Robust Summary Statistics for Strategic and Social Processes in Networks

Benjamin Golub

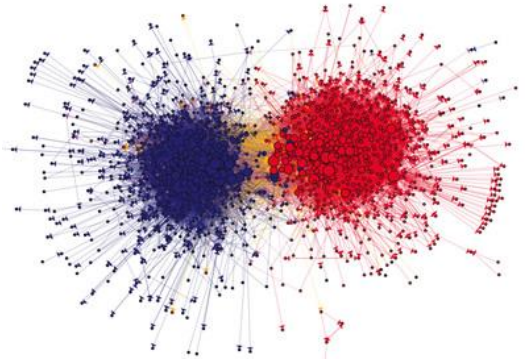
Harvard

Substantive questions

- Who are the most **influential** agents/groups?
  - In **coordination**
  - In **communication**/gossip
- Is a network good at coordinating?
  - Will its agents achieve a **high payoff**?
  - Will they be able to converge to equilibrium strategies **quickly**?
- How to **intervene** in/**disrupt** the network?

- Examples:
  - Adopting technologies, e.g. cryptography.

- Practical relevance:
  - **Cohesive** networks behave more like units
  - **Segregated** networks converge slowly



- Limited budget, must target **some** nodes.

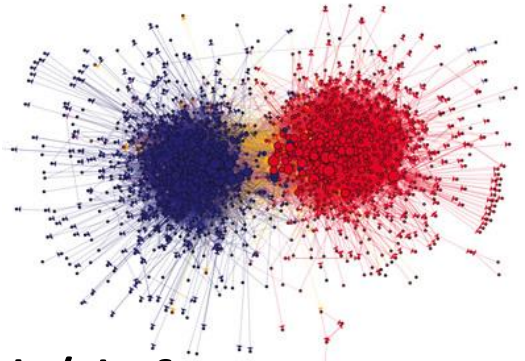
Advances to date

- Who are the most **influential** agents/groups?
  - In **coordination**
  - In **communication**/gossip

- Answer:
  - Network **centrality**.

- Is a network good at coordinating?
  - Will its agents achieve a **high payoff**?
  - Will they be able to converge to equilibrium strategies **quickly**?

- Answers:
  - **Homophily**/segregation measures
  - **Cohesion.**



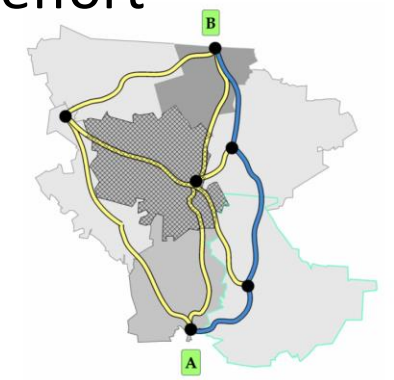
- How to **intervene** in/**disrupt** the network?

- Attack/defense games.

Practical complications

- Network **responds** to intervention
  - Agents **adjust** strategies.
  - Need **game-theoretic** modeling.

- Example:
  - Melissa Dell (2015): drug trafficking responds to enforcement effort



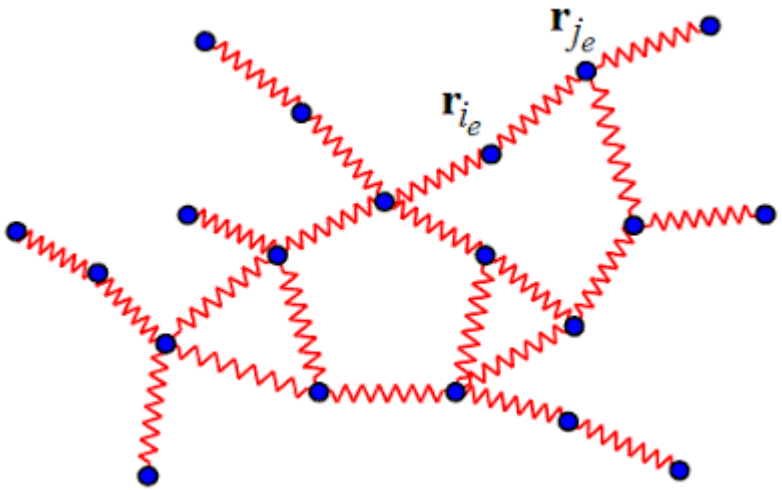
- Network **imperfectly** observed
  - **Random** noise.
  - Strategic **activation** of relationships.

- Examples:
  - Players strategic about when to activate their relationships (Chandrasekhar, G, and Yang 2017)

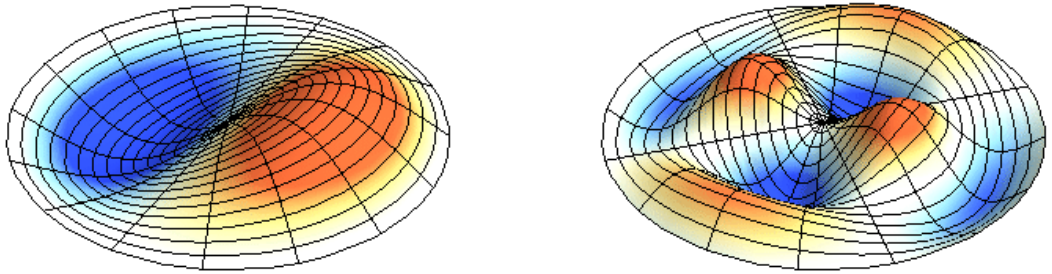
- Observing network is **costly**.

- Full survey either expensive or impossible.

Simple, physics-inspired models



- Simple laws of motion
  - Capture key “forces”
  - Use intuitions from forces, energies
  - ***Not*** combinatorial/algorithmic



- Focus on useful decompositions

- Find ways to easily *measure* the key dimensions

- Networks without networks[1]
- Be smart about censoring

[1] Breza, Chandrasekhar, McCormick, Pan (2017)

Takeways/a recipe

- Game theory + “physics/engineering”
  - Cook up models with reasonable decision-making and nice laws of motion/decompositions.

- Now add some statistics
  - Make sure the above items are robust to sampling;
  - We know how to estimate them when there is systematic bias in the links we measure

- Extensible
  - “Multiscale, multiplex, multimodal,” etc.
  - Better chance of this if math is simple and linear.
  - Recent encouraging finding: game theory with incomplete information is secretly quite similar to game theory with network structure – a hope of incorporating incomplete information.