Introduction to Social Network Analysis (SNA)

Understanding Relationships in Social Structures

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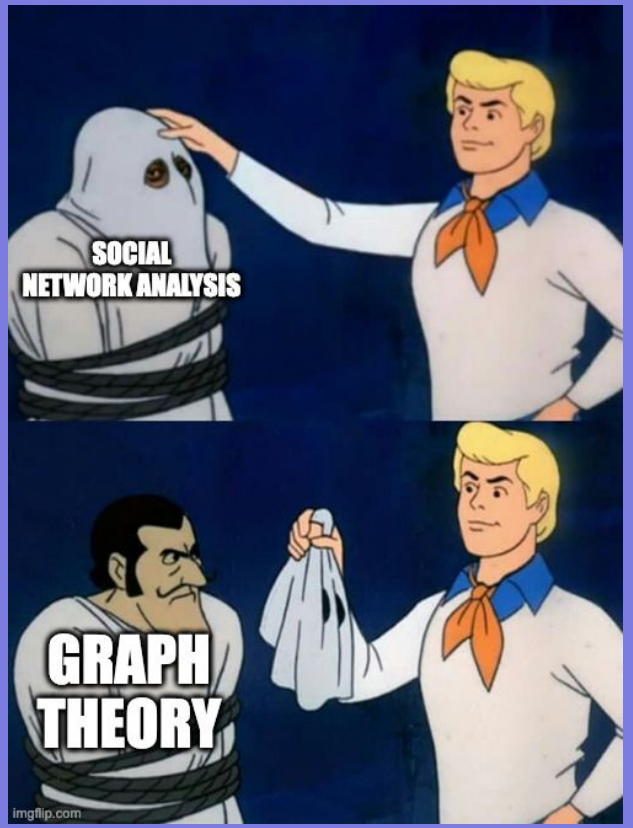
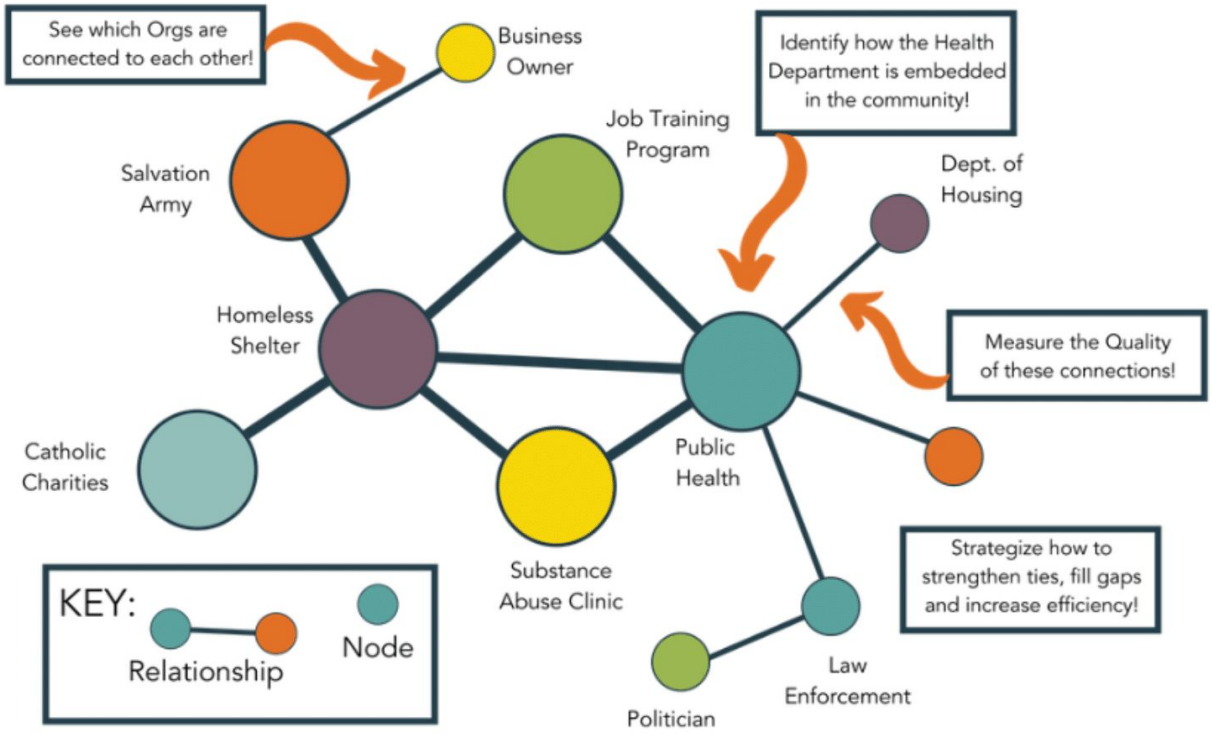
What is Social Network Analysis?

