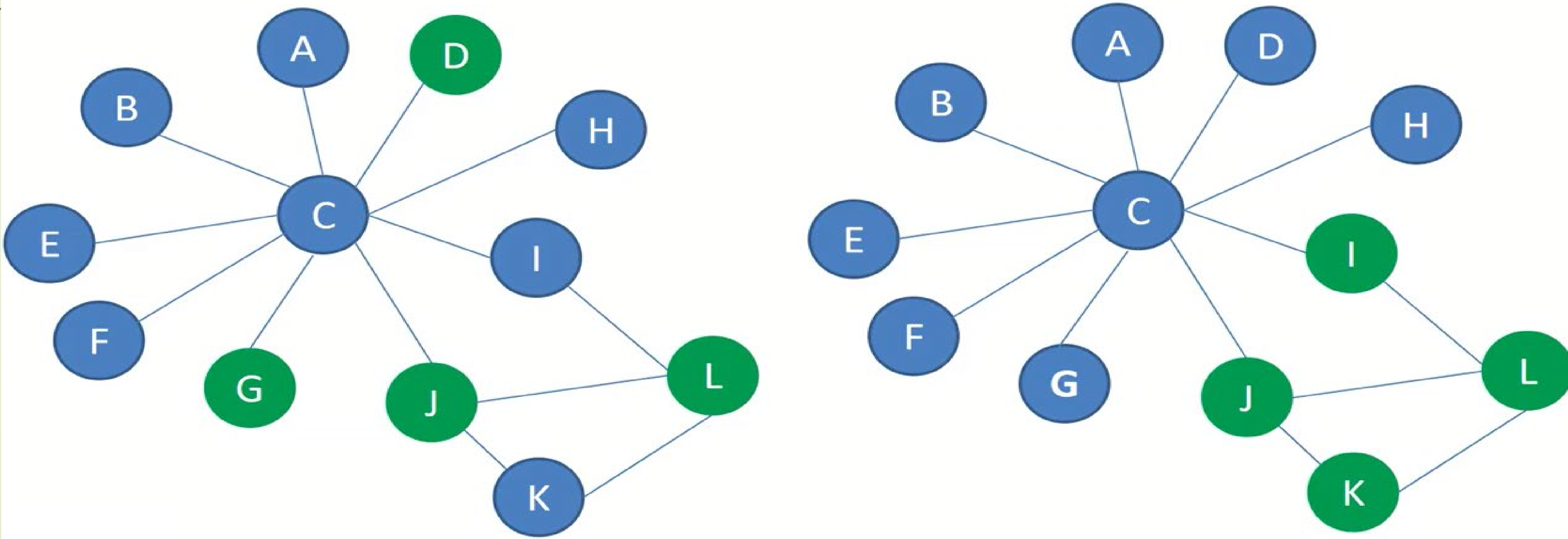
There are two potential causal mechanisms:

- **Social selection:** similar people are attracted to each other and tend to form social ties
- **Social influence/contagion**: people are often influenced by those in their social network through the diffusion of information and the pressure to conform.This is sometimes referred to as peer effects and it is thought to be stronger among people who are already similar in other ways.



Homophily

Below you see another example of two networks with blue and green nodes. In the network on the left, the green nodes are randomly spread through the network. This network is not homophilic.
The green nodes in the network on the right are connected to each other to a larger extent. This network is homophilic.



Homophily

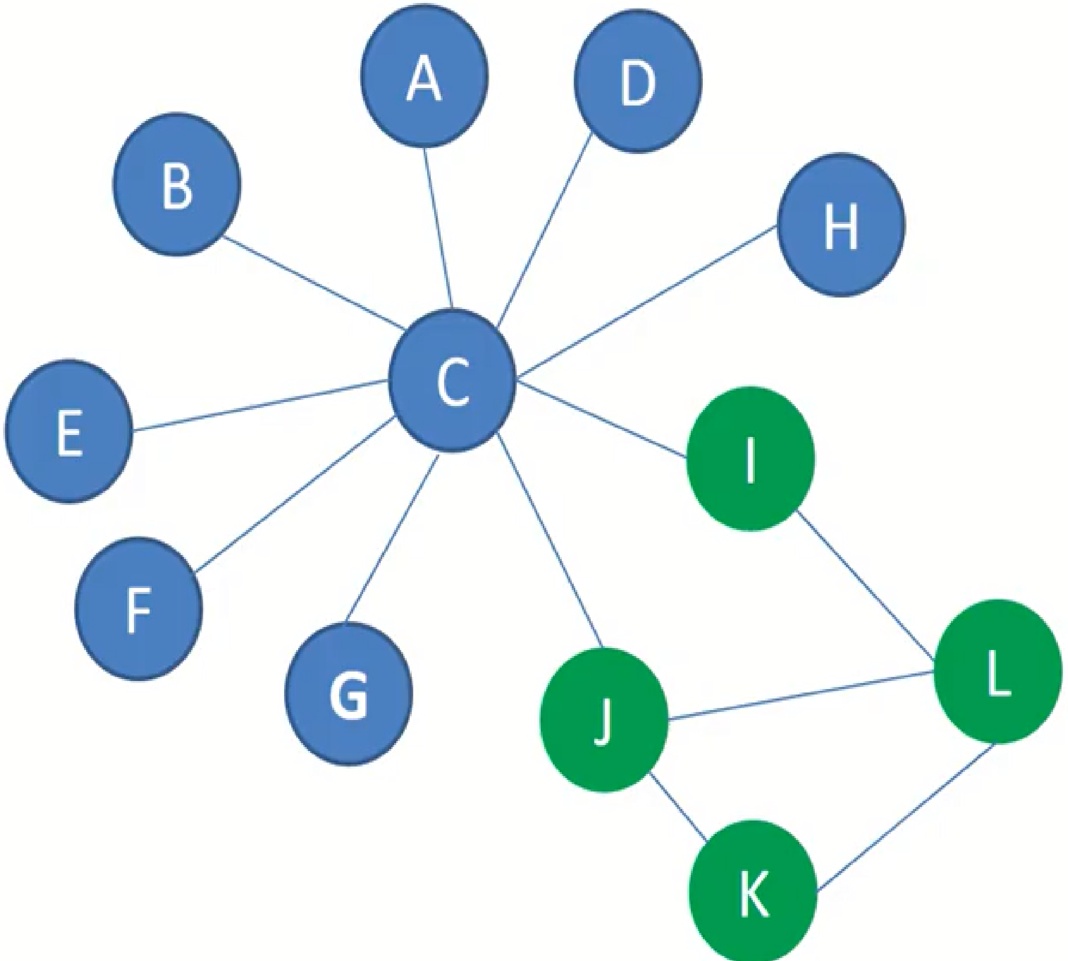
Before defining homophily we need to define the connectance of a network, which is the probability that 2 nodes are connected.
Say we have a network with N nodes and M edges.
The connectance is then the ratio between the actual number of edges and the number of edges if the network was fully connected, the latter being the number of combinations of 2 out of N:

