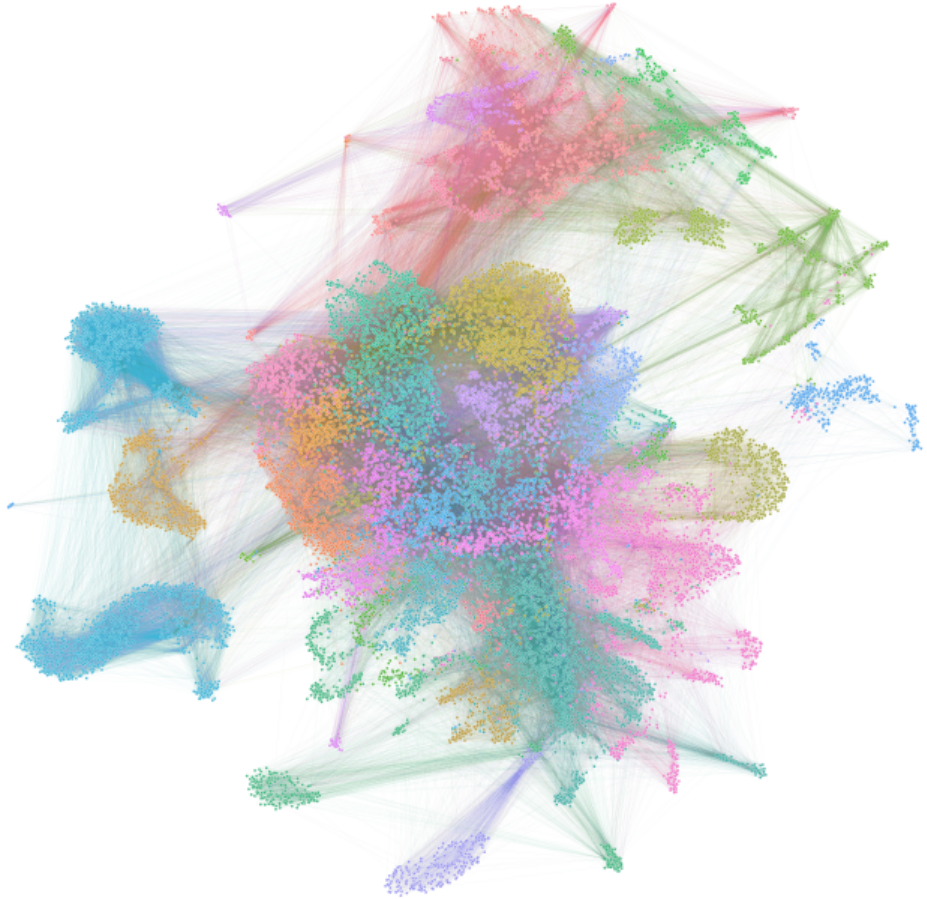
What are networks (and why should you care)?

What are networks?