Definition: A research method used to visualize and analyze relationships and connections between entities or individuals within a network.

Graph Theory: The mathematical theory of the properties and applications of graphs.



What Does This Look Like?



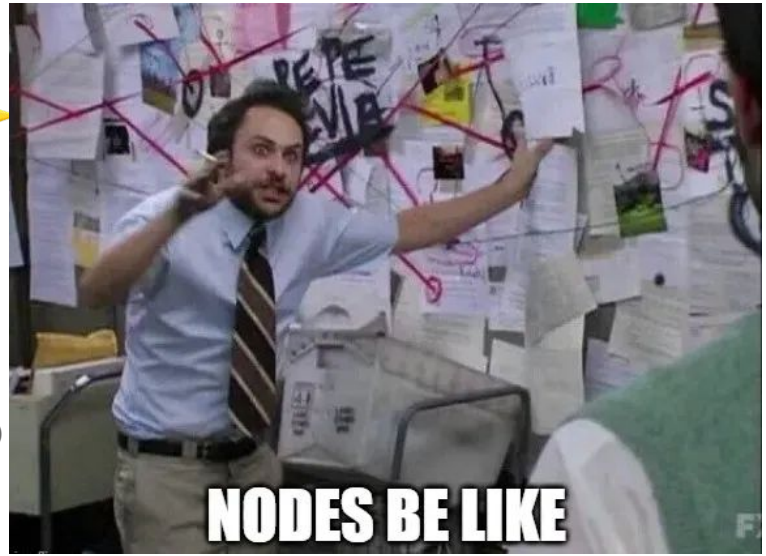
This is an example of mapping a real-world network! Notice how well connected the Homeless Shelter is.

✨ Definitions! ✨

High-level Building Blocks:

- Nodes (Vertices)
  - Individual entities within the network.
  - Can be **people**, **organizations**, **groups**, or even **concepts**.
- Edges
  - Connections or relationships between nodes in a social network.
  - Can be **directed** or **undirected**

✨✨ More Definitions! ✨✨



Types of Nodes:

- Central Nodes
  - Nodes with a **large number of connections**
  - Ex. Taylor Swift on Twitter (95.2M Followers)
- Isolated Nodes
  - Nodes that have **few or no connections**
  - Ex. Personal website
- Peripheral Nodes
  - Nodes that live on the **edges of the network**
  - Maintain the **lowest number of connections**
- Hub Nodes
  - Nodes that maintain a **large number of connections**
  - Analogous to bus depots or transit hubs in a transportation network
  - Ex. Homeservers for decentralized social media (Mastodon/Pixelfed/Lemmy/Matrix)
- Cutpoint Nodes
  - Also called **Articulation Points**
  - Nodes where its **removal would split a graph into two components**
  - Ex. An internet service provider

✨✨✨ Even More Definitions! ✨✨✨

Types of Edges:

- Directed Edges
  - A **one-way** relationship between nodes
  - Ex. Invitations, Followers, etc.
- Undirected Edges
  - A **bi-directional** relationship between nodes
  - Ex. Friends, Groups, etc.
- Weighted Edges
  - A relationship with value assigned to them that represents its **strength** or **intensity**
  - Ex. Best friends vs acquaintances, Multiple connections, etc.
- Bridge Edges
  - An edge that **connects two groups of nodes**.
  - **Similar** to an **Articulation Point**
  - Ex. A marriage between two families

Game Time!

