

NETWORK ANALYSIS: HOW GRAPH THEORY APPLIES TO THE SOCIAL SCIENCES

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EXPLORATIONS IN GRAPH THEORY
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WHAT IS NETWORK ANALYSIS?

- Network Analysis is used in social sciences like sociology, anthropology, psychology, and political science.
- A network can be classified as a path to which variables are connected!
- It is interdisciplinary, meaning each unit can represent a person, positions, behaviors, and other characteristics.
- It is the base of social structure.
 - Essentially, it analyses patterns of relationships among variables.

“Network Analysis forces us to conceptualize carefully the nature of the entities and relations, as well as the properties and dynamics that inherit these relations”
– Jonathan H. Turner, University of California

Some examples of Network Analysis in the social sciences:

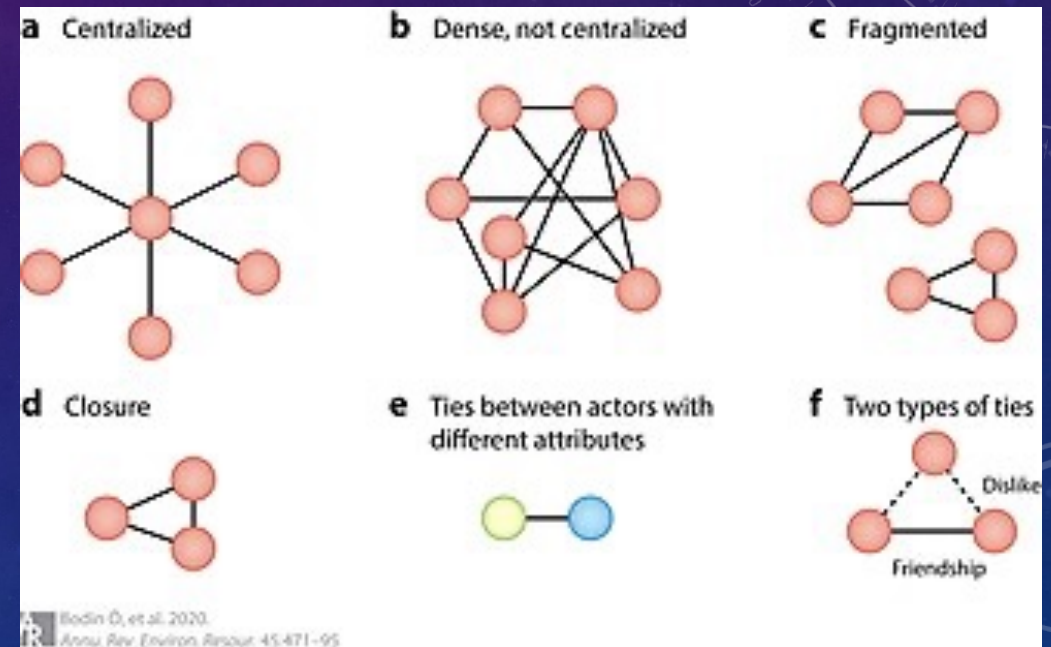
- Patterns of how people interact with one another
- Ethics between people and businesses, and how these ethics influence various properties

In 1991, Jonathan H. Turner published an article on Network Analysis and used the research from different experiments to explain the applications to Sociological Theory!

NODES, TIES, AND KEY TERMS!

Network Analysis uses different names for terms we may already be familiar with!

- Nodes: These are the points of the graph. Think of these as vertices.
- Ties: These are the edges of a diagram.
- Centrality: The importance of a node in correspondence to the other factors.
- Density: The connectedness of the nodes with the ties.
- Brokerage: The relationship between non-connected nodes.



HOW DOES GRAPH THEORY APPLY?