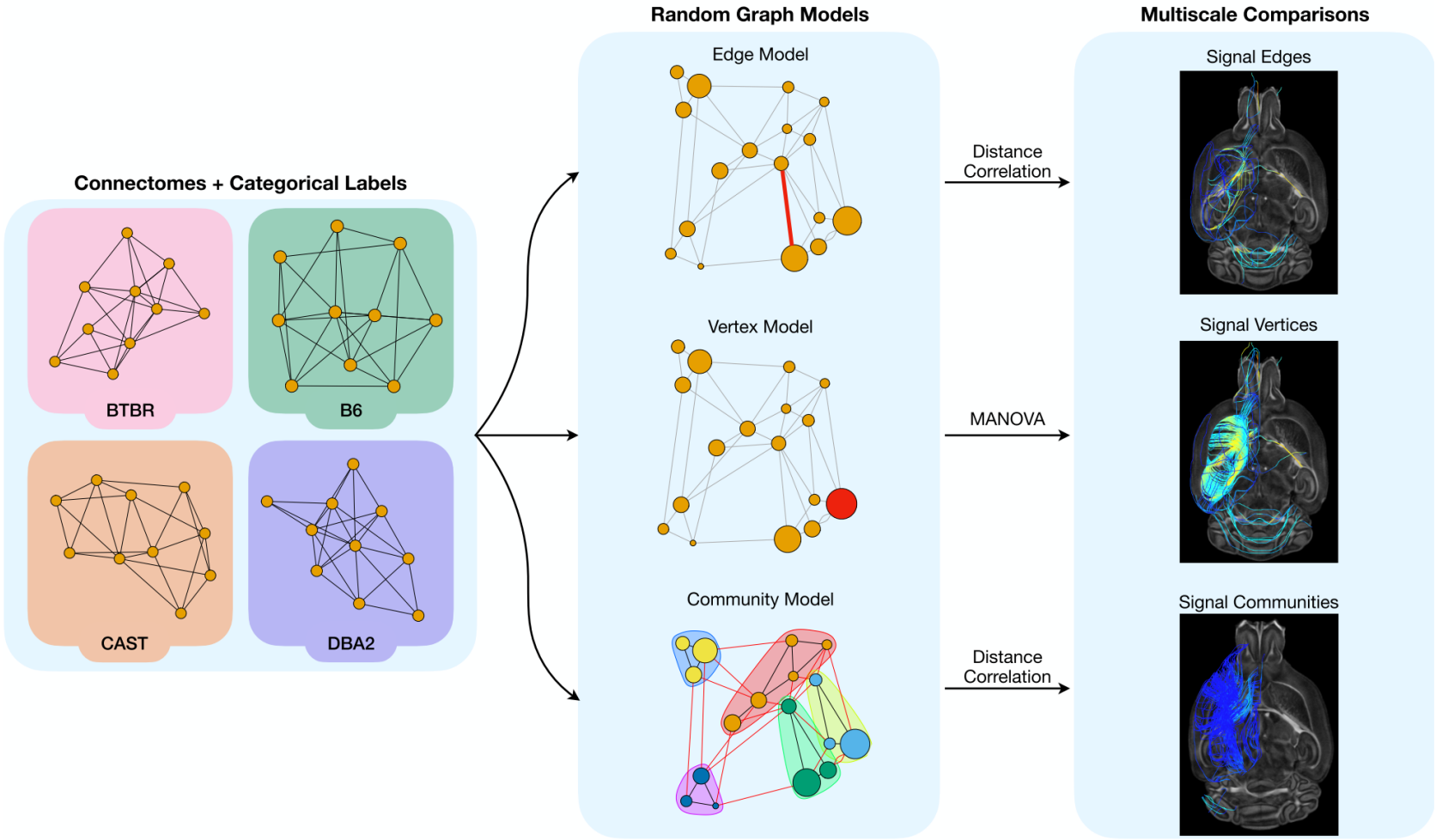
- Networks are a mathematical way of representing a set of objects and the relationships among them.
- These "objects" are termed **nodes** or **vertices**.
- These relationships are termed **edges** or, less often, **links**.
- Networks are also called **graphs**.