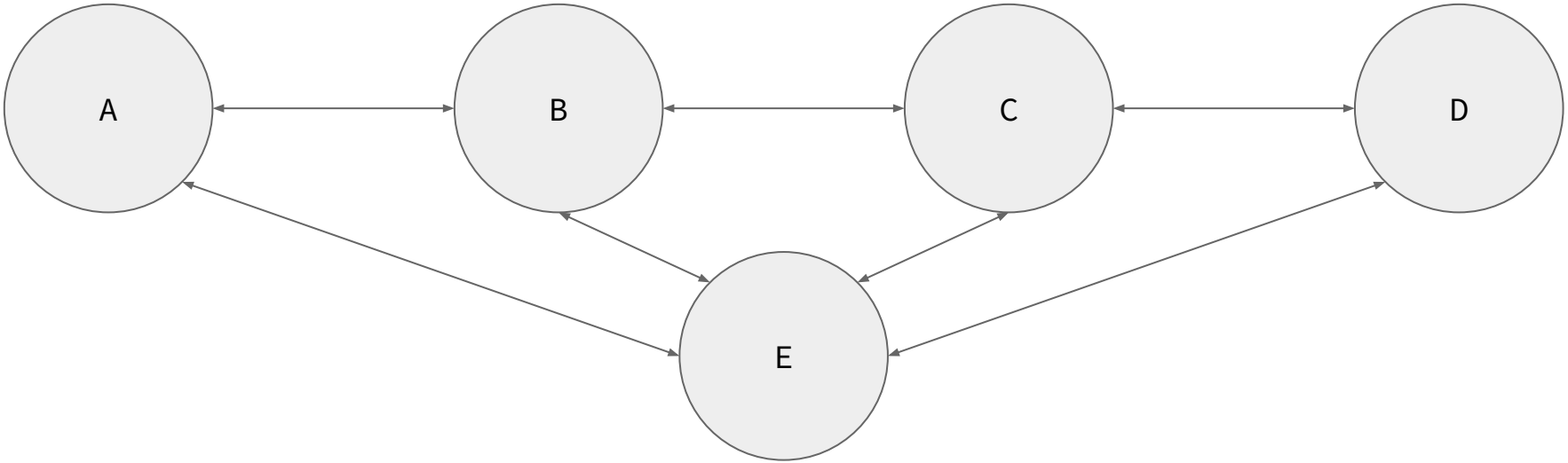

NOT SURE IF "1" MEANS I HAVE ONE EXTRA LIFE
OR IF THIS IS MY LAST LIFE

☎ Telephone! ☎

Isolated Nodes with Undirected Edges

☎☎ More Telephone! ☎☎

Same as before, but with a Hub Node



Useful Theories and Properties

‼️ Centrality ‼️

A measure of **“importance”** of a node in a network.

