

## 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.

**Practice Quizzes - Ungraded Practice Quiz Questions.** There are non-graded short "practice quiz" questions that accompany some of the videos to help you gauge your basic understanding and just review concepts. These also appear as an non-graded quiz along with each week's material. The platform may require you to fill them out to complete them week, but the grade on these will not count.

**Quizzes - Graded Problem Sets.** There are graded weekly problem sets that you must answer with at least 70 percent correct to continue to the next week's material. The problem sets are more substantial and designed to help you put the concepts to use. You may redo the problem sets if you do not pass one on the first attempt, but the platform limits how frequently you can retry a problem set within a limited time period. You may discuss problems from the problem sets with other students in the online discussion forum, but without providing explicit answers.

**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.

**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.

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

**Final Grade Calculation.** The final grade is based on ten percent of the percentage score of each problem set and 30 percent of the percentage score on the final.

## **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:

Much of the material for the course is covered with added detail and references in a text: Matthew O. Jackson *Social and Economic Networks*, Princeton University Press (here are the Amazon page and Princeton University Press page for the book. The text is optional and not required for the course. It provides more detail on some topics and more extensive examples and results and reading lists. 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.

You can also find links to the data covered in the course on my web page

## **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: Chapters 2 and 3

- 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: Chapters 4, 5.

- 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: Chapters 6 and 11.

- 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: Chapter 7.

- 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: Chapter 8.

- 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: Chapter 9.

- Final Exam. (Week 8)