Example networks / applications

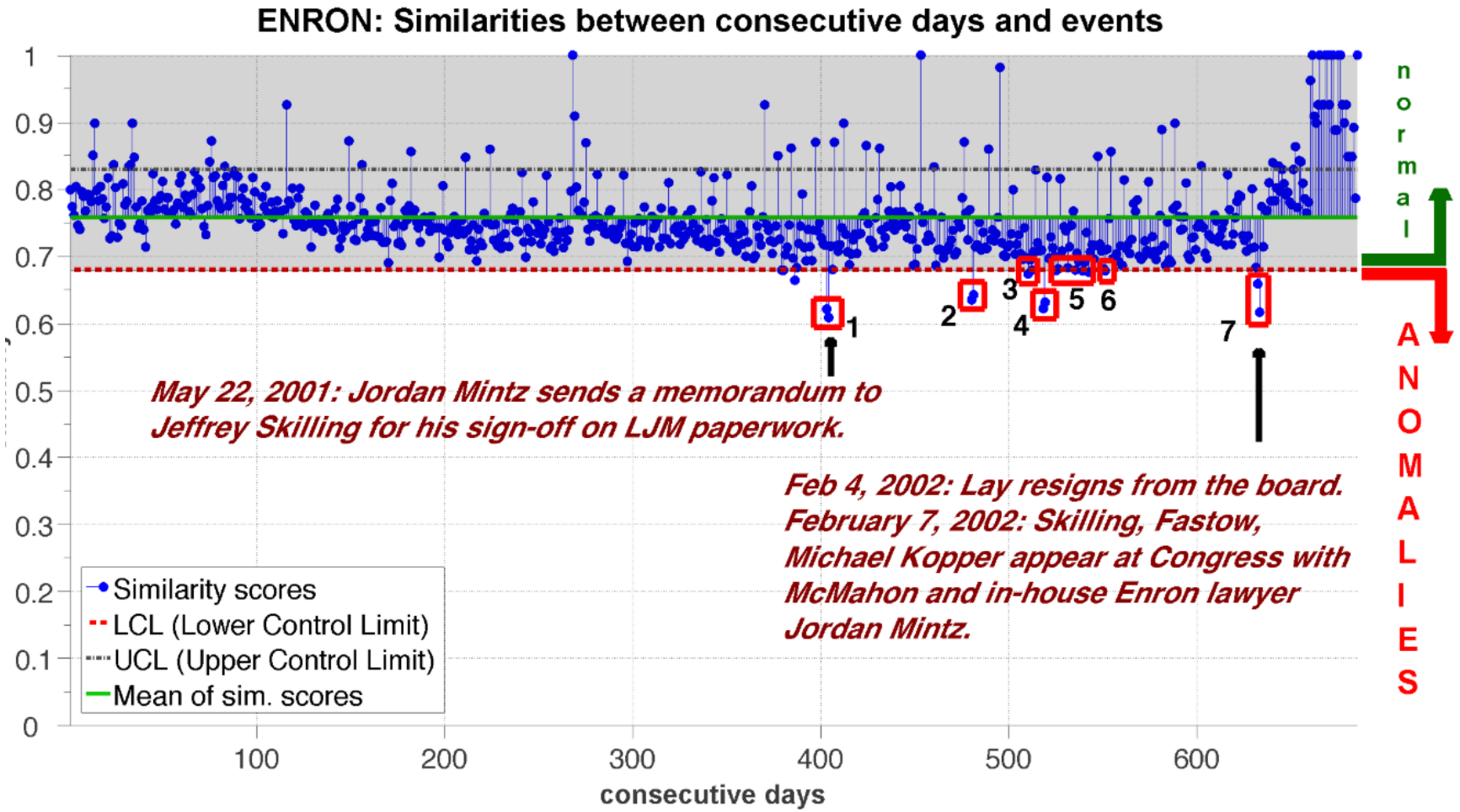
Connectome



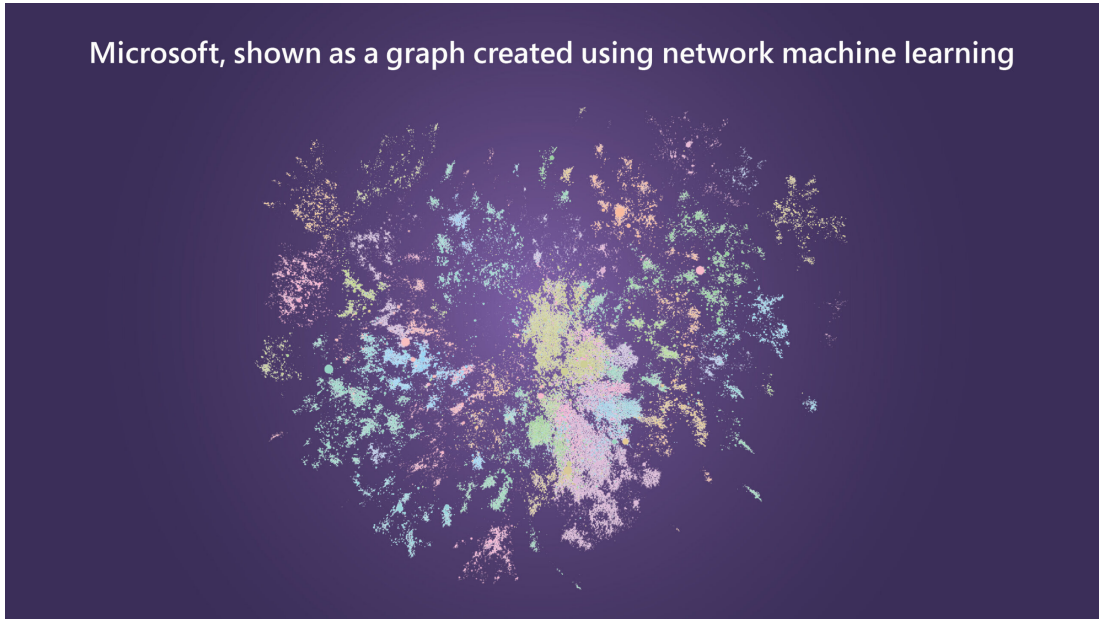