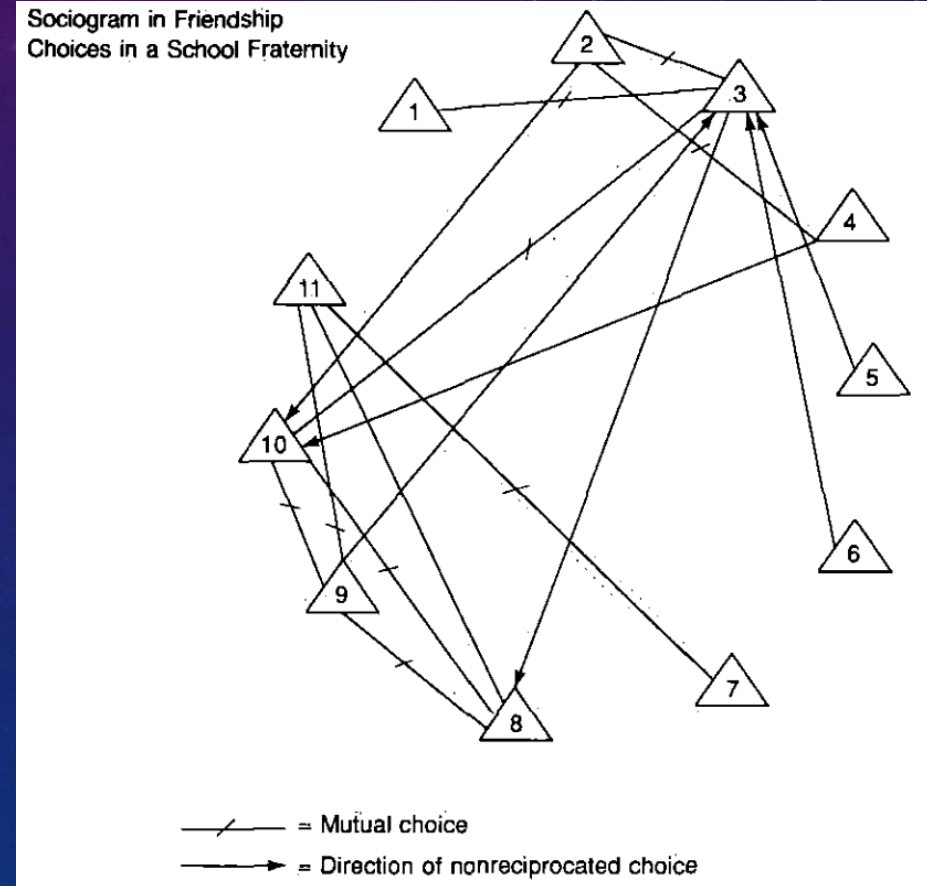
- We can use key ideas in graph theory to help visualize data that is directly correlated to the social sciences.
- Sociograms, graphs, and matrices are all useful tools to help visualize data for network analysis.

The diagram to the right is a sociogram of data from an experiment (directly from Turner's article) based on choices people made with regards to communication. Each number (node) represents a person, and each line (tie) represents the agreement between the fraternity members.

We can see that if there was a mutual agreement between individuals in a fraternity, the graph was modeled with a marked tie and no arrow-head.

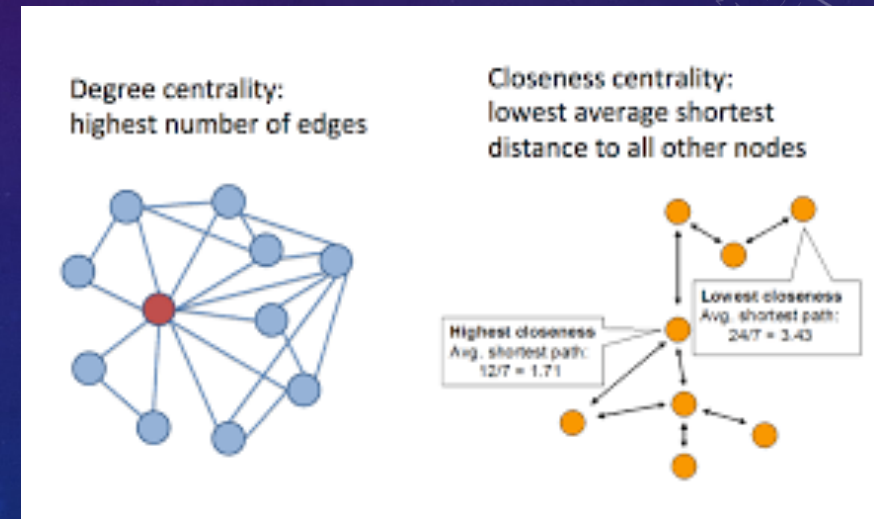
If the fraternity members did not agree with personal choices, the tie had an arrow-head.

This is just one small example of network analysis!