$$\mathrm{p} = \frac{M}{\binom{N}{2}} = \frac{2M}{N(N-1)}$$

Homophily

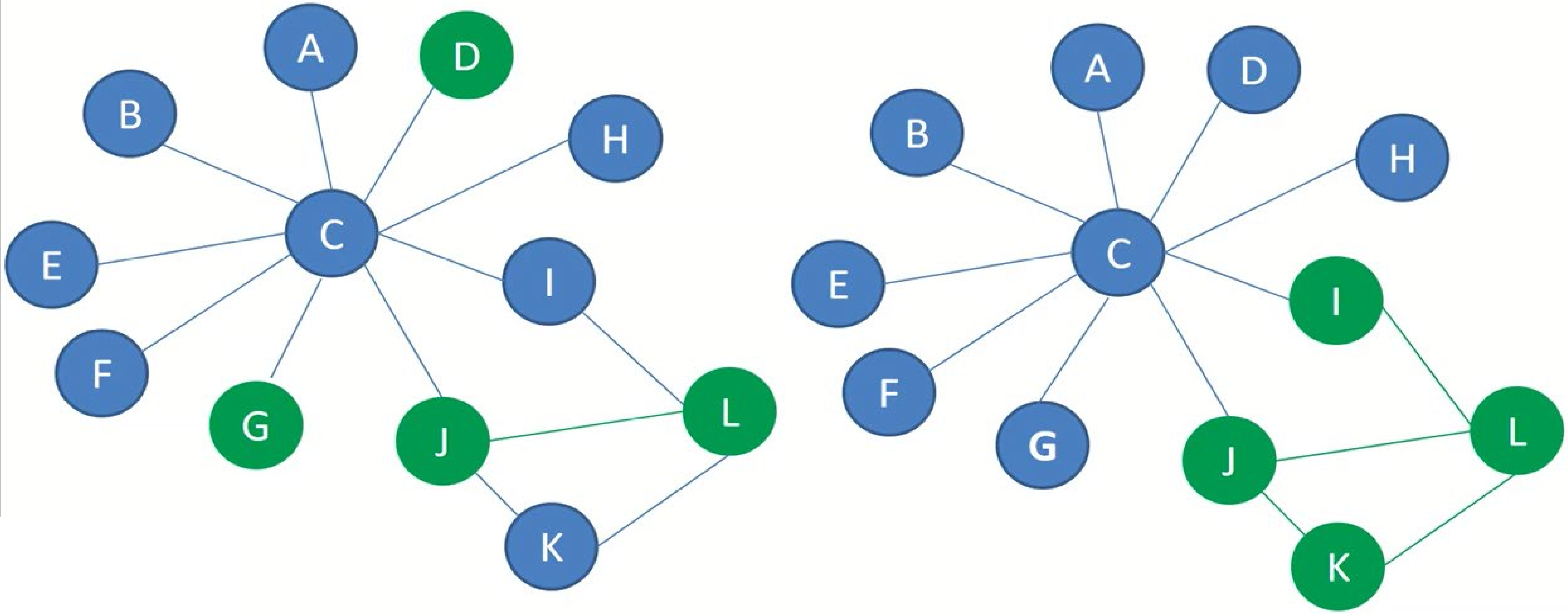
In the below example, the connectance equals 20%.

- p = connectance = probability 2 nodes are connected (0<p<1)
- N: number of nodes
- M: number of edges
- $p = \frac{M}{\binom{N}{2}} = \frac{2M}{N(N-1)}$
- Our example
  - N = 12
  - M = 13
  - p = 20%



Homophily

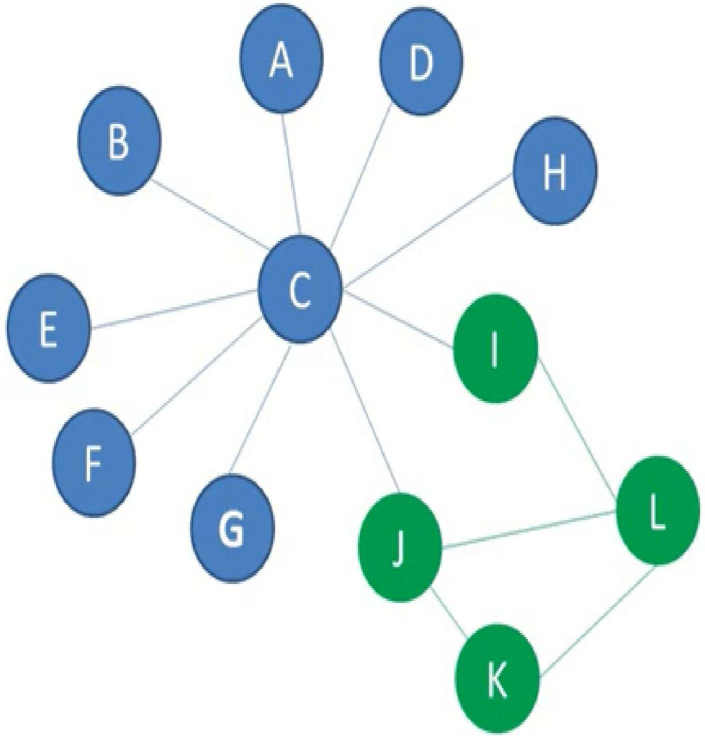
Dyadicity : measures connectedness between nodes with same label



Both of them have 12 nodes, 8 that are blue and 4 that are green. Clearly the distribution of the green and blue nodes is different. In the network on the left there is only 1 edge between the green nodes, but on the right there are 4. There is higher connectedness between green nodes in the network to the right.

