

CS2850
ECON2040
INFO 2040
SOC 2090

Fall 2023
Professor David Easley
Professor Yian Yin

Networks

This interdisciplinary course examines network structures and how they matter in everyday life. The course examines connections in the computing, economic, sociological and natural worlds and how the structure of these connections affects these worlds. Tools of graph theory and game theory are taught and then used to analyze networks. Topics covered include the web, the small world phenomenon, markets, contagion, search and the evolution of networks.

The course is designed at the introductory undergraduate level with no formal prerequisites.

Text and Videos:

Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010

Networks, Crowds and Markets, CornellX: INFO2040x on edX by David Easley, Jon Kleinberg and Eva Tardos

Course Outline

1. Graph Theory and Social Networks

The course begins with a discussion of some of the general properties of networks. It develops this through examples from social network analysis, including the famous "strength of weak ties" hypothesis in sociology, and it connects these themes to recent large-scale empirical studies of on-line social networks.

Reading: Chapters 1-3 and Chapter 5

Videos: Graph theory module through "Network Balance Implies Polarization"

2. Game Theory

Since most network studies require us to consider not only the structure of a network but also the behavior of the agents that inhabit it, a second important set of techniques comes from game theory. This too is introduced in the context of examples, including the design of auctions and some "paradoxical" phenomena surrounding network traffic congestion.

Reading: Chapters 6, 8, and 9 (Chapter 7 will be covered later in the course)

Videos: Module 2

3. Markets and Strategic Interaction on Networks

The interactions among participants in a market can naturally be viewed as a phenomenon taking place in a network, and in fact network models provide valuable insights into how an individual's position in the network structure can translate into economic outcomes. This provides a natural illustration of how graph theory and game theory can come together in the development of models for network behavior. Our discussion in this part of the course also builds on a large body of sociological work using human-subject experiments to study negotiation and power in networked settings.

Reading: Chapters 10-12

Videos: Module 3

4. Information Networks and the World-Wide Web

The Internet and the Web of course are central to the argument that computing and information is becoming increasingly networked. Building on the earlier course topics, we describe why it is useful to model the Web as a network, discussing how search engines make use of link information for ranking, how they use ideas related to power and centrality in social networks, and how they have implemented network-based matching markets for selling advertising.

Reading: Chapters 13-15

Videos: Module 4

5. Network Dynamics: Population Models

Networks are powerful conduits for the flow of information, opinions, beliefs, innovations, and technologies. We begin by considering how these processes operate at the level of populations, when we can't necessarily observe the network itself, but only its effects on aggregate behavior. As part of this, we consider phenomena including information cascades, "tipping points" in the success of products with network effects, and the distribution of popularity.

Readings: Chapters 16-18, and Chapter 22

Videos: Module 5

6. Network Dynamics: Structural Models

We continue our exploration of how things flow through networks, focusing on what we can learn from details of the network structure itself. Here we study how both behaviors and diseases can spread through a social network, and also some of the network phenomena that underpin the "six degrees of separation" effect.

Readings: Chapters 19-21

Videos: Module 6

7. Institutions and Aggregate Behavior

Finally, a perspective based on networks can provide novel insights into the structure of social institutions, and into basic policy questions in many areas. We illustrate this theme with examples based on markets, voting theory, and property rights.

Readings: Chapters 23-24

Grading

- Midterm exam
- Problem sets
- Final exam in December

Academic Integrity

You are expected to maintain the utmost level of academic integrity in the course. Any violation of the code of academic integrity will be penalized severely.

You are allowed to collaborate on the homework to the extent of formulating ideas as a group. However, you must write up the solutions to each problem set completely on your own, and understand what you are writing. You must also list the names of everyone that you discussed the problem set with.

Collaboration is not allowed on the other parts of the coursework.

Finally, plagiarism deserves special mention here. Including text from other sources in written assignments without quoting it and providing a proper citation constitutes plagiarism, and it is a serious form of academic misconduct. This includes cases in which no full sentence has been copied from the original source, but large amounts of text have been closely paraphrased without proper attribution. To get a better sense for what is allowed, it is highly recommended that you consult the [guidelines maintained by Cornell](#) on this topic. It is also worth noting that search engines have made plagiarism much easier to detect. This is a very serious issue; instances of plagiarism will very likely result in failing the course.