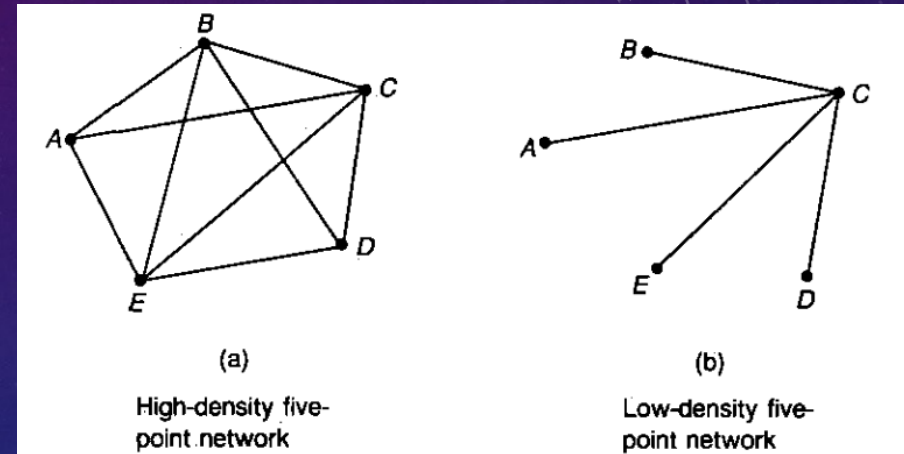
THE IMPORTANCE OF CENTRALITY

- “Centrality” is derived from “center”
- We can think of centrality as the node with the most ties. Essentially this is degree centrality.
- Applying class concepts, we can describe a centrality as a vertex with the highest degree.
 - This means the vertex has the most connected edges.



THE IMPORTANCE OF DENSITY

- Density is a major term in Network Analysis!
- Higher density networks have more connections to nodes than lower density networks do!
- The goal of density in relation to network analysis is to find the maximum number of ties!
- The diagram to the right is a basic example from Turner's article on network analysis where he describes the difference of high density and low density in social networks!

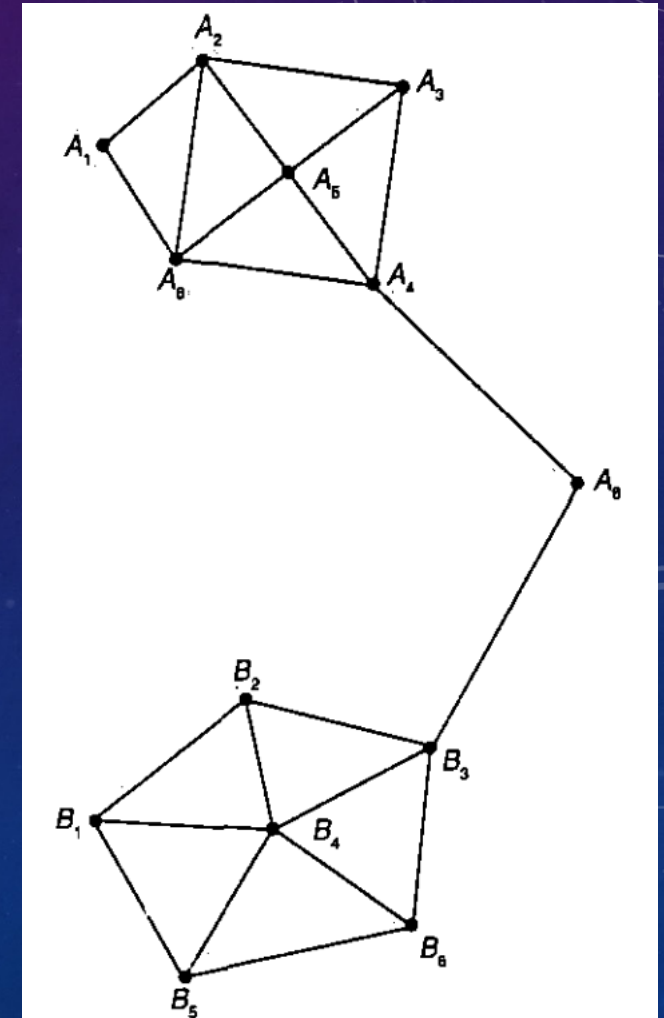


Applying concept from class, we can see that graph (a) has a higher density than graph (b) does. Based on this information, we can conclude that a tree can have lower density than a cycle graph due to the lack of edges!

THE IMPORTANCE OF BROKERAGE

- Brokerage helps to examine the connection of two variables, when they are not actually connected to one another.
 - These nodes share a common node, but are not tied together
 - There is an indirect relationship between the nodes!