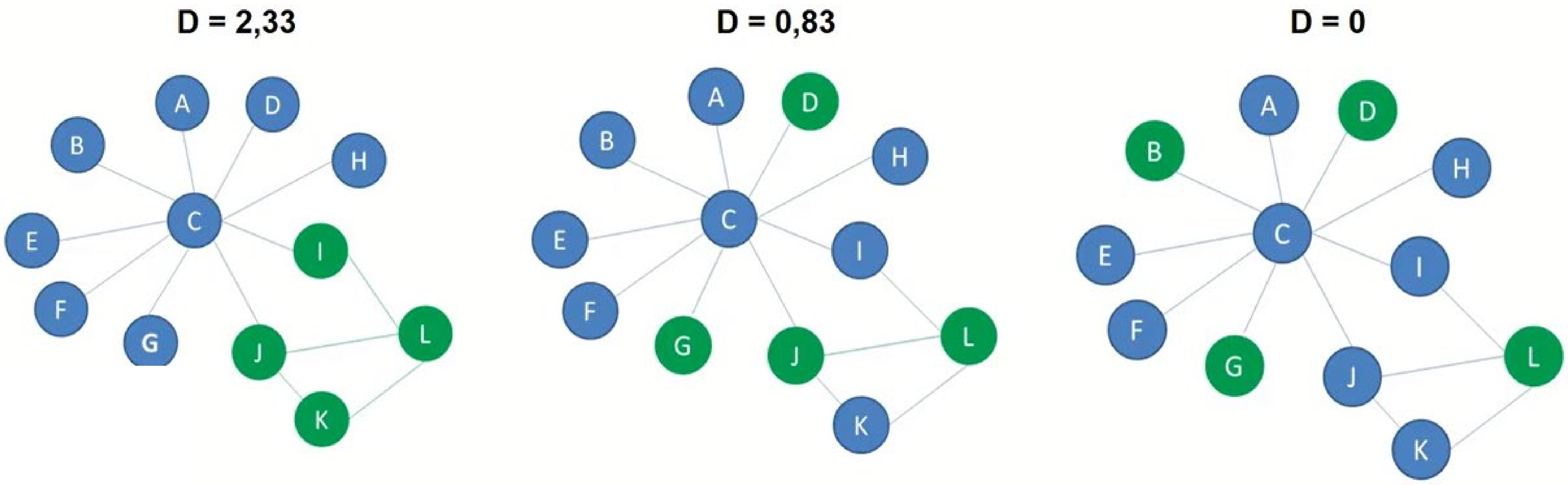
Homophily

- Dyadicity: measures number of same label edges compared to what is expected in random configuration of network
- Expected number of same label edges: $\binom{n_g}{2}.p = \frac{n_g(n_g-1)}{2}.p$
- Example
  - 8 blue nodes, 4 green nodes, connectance=0,2
  - =4*3/2*0,2=1,2
- Dyadicity = number of same label edges/ expected number of same label edges
- Example
  - 4/1,2=3,33



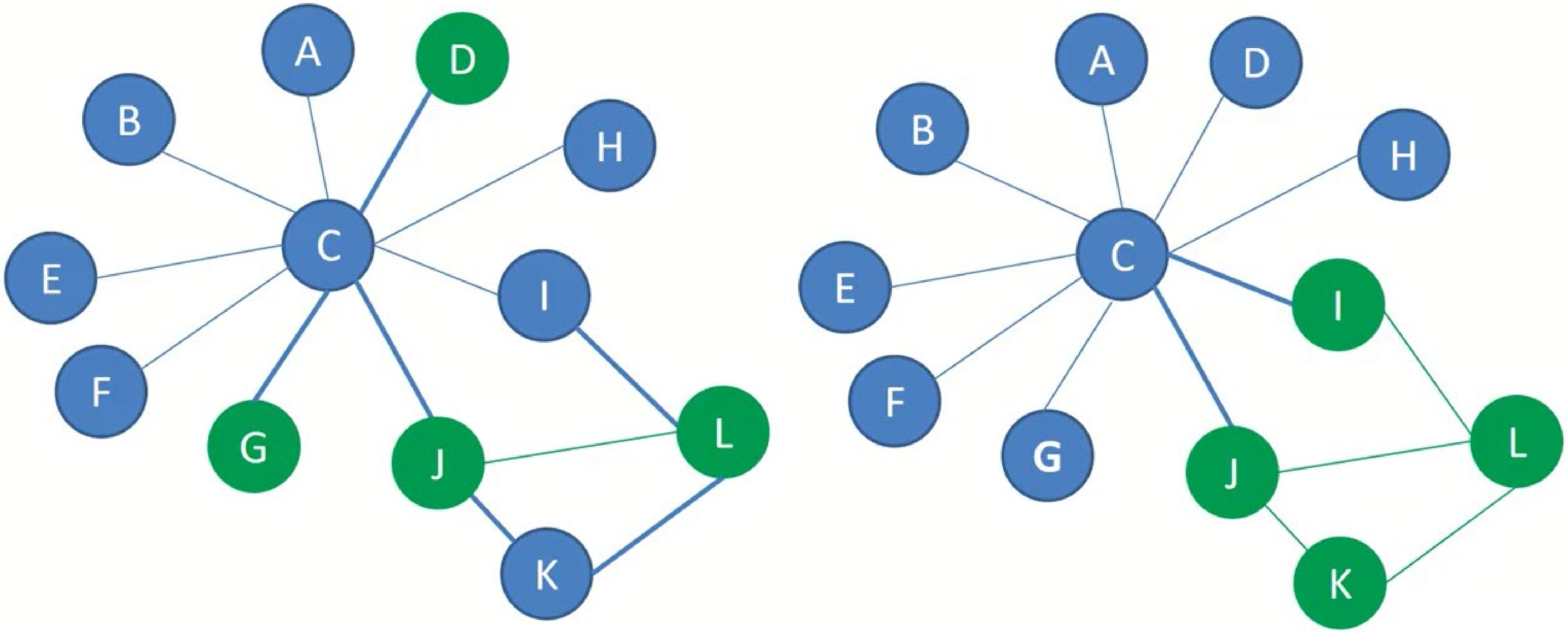
If the dyadicity is greater than 1 we say that the network is dyadic because nodes with the same label are more connected amongst themselves. If the dyadicity is almost equal to one, the distribution of the labels is the same as in a random network. If the dyadicity is less than 1 we say that the network is anti-dyadic since nodes with the same label are less connected amongst themselves.

