
Management Science and Engineering 238
Network Structures and Analysis

Tuesdays and Thursday, 12:50 PM–2:05 PM
Building 550, Room 550D
3 units

Instructor:

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Note:

The course is held every Tuesday and Thursday. On Thursday, May 8, we will have a *guest lecture* by Orkut Buyukkokten from Google, who started the Orkut social networking platform.

Also, *note that there is no class on Thursday, May 29.*

Course webpage:

Course materials will be available at `http://eeclass.stanford.edu/msande238`.

Course description:

This course broadly investigates the role of network structure in in social, technological, and economic systems. Networks are pervasive in all walks of modern life; some are explicit, such as telecommunication networks, road networks, the network of hyperlinks on the World Wide Web, and online social networks; while others are implicit, such as the network of collaborators in an academic discipline, or the network depicting spread of a virus (biological or technological).

The study of networks is a vast field, spanning operations research, computer science, economics, sociology, physics, biology, and many other disciplines. As such we will restrict our attention to a few key areas of investigation.

The areas to be covered are:

1. Basics of graphs and networks (1-2 lectures)
2. The strength of weak ties (1-2 lectures)
3. Structural balance (1-2 lectures)
4. The small world phenomenon (2-3 lectures)
5. Power laws (2-3 lectures)
6. Network externalities (3-4 lectures)
7. Dynamics on networks (3-4 lectures)

Note that this is the first time this course is being offered; as a result, the guideline of topics above is representative of what I will try to cover, and the approximate attention given to each topic. However, depending on how things unfold during the course of the quarter, some topics may take more or less time than noted here.

Prerequisites

This course is intended for master's students and advanced undergraduate students. Although some of the material will be mathematically technical, I will develop most of the mathematics needed as we go along. Two indispensable prerequisites are *Math 51* (i.e., an adequate background in calculus), and *MS&E 220* (i.e., an adequate probability background). Students without these prerequisites can only enroll with permission of the instructor.

If you have taken these courses elsewhere and would like to know if you satisfy the prerequisite, contact Prof. Johari via e-mail prior to registering for the course.

Note that students seeking a more mathematical treatment of some of the topics in this course should consider taking either Prof. Matthew Jackson's course Economics 291, or Prof. Amin Saberi's course MS&E 337. This course is *not* intended for advanced doctoral students.

Grading

You are responsible for keeping up with all announcements made in class and for all changes in the schedule that are posted on the class website.

The grade will be based on the following:

- 50% problem sets
- 50% final project

There will be 3-4 problem sets for the course. All assignments will be posted to the course website. Depending on their length and difficulty, the total number of points in each set might vary. You can discuss the assignments among yourselves, but everybody must turn in his/her own written solutions in his/her own words. If you are having difficulty, find help right away— *do not wait until you fall even further behind!*

Late assignments will receive no credit; no exceptions will be made.

Please familiarize yourself with the Stanford Honor Code; violations will be prosecuted to the fullest extent of the (Stanford) law.

Readings

There are no formal textbooks for the course; I will post lecture notes as we progress. Some handouts will be drawn from the draft textbook *Networks* by Jon Kleinberg and David Easley; these will be distributed in hard copy only. Other readings (including relevant papers) will be posted on the course website.

Some related books are below; this list is by no means exhaustive!

1. *The Tipping Point*, Malcolm Gladwell. Much of this book is a popularized treatment of epidemics and fads. After taking this course, you should be able to critically evaluate the claims made by Gladwell (in fact, that would be a great course project).

2. *Small Worlds*, Duncan Watts; *Linked*, A.-L. Barabasi. Both these books are semi-popularized treatments of some of the theory and applications of complex network modeling.

3. *Social Network Analysis*, S. Wasserman and K. Faust. This is a classic text on the sociological approach to social network analysis, including discussion of topics such as structural balance and cohesiveness.

4. *Complex Social Networks*, F. Vega-Redondo. A more recent treatment of some of the mathematics and economics of complex networks as applied in social science settings.

5. *Random Graph Dynamics*, Rick Durrett. This is a mathematical treatment of some of the key network models brought up in this class, notably the Erdos-Renyi random graph model and the preferential attachment model, among others. (This book is used by Prof. Amin Saberi for Information Networks, MS&E 337.)