Social Network Analysis
Syllabus

Columbia University
G4062, Spring 2013
Wed 4:10pm-6:00pm
644 Seeley W. Mudd Building

Instructor: Nick Beauchamp
Email: nb2389@columbia.edu
Office: 712, International Affairs Building
Office Hours: Th 3-5pm, and by appt.

TA: Sang Won Han
Email: sh3083@columbia.edu

Overview

Social networks have always been at the heart of human interaction, but with the explosive growth of the internet over the last two decades, network analysis has become increasingly central to all branches of the social sciences: sociology, economics, political science, psychology, and so on. How do people influence each other, bargain with each other, exchange information (or germs), or communicate online? A diverse array of deep questions about human behavior can only be answered by examining the social networks encompassing and shifting around us. This network analysis has emerged as a cross-disciplinary science in its own right, and has in fact proven to be of even greater generality and broader applicability than just the social, extending to ecology, physics, genetics, computer science, and other domains. This course seeks to teach students the foundations of what has become the new and quite coherent field of network analysis.

We begin by discussing network structure and formation from a general perspective: The course starts with the micro-structure of networks and the foundational concepts of graph theory, and then moves to the macro, including the famous small-world phenomena and other means of describing and characterizing large-scale structures. Then we turn to network formation, the structure of random networks, and the origins of large-scale structures in the strategic creation of network ties. This is where some of the most interesting work was done in the earlier stages of modern network analysis. We then move away from the pure structure of networks, to what has become the heart of the recent wave of network analysis: social behavior on networks. We begin with information percolation and contagion across networks – although once again, these ideas apply more broadly, not just to information but also to real-world (viral) contagion, for instance. After moving from percolation to cascades and epidemics, we spend the last few weeks with a series of readings on strategic games on social networks: cooperation games, economic models, and voting. We finish with a brief look at spatial and agent-based models, which after all are merely games on a specific sort of network (the spatial grid).

Assignments

This course will combine lectures, discussions, and student presentations. The presentations will be central to the course, and each student will be asked to make two: one on a paper of their choosing, and the second on their own project. Because network theory is such a vast and complex domain, even a semester-long course can only touch on a few substantive topics; therefore, rather than being given a small subset of seminal papers from this rapidly evolving field, students will be asked to select a paper of their own choosing to present. A selected bibliography of possible papers will be provided, and students will be asked to select a few possibilities from this list and their own research, from which I will select one paper. Every day approximately three students will briefly (10-15 minutes) present the papers they've chosen, and towards the end of the semester this will shift over into project presentations. There will also be three short homeworks, and a final project. Students are encouraged to do the final project (and project presentation) in pairs if they choose.

Readings

Only in the last few years have adequate textbooks in network analysis finally appeared. Easley and Kleinberg's *Networks, Crowds and Markets* (2010) and Newman's *Networks* (2010) will be our central texts. The former tackles a wide range of topics in network analysis, from structures to games and strategic behavior. The latter is a bit more focused on structure, with somewhat less on information flow and strategy, but the two complement each other well. They cover many of the same topics, but with different emphases, and are usefully read in juxtaposition for many of the topics we will cover. Also required, but less central, is Jackson's *Social and Economic Networks* (2008). Jackson's book remains unparalleled for its depth of analysis of strategic behavior on networks, although we will only avail ourselves of portions of it.

Textbooks (Available at Book Culture)

1. Easley and Kleinberg, *Networks, Crowds, and Markets: Reasoning about a highly connected world.* Cambridge Univ. Press, 2010.
2. Newman, *Networks: An introduction.* Oxford Univ. Press, 2010.
3. Jackson, *Social and Economic Networks.* Princeton Univ. Press, 2008.

Pre-requirements

Students are expected to be familiar with basic algebra, and some knowledge of linear algebra will be helpful, but is not required. Though at times challenging, the core mathematical concepts will mainly be developed along the way.

Grading

- Homework: 30%
- Paper presentation: 15%
- Project presentation: 15%
- Attendance and discussion participation: 10%
- Final project: 30%

Plagiarism and Academic Dishonesty. Students must do all their work within the boundaries of acceptable academic norms. See the Academic Honesty page of the CU website regarding college policy on plagiarism and other forms of academic dishonesty, http://www.columbia.edu/cu/history/ugrad/main/handbook/academic_honesty.html. Students found guilty of plagiarism or academic dishonesty will be subject to appropriate disciplinary action, which may include reduction of grade, a failure in the course, suspension or expulsion. Note that this policy applies to all work done for the class – homework, presentations, and final papers – unless explicitly a group assignment.

Late policy and attendance. Homeworks will lose one half a letter grade for each day late unless an exception has been discussed beforehand. Late final projects will not be accepted. Attendance for all classes is required.

Course Schedule

This schedule is subject to change as various topics may take more or less time than anticipated. Homework schedule TBD.

1: 1/23 Introduction: The ubiquity of networks
Newman, Ch. 1-5; *Easley & Kleinberg*, Ch. 1

The structure of networks

2: 1/30 The building blocks: graphs, links, and local structures
Newman, Ch. 6; *Easley & Kleinberg*, Ch. 2
(May extend into Week 3)

3: 2/6 Measurement 1: Centrality
Newman, Ch. 7.1-7.7; *Easley & Kleinberg*, 13-14.

4: 2/13 Measurement 2: Balance and Homophily
Newman, Ch. 7.8-7.13; *Easley & Kleinberg*, 3-5.

5: 2/20 Large-scale structures and small worlds
Newman, Ch. 8; *Easley & Kleinberg*, Ch. 18, 20.

6: 2/27 Network analysis and visualization tools: Pajek, Gephi, NetworkX, igraph, etc.

Network formation

7: 3/6 Random networks
Newman, Ch. 12-13.

8: 3/13 Network formation
Newman, Ch. 14-15; *Jackson*, Ch. 5, 6, 11 (selections).

- : 3/20 BREAK

Information and contagion

9: 3/27 Percolation and information
Newman, Ch. 16; *Easley & Kleinberg*, Ch. 16; *Jackson*, Ch. 7, 8 (selections).

10: 4/3 Epidemics and information cascades
Newman, Ch. 17; *Easley & Kleinberg*, Ch. 19, 21.

Strategic behavior

11: 4/10 Games on networks 1
Easley & Kleinberg, Ch. 6, 7; *Jackson*, Ch. 9.

12: 4/17 Games on networks 2
Easley & Kleinberg, Ch. 12, 23; *Jackson*, Ch. 12.

13: 4/24 Spatial and agent-based models
Easley & Kleinberg, Ch. 4
Hands-on with Netlogo.

14: 5/1 Project presentations
Final Project due 1 week later.