- Dyadicity
  - > 1: dyadic
  - ~ 1: random
  - < 1: anti-dyadic



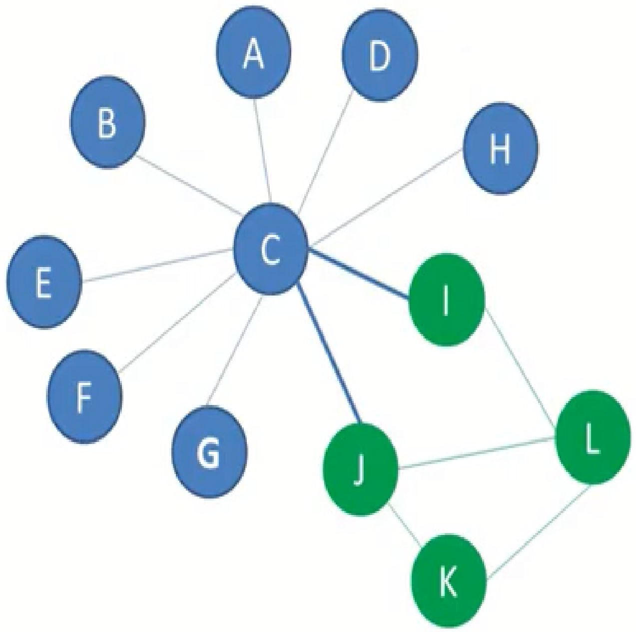
Heterophilicity

For a network to show signs of homophily, it is not enough for nodes of the same label to be more connected. There should also be fewer connections between nodes of opposite labels. This is measured with heterophilicity.



Heterophilicity

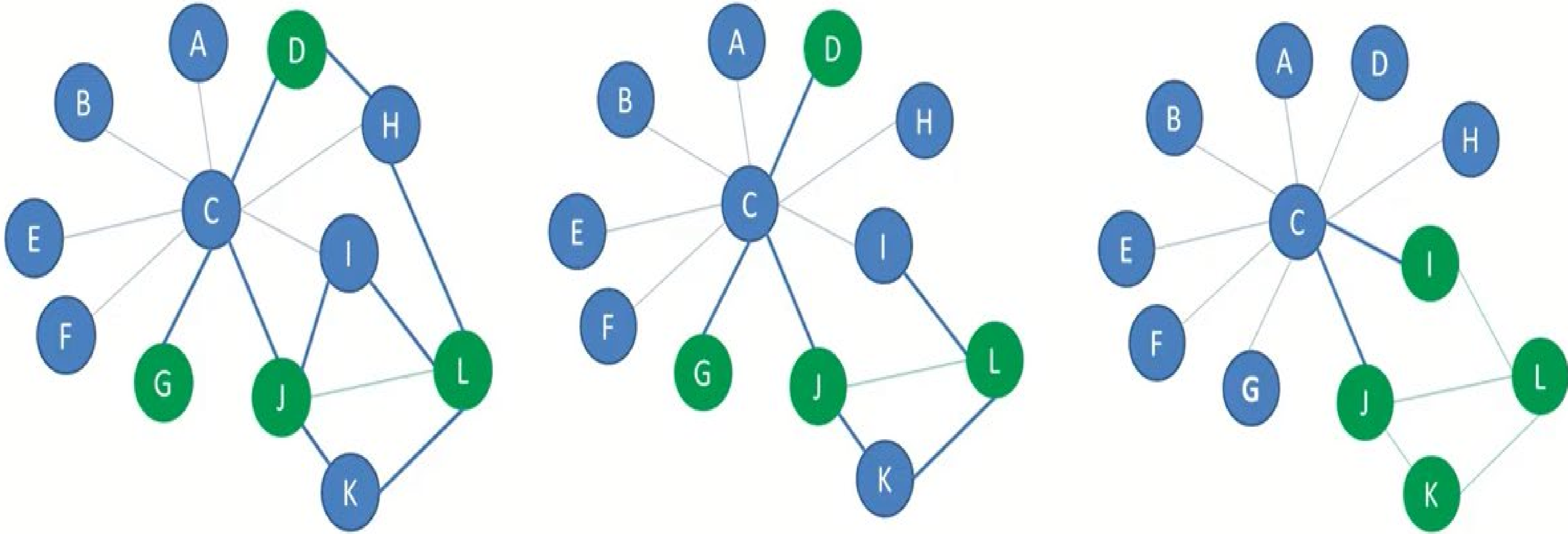
- Heterophilicity: measures connectedness between nodes with different labels compared to what is expected in random configuration
- Expected number of cross-label edges=n_b*n_g*p
- Example
  - 8 *4*0,2=6,4
- Heterophilicity= actual number of cross label edges /expected number of cross label edges
- Example
  - 2/6,4=0,31