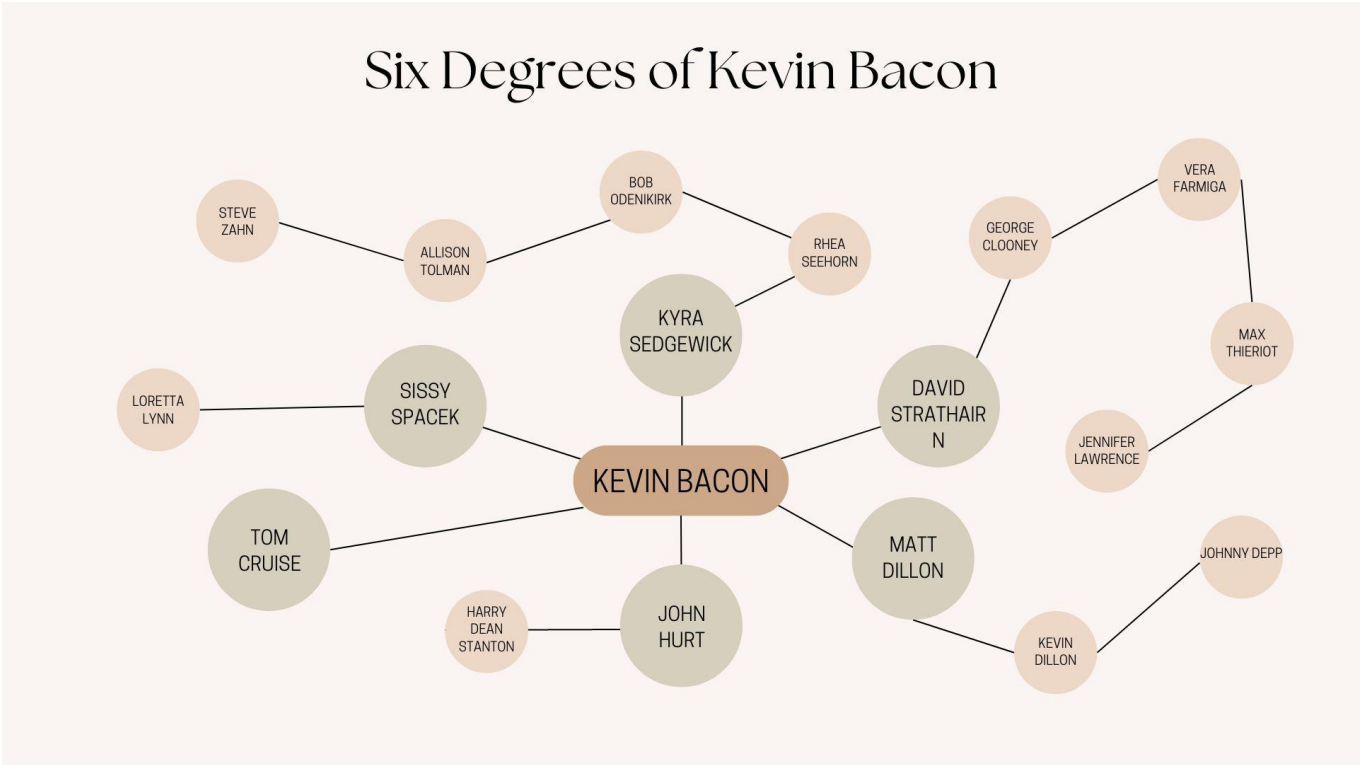
- Degree Centrality
  - Importance score based on the **number of direct links** held by a node
- Betweenness Centrality
  - Importance score based on the **number of times a node lies on the shortest path between two other nodes**
- Closeness Centrality
  - Importance score a **node’s ‘closeness’ to all other nodes** in the network.
- Eigen-Centrality
  - **Similar to Degree Centrality**
  - Also **takes into account how well connected a node is**, and how many links their connections have, etc.

🌎 Small World Theory 🌎

Definition: The theory that most nodes can be reached from any other node through a relatively short path of connections.

- Also leads to the “six degrees of separation” phenomenon
- This property tends to imply efficient transfer of information and well-connectedness

Example: Six Degrees Of Kevin Bacon



Structural Hole Theory

Definition: Individuals who span the structural holes, or gaps, in a network act as a bridge between different groups and hold a strategic advantage.

- These bridge nodes can manipulate information flowing between the groups
- This can be of particular importance when investigating the flow of misinformation

💪 Strength of Weak Ties Theory 💪

Definition: Weak ties or connections often provide more novel information and resources compared to strong ties.

- These “weak” relationships can serve as important bridges between different groups within a network

Example:

- Alex is looking for a new job.
- Strong Ties: Close friends work in the same field; limited job opportunities.
- Weak Tie: Jamie, an acquaintance in a different industry, knows someone hiring in Alex’s field.
- Outcome: Jamie shares the job opening, giving Alex access to new opportunities.

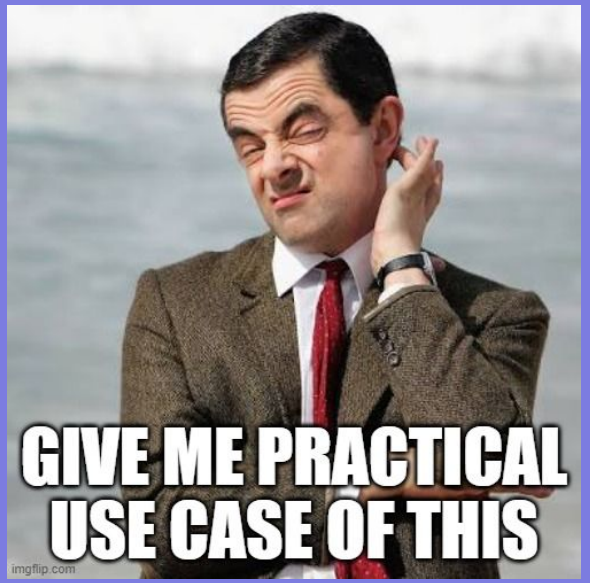
 Homophily and Heterophily 

Definitions: Homophily refers to the tendency of similar nodes to connect, while heterophily is the opposite.