More connectome

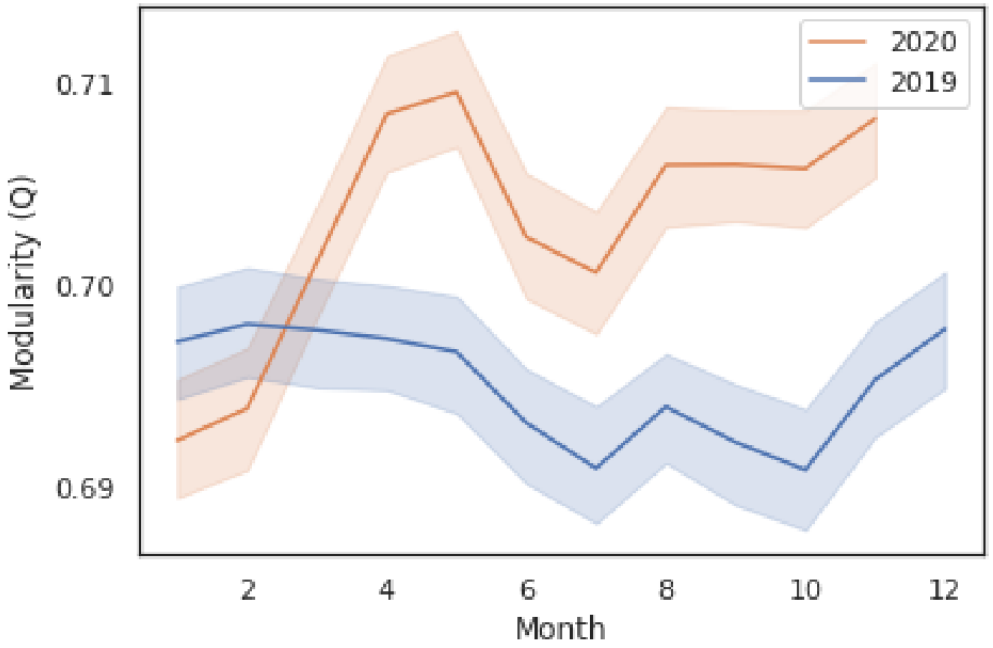


Enron anomaly prediction



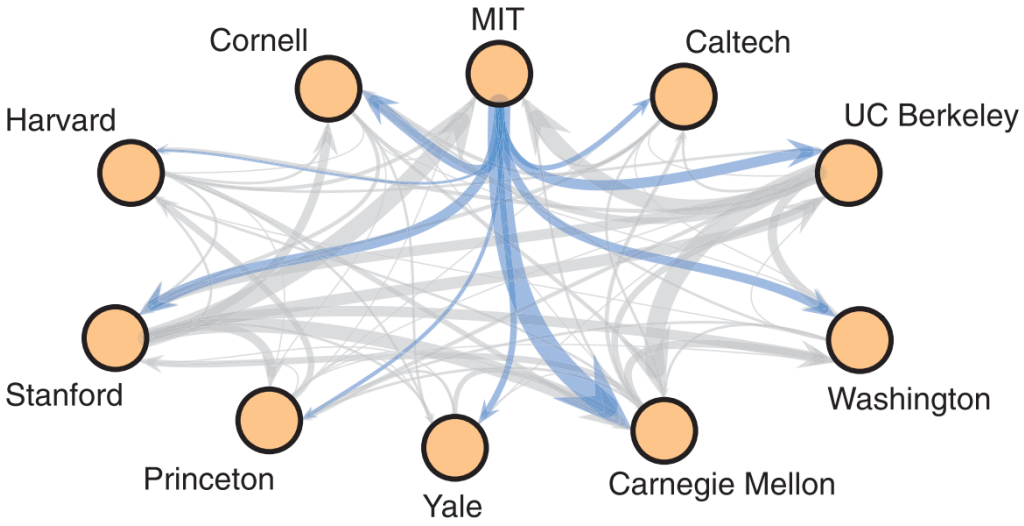