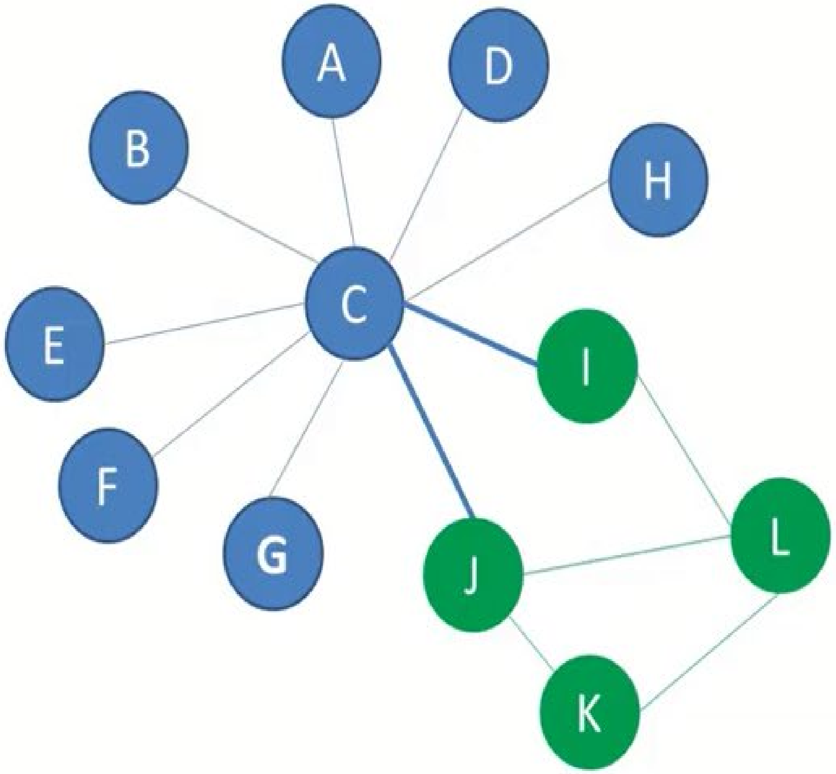
Heterophilicity

- Heterophilicity
  - > 1: heterophilic
  - ~ 1: random
  - < 1: heterophobic

H = 1,16 H = 0,94 H = 0,31



- Homophilic network
  - Dyadicity > 1
  - Heterophilicity < 1



Dyadicity = 2,33

Heterophilicity = 0,31

- Dyadicity and heterophilicity not to be interpreted in an absolute way
- Network can be either dyadic or heterophobic
- Not random distribution of labels can be meaningful

Balance Theory

- One of the most important concepts to emerge from the early days of social network analysis was *balance theory*. The early focus in balance theory was on the cognition or awareness of sociometric relations, usually positive and negative affect relations such as friendship, liking, or disliking, from the perspective of an individual.
- The idea of balance arose in Fritz **Heider's** (1946) study of an individual's cognition or perception of social situations. Heider focused on a single individual and was concerned about how this individual's attitudes or opinions coincided with the attitudes or opinions of other “entities” or people. The entities could be not only people, but also objects or statements for which one might have opinions. He considered ties, which were signed, among a pair or a triple of entities. Specifically.

Balance Theory

- For example, we can consider two individuals, focusing on one of them as primary, and their opinions about a statement, such as “We must protect the environment.” If both actors are friends, then they should react similarly to this statement — either both should oppose the statement (and hence, both have a negative opinion about it) or both should favor it (and have positive opinions).

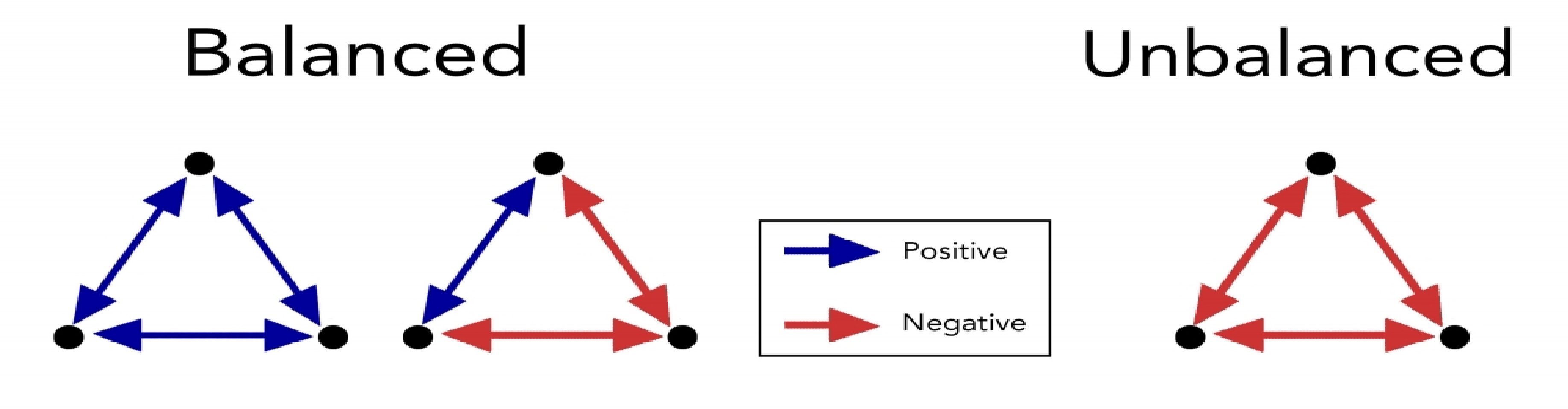
- Structural Balance Theory models relationships between members of a group and describes how they evolve over time. The theory’s axioms give rise to balanced and unbalanced configurations, which researchers have used to gain insight on many real-world systems.

