Social Network Analysis
Syllabus

Northeastern University
POLS 7334, Spring 2015
M 4-7 pm

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Overview

Social networks have always been at the center of human interaction, but especially with the explosive growth of the internet, network analysis has become increasingly central to all branches of the social sciences. How do people influence each other, bargain with each other, exchange information (or germs), or interact online? A diverse array of deep questions about human behavior can only be answered by examining the social networks encompassing and shifting around us. 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 will examine the key papers in the development of social network analysis, and will develop the theory and methodological tools needed to model and predict social networks and use them in social sciences as diverse as sociology, political science, economics, health, psychology, history, or business. The core of the course will comprise the essential tools of network analysis, from centrality, homophily, and community measurement, to random graphs, network formation, information flow, and strategic games. Alongside this we will read a series of substantive and seminal papers, shaped in part by the interests of the students and their various backgrounds, with a particular focus on the difficult task of causal inference in social networks. The course will also provide an introduction to network modeling and analysis using R, and network visualization using R and Gephi.

Assignments

This course will combine lectures, discussions, and student presentations. Because network theory is such a vast and complex domain, even a semester-long course can only touch on a few substantive topics; therefore, in addition to the textbooks and a few core papers, students will be asked to select papers that suit their substantive interests from the associated bibliography. Every day one or two students will briefly (10-15 minutes) present the papers they've chosen, although towards the end of the semester this will shift over into project presentations. There will also be three homework assignments, and a final project in which students will apply some of what they have learned to a

research question of interest to them. 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 more focused on structure and formal analysis, but presents a very unified and systematic approach – although we will only cover the more introductory parts of his rich mathematical treatment. We will also avail ourselves of portions of Jackson's *Social and Economic Networks* (2008), which remains unparalleled for its depth of analysis of strategic behavior on networks. Other than Newman's, the textbooks are made available by their authors for free online.

In addition to these textbooks, we will also be reading and presenting current and seminal papers in SNA. Students will participate in selecting the papers we choose, so please see the associated Bibliography for a list of possible papers – although students are welcome to suggest items not on the list, particularly more recent research.

Textbooks

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.

Prerequisites

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

Policies. Homeworks and other projects will lose a half-letter grade for each day late unless an exception has been discussed beforehand. Attendance is essential for all classes. Plagiarism is bad.

Course Schedule

This schedule is subject to change as various topics may take more or less time than anticipated. We will develop the schedule for the papers we will read and present in the first class session.

Jan 12 Introduction: The ubiquity of networks
Newman, Ch. 1-5; *Easley & Kleinberg*, Ch. 1

Jan 19 No class – MLK day

The structure of networks

Jan 26 The building blocks: graphs, links, and local structures
Newman, Ch. 6; *Easley & Kleinberg*, Ch. 2

Feb 2 Measurements 1: Centrality
Newman, Ch. 7.1-7.7; *Easley & Kleinberg*, 13-14.

Feb 9 Measurements 2: Triadic closure, homophily, similarity
Newman, Ch. 7.8-7.13; *Easley & Kleinberg*, 3-5.

Feb 16 No class – Presidents' day

Feb 23 Modularity and Community Detection
Newman, 11.2-11.4, 11.6-11.7, 11.9 - end; *Jackson*, 13.2; *Easley & Kleinberg*, 3.6, 3.A

Network formation

Mar 2 Large-scale structures and small worlds
Newman, Ch. 8; *Easley & Kleinberg*, Ch. 18, 20.
Random networks
Newman, Ch. 12, but skim 12.6; 13.2 but not 13.2.1 or anything after.

Mar 9 No class – Spring Break

Mar 16 Network formation and ERGM
Newman, Ch. 14-14.2, 14.4.4, 14.5 - end; 15.1 but stop at 15.1.1, 15.2-15.2.1 (skim or skip the harder math) *Jackson*, Ch. 5, 6, 11 (selections).

Information and contagion

Mar 23 Percolation and information
Newman, Ch. 16; *Easley & Kleinberg*, Ch. 16; *Jackson*, Ch. 7.

Mar 30 Epidemics and information cascades
Newman, Ch. 17 but no third-decimal sections (ie, skip 17.8.1, 17.10.1, 17.10.2, 17.11.1, or 17.12.1) ; *Easley & Kleinberg*, Ch. 19, 21; *Jackson*, 8.3 but not 8.3.6 and following.

Strategic behavior

Apr 6 Games on networks 1
Easley & Kleinberg, Ch. 6, 7; *Jackson*, Ch. 9.

Apr 13 Causal inference
Fowler, Shalizi, Snijders
If time permits: Games on networks 2
Easley & Kleinberg, Ch. 12, 23; *Jackson*, Ch. 12.

Apr 20 No class – Patriots' day
Possible presentation overflow sometime that week

Final Project due ∼1 week later.