Organizational communication

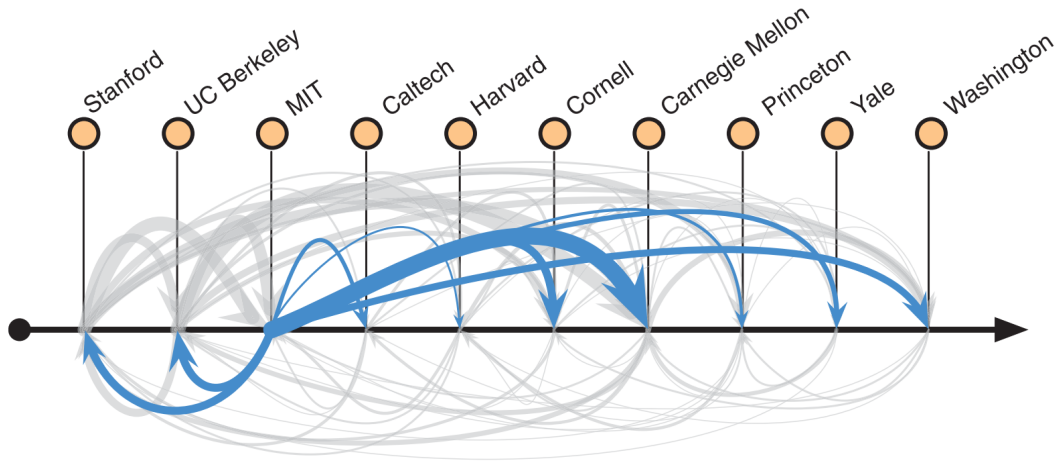




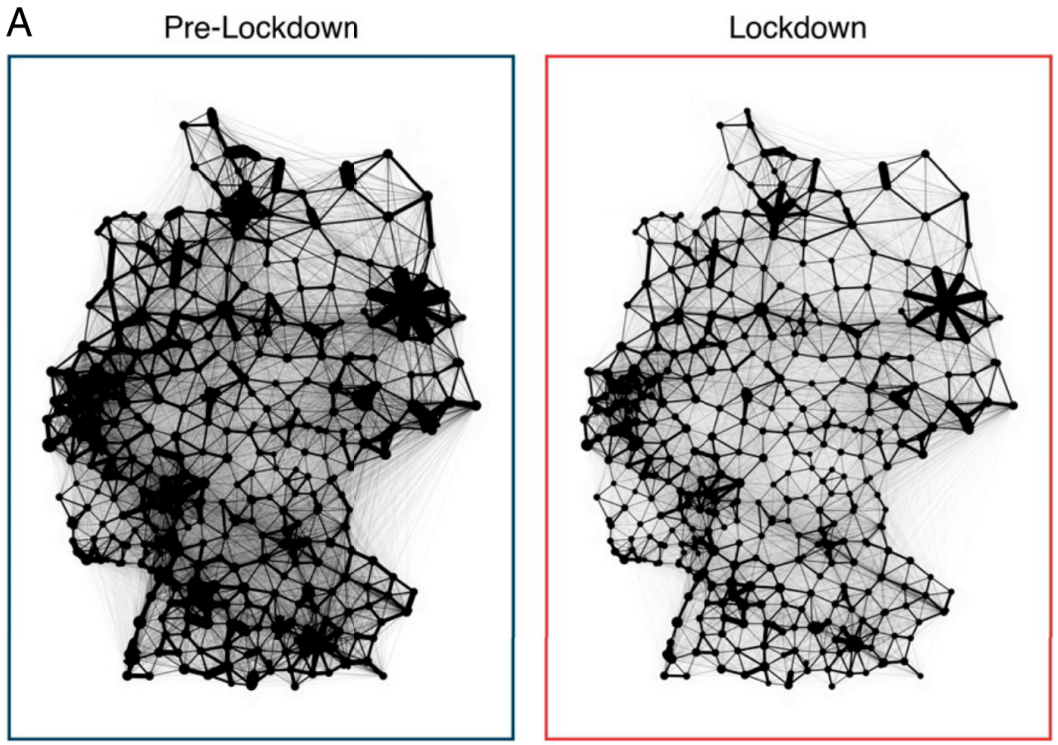
Advancing organizational science using network machine learning to measure innovation in the workplace
Zuzul et al. arXiv:2104.00641 (2021)