It Works in Theory

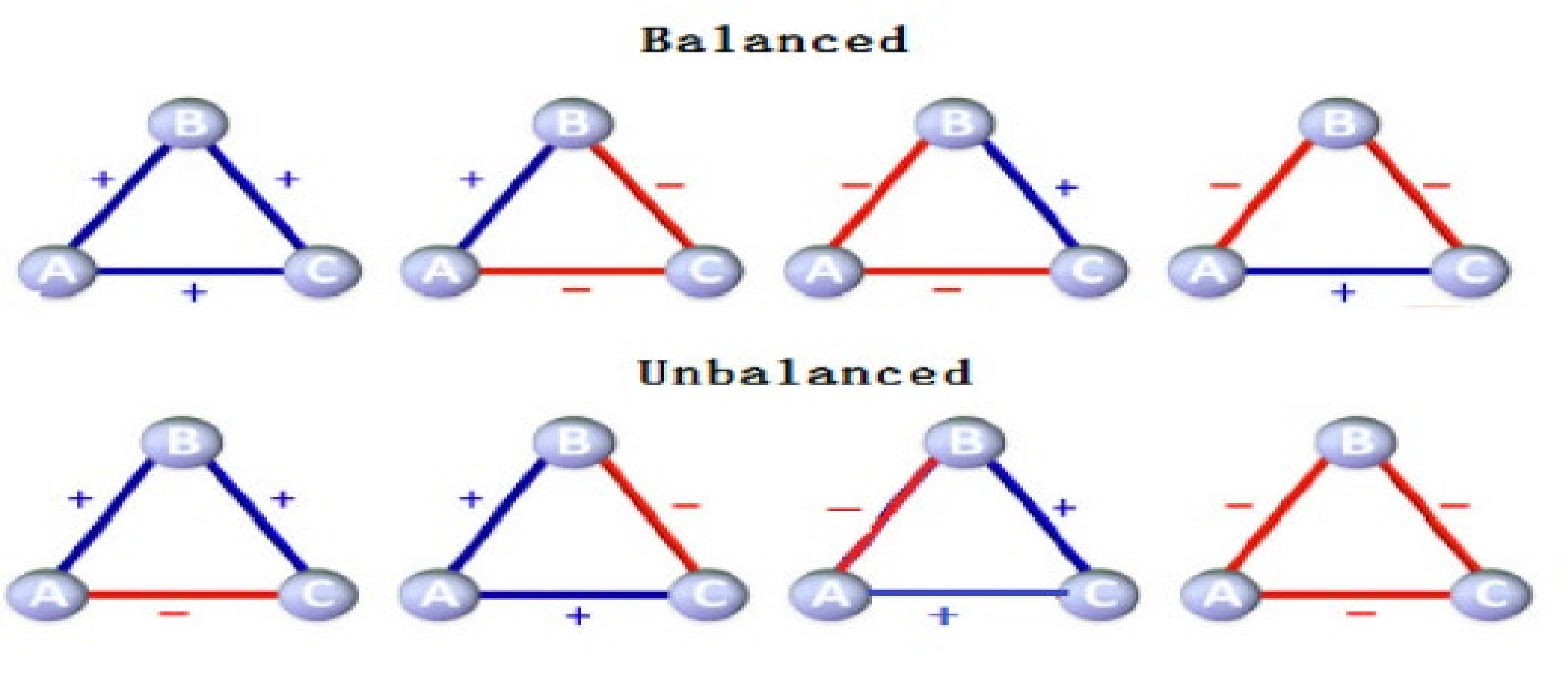
- Structural Balance Theory is a simple model of relationships. One individual has either a positive or negative relationship with another, and vice-versa. This gives rise to 16 different sets of relationships between three people, the conventional unit in the theory.

SBT also has four rules:

- - A friend of a friend is a friend,
- - A friend of an enemy is an enemy,
- - An enemy of a friend is an enemy,
- - An enemy of an enemy is a friend.
- According to these rules, only two triads should be stable, or balanced: a group with three mutual friends or a group where two members join together against the third. Accordingly, the researchers expected to see the network converge to a state where most of its subsets were one of these two triads. They also suspected that traders in these balanced triads would meet with more success than their unbalanced colleagues.



The researchers found that these three triads persisted in the system, even though only two are balanced under classical Structural Balance Theory.



Balanced complete graph

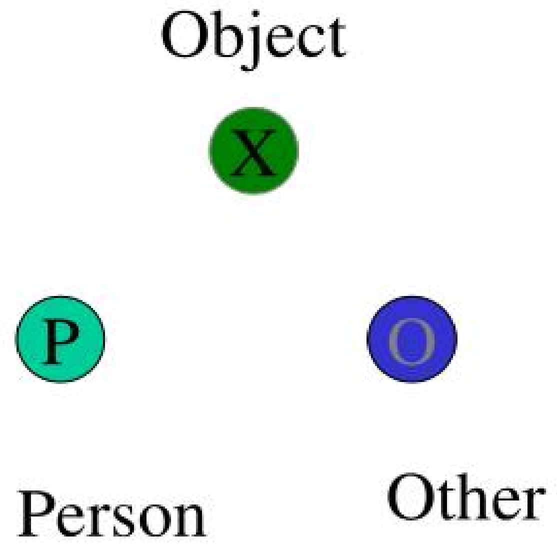
- Specifically, we say that a labeled complete graph is balancedif every one of its triangles is balanced — that is, if it obeys **Structural Balance Property**: For every set of three nodes, either all three edges are labeled +, or exactly one edge is labeled +

Balance Theorem

- If a labeled complete graph is **balanced**, then either *all pairs of nodes are friends*, or else the nodes can be divided into **two groups X and Y** such that *every pair of nodes in X like each other, every pair of nodes in Y like each other*, and **everyone in X hates everyone in Y**

Social Balance & Transitivity

Heider's work on cognition of social situations, which can be boiled down to the relations among three 'actors':



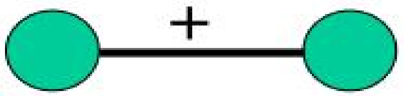
Heider was interested in the correspondence of P and O, given their beliefs about X

Social Balance & Transitivity

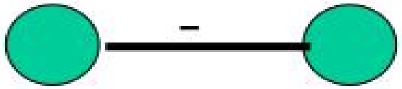
Each dyad (PO, PX, OX) can take on one of two values: + or -

Two Relations:

