

Social and Economic Networks: Online

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Overview

Social networks pervade our social and economic lives. They play a central role in the transmission of information about job opportunities and are critical to the trade of many goods and services. They are important in determining which products we buy, which languages we speak, how we vote, as well as whether or not we decide to become criminals, how much education we obtain, and our likelihood of succeeding professionally. The countless ways in which network structures affect our well-being make it critical to understand how social network structures impact behavior, which network structures are likely to emerge in a society, and why we organize ourselves as we do. This course provides an overview and synthesis of research on social and economic networks, drawing on studies by sociologists, economists, computer scientists, physicists, and mathematicians.

The course begins with some empirical background on social and economic networks, and an overview of concepts used to describe and measure networks. Next, we will cover a set of models of how networks form, including random network models as well as strategic formation models, and some hybrids. We will then discuss a series of models of how networks impact behavior, including contagion, diffusion, learning, and peer influences.

Requirements/Prerequisites

The course is aimed at people interested in researching social and economic networks, but should be accessible to advanced undergraduates and other people who have some prerequisites in mathematics and statistics. For example, it will be assumed that students are comfortable with basic concepts from linear algebra (e.g., matrix multiplication), probability theory (e.g., probability distributions, expected values, Bayes' rule), and statistics (e.g., hypothesis testing), and some light calculus (e.g., differentiation and integration). Beyond those concepts, the course will be self-contained.

Course Structure

The course consists of the following materials:

Videos. The main material is delivered via videos, which are broken into small chunks, usually between five and fifteen minutes each. There will be about an hour and a half of video content per week. You may watch the lecture videos at your convenience.

Slides. I have made available pdf files of all the lecture slides. In those files you can find references to all of the material covered in the videos.

Quizzes. There will be non-graded short "quiz" questions that accompany some of the videos to help you gauge your understanding.

Problem Sets. There are graded weekly problem sets that you will answer online, but may work through offline. You may discuss problems from the problem sets with other students in an online forum, without providing explicit answers. There are three varieties of problems:

- **Required: Graded Problem Sets.** These are the problem sets that you need to complete if you wish to earn a certificate for the course.
- **Optional: Empirical Problem Sets.** In four of the weeks I have also included some problems that have you work with data on various real-world networks. These involve you downloading and using software, so they are optional, but highly recommended.
- **Optional: Advanced Problem Sets.** In addition to the graded weekly problem sets, there will also be ungraded, more advanced problem sets available for those students who want to dig more deeply into some of the material. Answers to the advanced problem sets appear in the next week.

Data and Other Resources. Some of the problem sets ask you to work with network analysis programs and to analyze data. You can find links to the data and instructions for the network analysis programs embedded in the problem sets, and also posted separately under the Resources tab.

Final Exam. There is a final exam to help you pull together everything that you have learned.

Suggested Readings and Other Resources

The course is self-contained, so that all the definitions and concepts you need to solve the problem sets and final are contained in the video lectures. If you are interested in further readings (not required, but helpful):

Much of the material for the course is covered with added examples, detail and references in two books:

- A non-technical book for the general public: Matthew O. Jackson *The Human Network*, Pantheon Press and Atlantic Press (here are the Amazon page, Pantheon page, and Atlantic Books page (UK and commonwealth), for the book).
- A textbook aimed at researchers and advanced students: Matthew O. Jackson *Social and Economic Networks*, Princeton University Press (here are the Amazon page and Princeton University Press page for the book).

Additional background readings, including research articles and several surveys on some of the topics covered in the course can be found on my web page.

There are many programs for analyzing networks and visualizing them. Instructions in the course are for two free versions, Gephi and Pajek. There are also many others, and all have strengths and weaknesses. Here is a partial list of links to programs: Gephi, Pajek, UCINET, Statnet, NetworkX.

Timing and Topics

- Introduction, Empirical Background and Definitions (Week 1)
 Examples of Social Networks and their Impact, Definitions, Measures and Properties: Degrees, Diameters, Small Worlds, Weak and Strong Ties, Degree Distributions
 Book Readings: Chapters 1, 2

- Background, Definitions, and Measures Continued (Week 2)
 Homophily, Dynamics, Centrality Measures: Degree, Betweenness, Closeness, Eigenvector, and Katz-Bonacich. Erdos and Renyi Random Networks: Thresholds and Phase Transitions,
 Book Readings: Social and Economic Networks: Chapters 2 and 3; The Human Network: Chapters 2 and 5

- Random Networks (Week 3)
 Poisson Random Networks, Exponential Random Graph Models, Growing Random Networks, Preferential Attachment and Power Laws, Hybrid models of Network Formation.
 Book Readings: Social and Economic Networks: Chapters 4, 5; The Human Network: Chapter 2.

- Strategic Network Formation (Week 4)
 Game Theoretic Modeling of Network Formation, The Connections Model, The Conflict between Incentives and Efficiency, Dynamics, Directed Networks, Hybrid Models of Choice and Chance.
 Book Readings: Social and Economic Networks: Chapters 6, 11; The Human Network: Chapter 2, 9.

- Diffusion on Networks (Week 5)
 Empirical Background, The Bass Model, Random Network Models of Contagion, The SIS model, Fitting a Simulated Model to Data.
 Book Reading: Social and Economic Networks: Chapter 7; The Human Network: Chapter 3, 4.

- Learning on Networks (Week 6)

Bayesian Learning on Networks, The DeGroot Model of Learning on a Network, Convergence of Beliefs, The Wisdom of Crowds, How Influence depends on Network Position..

Book Reading: Social and Economic Networks: Chapter 8; The Human Network: Chapter 7.

- Games on Networks - Peer Effects (Week 7)

Network Games, Peer Influences: Strategic Complements and Substitutes, the Relation between Network Structure and Behavior, A Linear Quadratic Game, Repeated Interactions and Network Structures.

Book Reading: Social and Economic Networks: Chapter 9; The Human Network: Chapter 8.

- Final Exam. (Week 8)