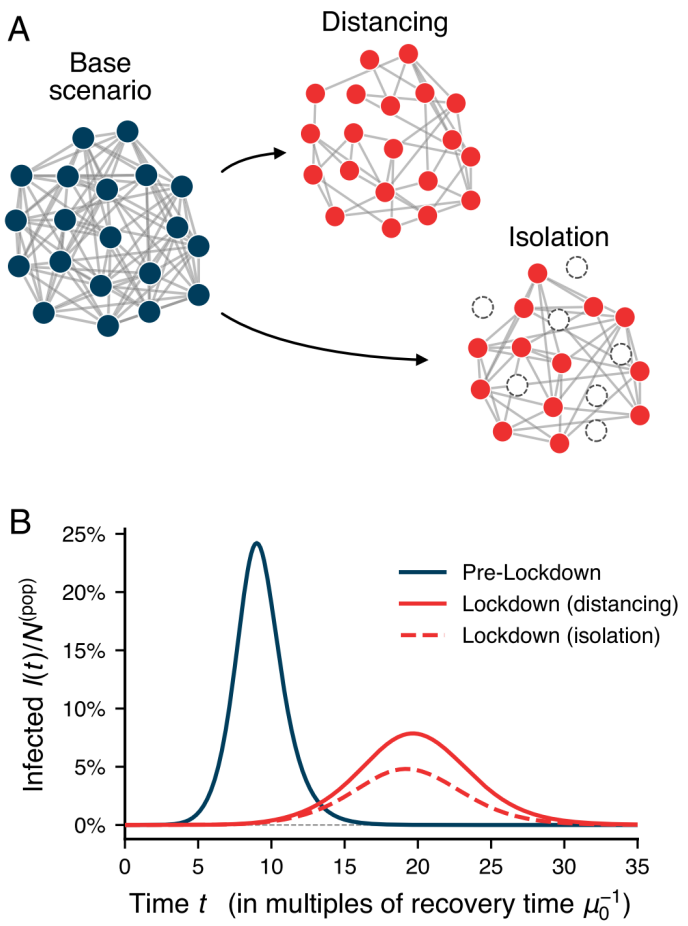
Faculty hiring and other hierarchies



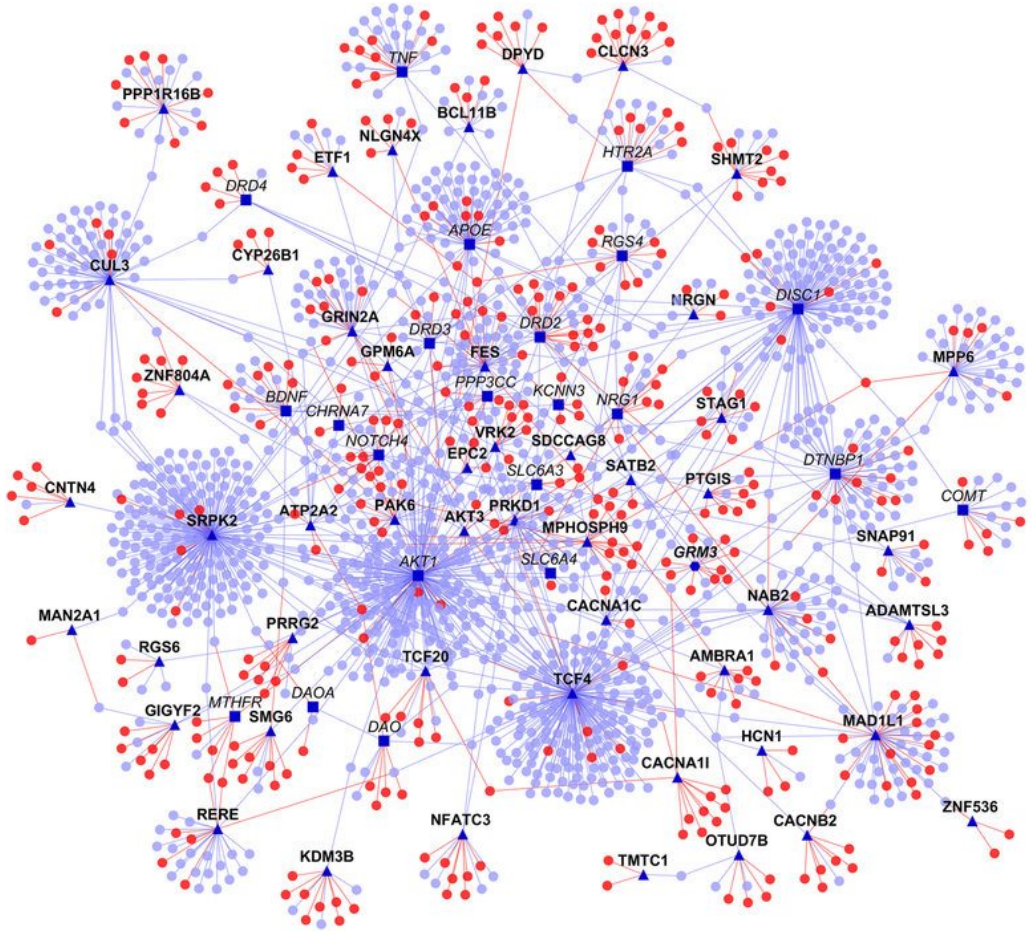


Pandemic spread





Protein-protein interaction



https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4898894/#!po=16.6667

What are NOT networks? - Hypergraphs

- Networks represent **dyadic** relationships: interactions between *two* things.
  - Example: an email from me to you
- **Polyadic** relationships (interactions between more than two things) are common.
  - Example: an email from me to you AND someone else
- We could ignore this:
  - Make an edge from me to you.
  - Make another, separate edge from me to someone else.
- **Hypergraphs** are a mathematical way of representing general polyadic relationships.

What are NOT networks? - Multigraphs

- Graphs (strictly speaking) usually have at most one edge between node i and node j.
- There may be multiple relationships between two nodes in data that we want to model.
    - Example: An email from me to you, and a phone call from me to you.
- Sometimes we can compress this information into at most one edge, and still use a graph.
    - Example: Create an edge if there was an email OR a phone call.
- **Multigraphs** allow for more than one edge from node i to node j.

Every time we represent something in the real world with a network, we're making a modeling choice

What can we do with networks? (i.e. What is this class about?)

Class Calendar