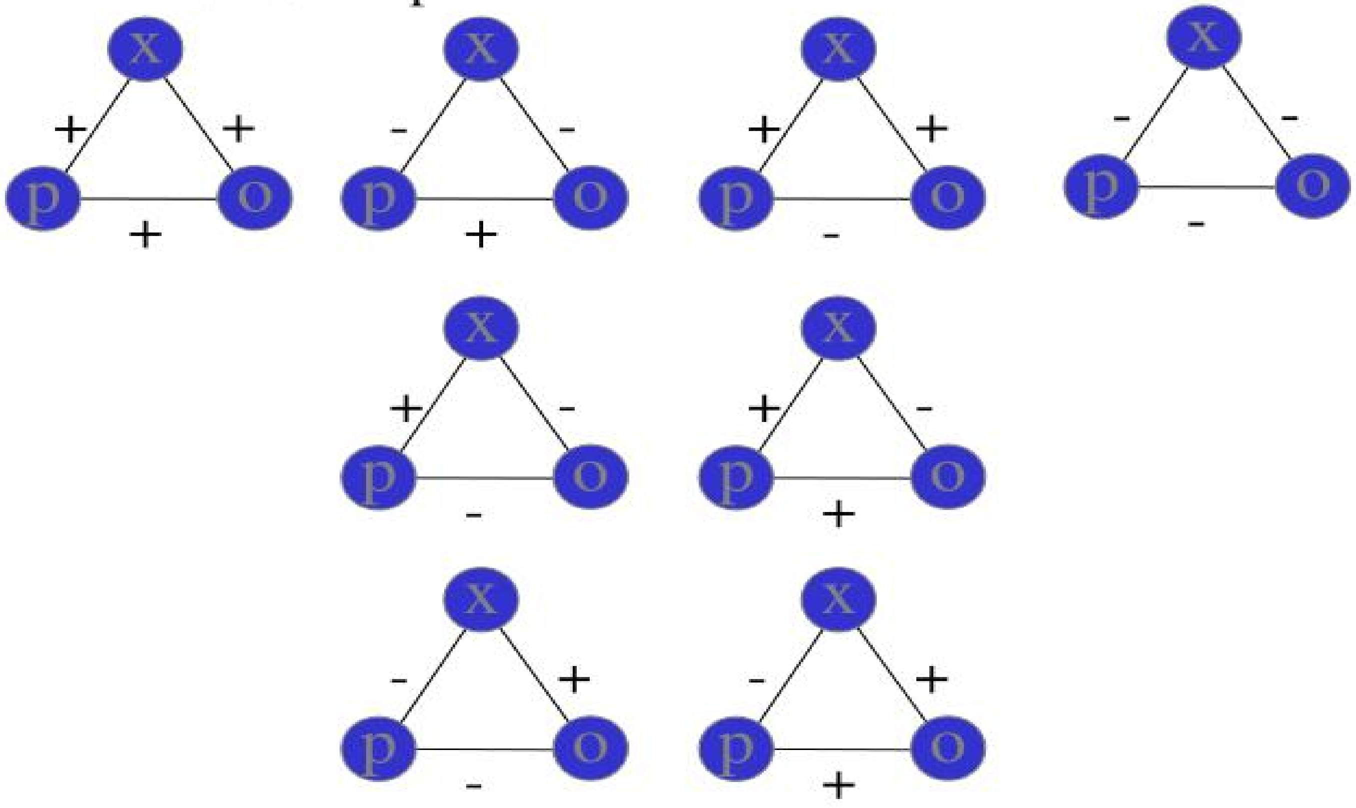
Like:



Dislike

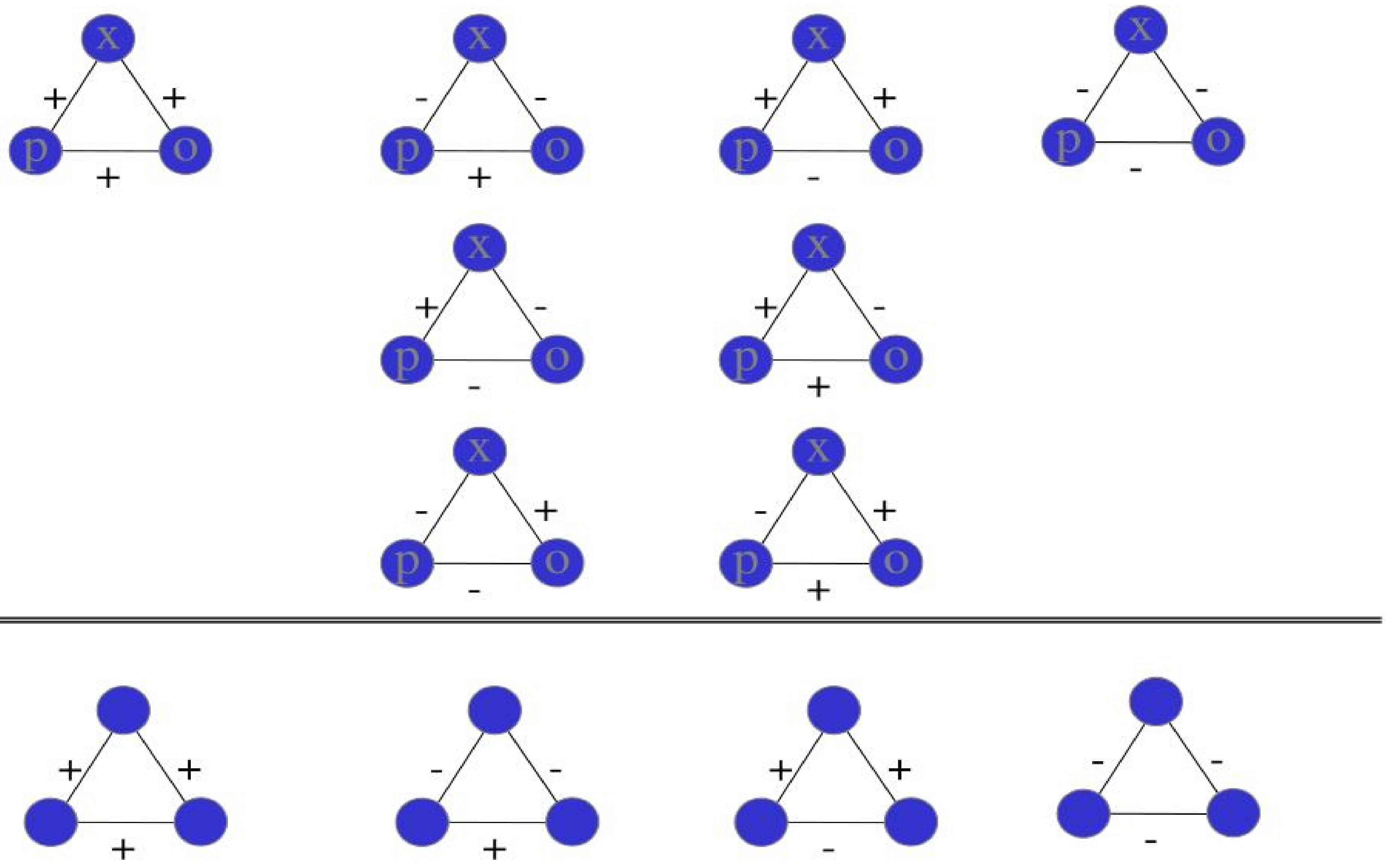


8 POX triples:



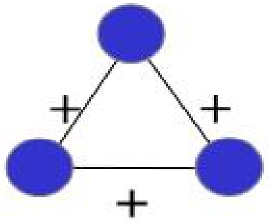
Social Balance & Transitivity

The 8 triples can be reduced if we ignore the distinction between POX:

