Summary and Objectives

This course will examine the foundations of and recent advances in Network Theory, Network Science and Applied Network Analysis from sociological, economic and statistical perspectives. The course is aimed at doctoral students conducting original research in applied network theory and analysis in a diverse set of fields including sociology, economics, statistics, computer science/machine learning, management, computational biology and physics. The course will follow a research seminar format, with deep critical examinations of original research papers from these disciplines, designed to teach networks research through an evaluation of networks research. Topics covered include: network structure, foundations of sociological network theory, weak ties and structural holes, embeddedness, homophily and assortative mixing, information diffusion in networks, small world phenomena, influence maximization in networks, statistical inference in networks, causal inference in networks, networks and coordination, network dynamics, networked experiments, estimating peer effects, networked interventions and more.

Topics Covered: The course will cover, but not be limited to, the following topics:

- Fundamentals of Network Structure
- Random Graphs
- Scale Free Networks
- Small World Phenomena
- The Strength of Weak Ties, Structural Holes, Embeddedness
- The Diversity-Bandwidth Tradeoff
- Homophily and Assortativity
- Information Diffusion and Cascading Behavior
- Contagion on Networks
- Influence Maximization
- Optimal Network Seeding
- Networks, Coordination and Cooperation
- Community Detection and Graph Evolution
- Theoretical Models of Causal Inference in Networks
- Applied Causal Inference in Networks: Peer Effects and Social Influence
Course requirements

There are three main requirements in this course:

1. **Participation in Class Discussion:** Clearly, discussion makes up the bulk of the class. You should consider that your participation in the discussion will be the key to you learning and benefiting from the class. Active, productive and useful participation that contributes to the learning we are accomplishing in the classroom will be rewarded.

2. **Discussion Questions:** Each week, you will be asked to write a short reflection on the reading for that week. The basic idea is to begin an intellectual discussion about the thoughts that the reading inspired in your with regard to research. The conversation could be about whether you think the scientific questions being asked in the work were intellectually important and why, what theoretical or methodological insights you gleaned from reading the papers were, where the research should go from here, what the strengths and weaknesses of the theory or methods entailed, what did you learn (or not learn from the work), what would you have done differently and why, etc.

3. **Final Term Paper:** You will write a final term paper that proposes a research study, introduces the puzzle or problem the research addresses, defends the intellectual importance of the work, describes and defends the methodology you would use to address the questions asked, describes and defends the data (if any) you would collect and how you would collect it, describes and defends the methods you would use to conduct analyses, describes the results that you would expect, comments on the contribution of the work in the literature describes next steps in the line of research it would create or contribute to.

**Grading**

Discussion Questions: 30%
Final Term Paper: 35%
Participation in Class Discussion: 35%
# Class Schedule

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<td>S12 12/3</td>
<td><strong>Approaches to Interference in Networked Experiments</strong></td>
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<td>S13 12/10</td>
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Reading List

Session 1: Fundamentals of Network Structure (9/3):

2. “Emergence of Scaling in Random Networks” Laszlo Barabasi and Reka Albert (1999); Science, 286 (5439), 509-512.

Optional Reading:


Session 2: Small World Phenomena (9/10):


Optional Reading:


Session 3: Weak Ties, Structural Holes & Embeddedness (9/17):


Optional Reading:

Session 4: Homophily & Assortativity (9/24):

Session 5: Diversity, Heterogeneity and Knowledge Productivity (10/1):

Optional Reading:

Session 6: Information Diffusion & Cascading Behavior (10/8):
26. “Sorting and Mixing” Thomas Shelling (1978); Micromotives and Macrobehavior; Chapter 4, Norton.

Optional Reading:


Session 7: The Influence Maximization Problem (10/15):


Optional Reading:


Session 8: Networks, Coordination and Cooperation (10/29):


Optional Reading:


Session 9: Theoretical Models of Causal Inference in Networks (11/5):


47. “Policy Interventions, Low Level Equilibria and Social Interactions” Robert Moffitt (2001) Social Dynamics


Session 10: Applied Causal Inference in Observational Networks (11/12):


Sessions 11: Experiments in Networks: Peer Effects and Social Influence (11/19)


Optional Reading:

Sessions 12: Approaches to Interference in Networked Experiments (12/3)

Sessions 13: The Future of Networks Research (12/10)