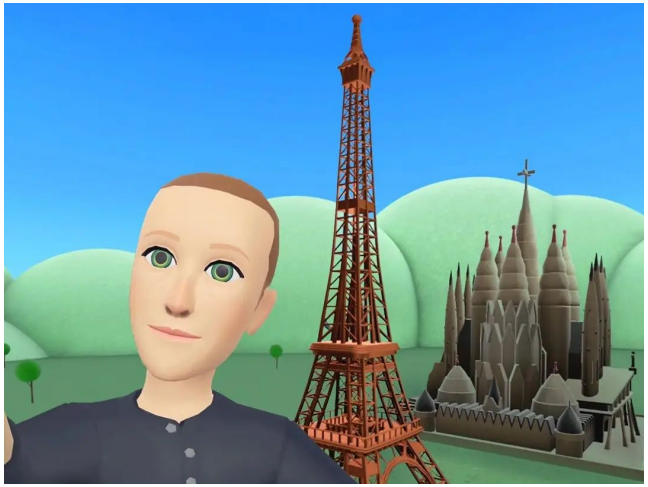
Examples:

- Homophily can be described by the tendency for companies in similar areas to connect and form relationships
- Heterophily can be seen in the challenges a company seeking diversity in their supply chain may face

Practical Applications



Social Media Networks



- Examples:
  - Facebook
  - Tiktok
  - LinkedIn
  - Steam
  - Discord
  - Canvas
- Useful to map relationships for a number of purposes:
  - Market research
  - Customer sentiment
  - Cultural trends
  - Political trends
  - SO MUCH MORE!

Steam

Steam is a video game marketplace with extensive social features.

- Users can add others as friends
- Users can create groups and add others to them
- Users can post about specific games in a game’s “community” tab
- Users can invite friends to join them in multiplayer games

♨♨ More Steam ♨♨

Let’s tie this back to what we discussed before!

Nodes: Users, Groups, Games

Edges: Friendships, Group Memberships, Game Ownership

If we go one level deeper…:

Directed Edges: Game Ownership

Undirected Edges: Friendship, Group Memberships

♨♨♨ Even More Steam ♨♨♨

What can we learn from platforms such as steam?

- Better understanding of gamer behaviour
- How social connections impact spend on games and in-game cosmetics
- Hours played together or alone

For a more statistical look at Steam, I suggest the following paper (Condensing Steam: Distilling the Diversity of Gamer Behavior): https://dl.acm.org/doi/10.1145/2987443.2987489

💊 Other Use Cases: Post-operative Care 💊

- Patients can have connections with:
  - Friends
  - Family
  - Care provider(s)
- Use cases:
  - Transplant patients
  - Pediatric patients post-op

Rather than a friend list, you can build a “care circle”!

Ethics


ETHICAL DILEMMAS
ETHICAL DILEMMAS EVERYWHERE
imgflip.com

😈 Anonymity Among Respondents 😈

Key Challenges:

- Achieving true anonymity is often impossible.
- Identifying individuals is necessary to create a common reference frame.

Robust ethical considerations and strong data governance frameworks are essential to protect individual rights while allowing for valuable research insights.

😈 Privacy Rights Among Non-Respondents 😈

Key Challenges:

- Respondents provide information about themselves and their relationships, often without consent from non-respondents.
- This raises ethical concerns, especially in sensitive contexts (e.g., HIV transmission research).

Researchers must carefully consider the potential harm to non-respondents and ensure that privacy and consent are respected in the context of the data collected.

Summary

✍️ In Summary ✍️

- Social Network Analysis (SNA) is a complex field with many facets that can be used to better understand how humans organize
- Graph theory can be a helpful way to model and analyze social networks
- These theories have many uses outside of traditional social media
- SNA will continue to be important in the age of AI and AI agents

 Questions? 

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