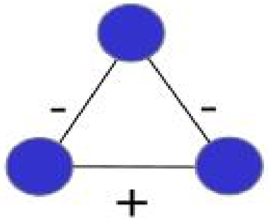


Social Balance & Transitivity

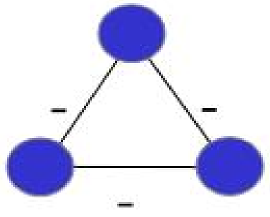
We determine balance based on the product of the edges:



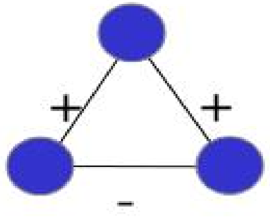
$(+)(+)(+) = (+)$ Balanced "A friend of a friend is a friend"



$(-)(+)(-) = (-)$ Balanced "An enemy of my enemy is a friend"



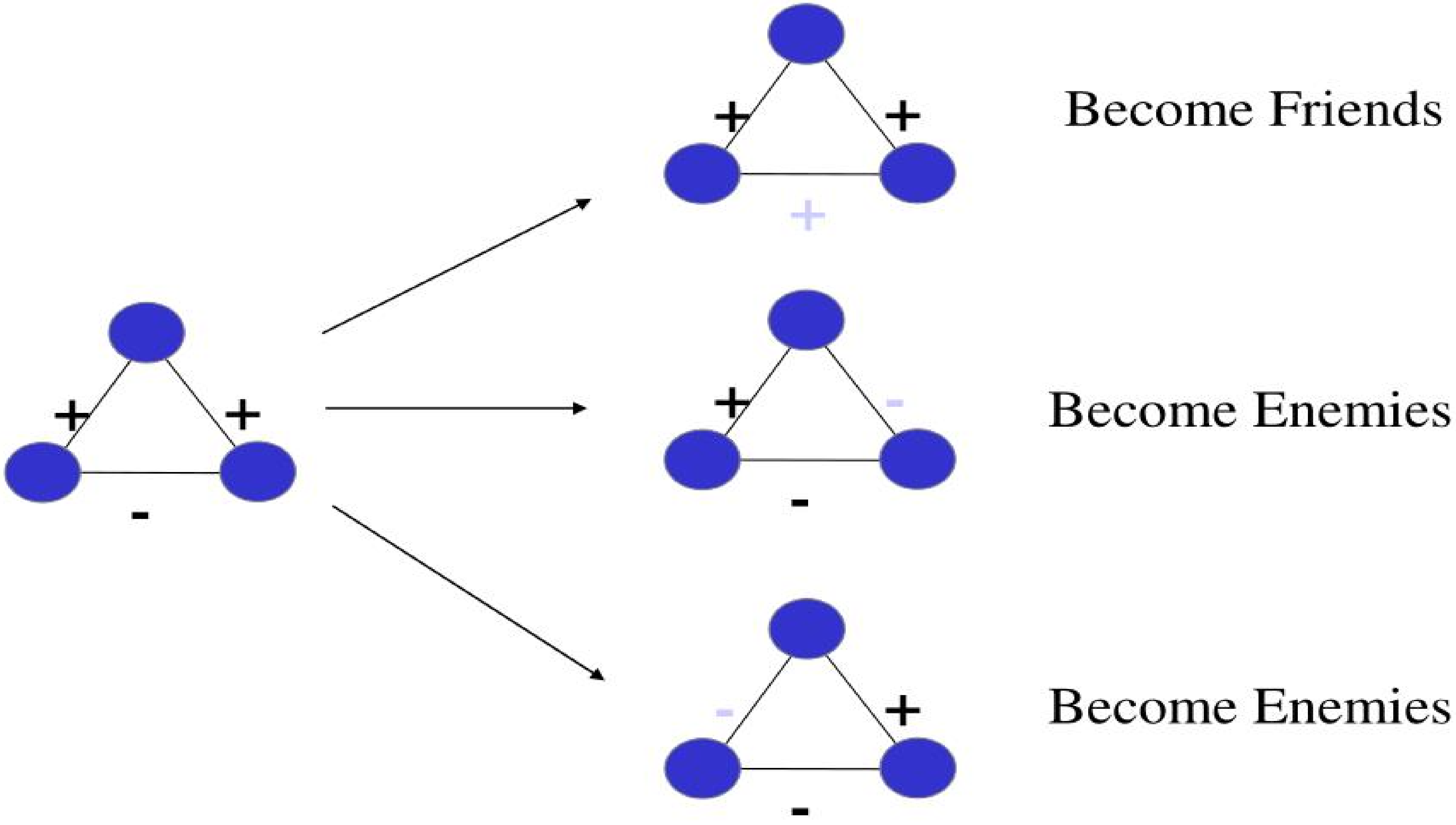
$(-)(-)(-) = (-)$ Unbalanced "An enemy of my enemy is an enemy"



$(+)(-)(+) = (-)$ Unbalanced "A Friend of a Friend is an enemy"

Social Balance & Transitivity

Heider argued that unbalanced triads would be unstable: They should *transform* toward balance



Summary

- Balance theory is an attitude theory
- You, another person and an object are the three components to the balance theory
- Each of the components can have a positive or negative relationship to each other.
- Attitude is in balance if the relationships are a positive algebraic result
- Attitude is not in balance if the relationships are a negative algebraic result.

Summary

- By nature, people are comfortable with balanced attitudes.
- Marketers need to choose product spokesperson(s) to maintain harmony and balance.

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Ref : Broad Learning Through Fusions: An Application on Social Networks