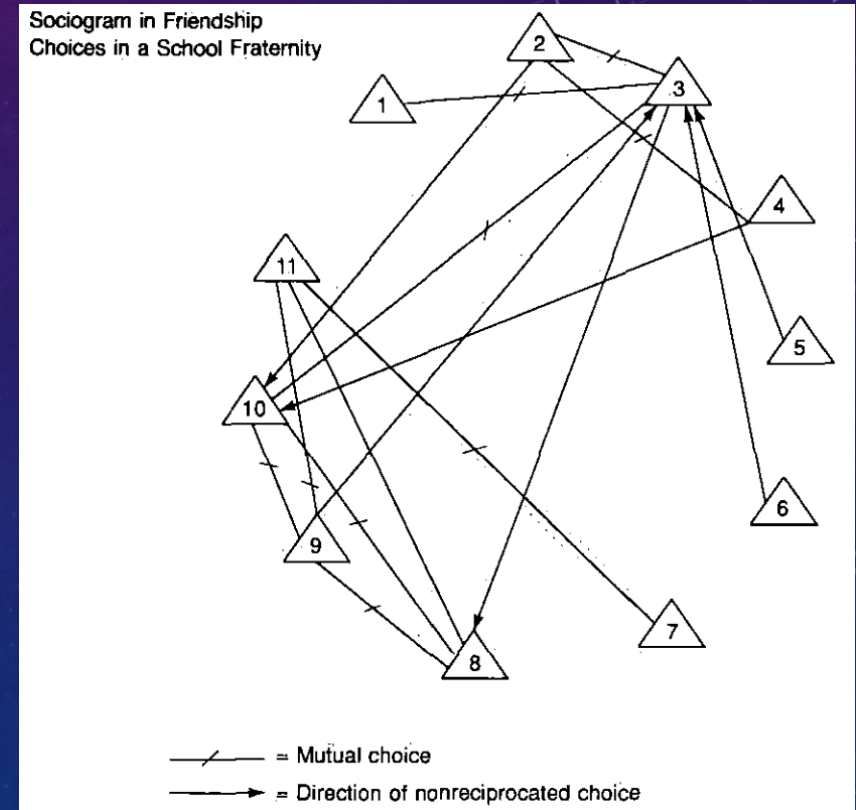
The diagram to the right is directly from Turner's article, where we can see brokerage potential. Here, A4 and B3 are not directly connected, but share a similarity to A6! We know this because there is a tie connected to A6. By this tie, there is some relationship between A and B that is not exactly direct!



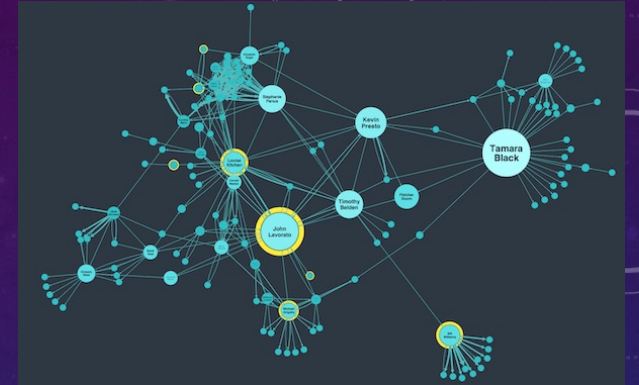
APPLIED EXAMPLE!

Going back to the communication example and applying key terms:

- **Centrality:** Node 3 has the largest number of ties with a degree of 7! This means that node 3 is the most important out of all 11 nodes in the sociogram! However, the graph is not exactly centralized since other nodes have different degrees.
- **Density:** The density of this sociogram is classified as high! Most of the nodes are connected to another, and there are some cycles! One cycle is {10, 3, 2, 10}. There are some nodes with a degree of 1, meaning they lower the density, but since most have at least degree 2 we can classify the graph as high density.
- **Brokerage:** One example of brokerage in the sociogram is the connection between nodes 11, 7, and 8. Node 11 is connected to both nodes 7 and 8, but nodes 7 and 8 are *not* connected to one another! This means there is an indirect relationship between nodes 7 and 8 because they both share a common node (node 11).



IS IT USEFUL?



Network analysis is incredibly useful when exploring connections between variables! It helps us understand the relationship between people, places, behavior, personal opinions, and much more! The application of graph theory helps researchers and experimenters in the field of social science visually express their findings! Graph theory can be a tool in obtaining the accuracy, comparisons, and validity of findings as well. It is possible to examine any kind of social interaction with the help of network analysis, and it is just one tool to create an experiment to support new findings.

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