

QTM 385/SOC 508: Advanced Network Analysis
Emory University

Classroom: Rich Building 104
Time: MW 2:30-3:45PM
First Few Weeks Online

Email: weihua.an@emory.edu
Zoom Office Hour: W 1:30-2:15PM
<https://emory.zoom.us/j/9909854398>

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Office Hour: W 4-5PM; [Meeting ID: 385 623 6545](#) (Passcode: QTM385)

Course Description

Interest in network analysis has EXPLODED in the past few years, due to new advancements in statistical modeling and the rapid availability of network data. This course covers the major methods to collect, represent, and analyze network data. Selected topics include centrality analysis, positional analysis, clustering analysis, the exponential random graph model for modeling network formations, the stochastic actor-oriented model for dynamic network analysis, meta network analysis, weighted network analysis, text network analysis, causal analysis of network effects, and social network-based predictions and interventions. Examples are drawn from a wide range of disciplines. Students will learn hands-on skills to conduct their own research by using network packages in R such as “statnet” and “RSiena”. This course requires a basic knowledge of logistic regression and basic programming skills in R.

Requirements

1. Class discussion and participation (20%). Each group of no more than three students will lead one class discussion. ([Sign up for a group.](#)) For each required reading, the group will prepare up to 5 slides to summarize the content and present 2-3 questions for class discussion. All students are expected to read the required readings before class.
2. Four assignments (20%). A typical assignment includes a memo and a computation task. The memo is a 300 word commentary on one required or recommended reading for a particular class. Students are allowed to discuss the assignments with others, but the code and the write-up must be the student’s independent work. Each day of late submission of an assignment will cost 20% of that assignment grade.
3. Midterm (30%). Midterm is open book. No collaboration is allowed.
4. Research project (20%). Each group of no more than three students will work on a final project. Students have two options. (1) Conduct a new study that addresses new research questions with new data. (2) Conduct a study that replicates a previous study or analyzes previous data in novel ways. The project is expected to be about 3,000 words in length (5,000 words for graduate students). Each project should include an introduction to the research question, data and methods, results, and conclusion and discussion.
5. Project presentation (10%). Students will give a presentation of no more than five slides on their final project before submission.

Grading Scale

94-100	-----	A	80-82	-----	B-
90-93	-----	A-	70-79	-----	C
87-89	-----	B+	60-69	-----	D
83-86	-----	B	0-59	-----	F

Recommended Textbooks

1. Wasserman, Stanley and Katherine L. Faust. 1994. *Social Network Analysis: Methods and Applications*. New York: Cambridge University Press.
2. Lusher, D., Koskinen, J. & Robins, G. 2013. *Exponential Random Graph Models for Social Networks: Theory, Methods, and Applications*. Cambridge University Press.

Honor Code

The Honor Code is in effect throughout the semester. By taking this course, you affirm that it is a violation of the code to cheat on exams, to plagiarize, to deviate from the teacher's instructions about collaboration on work that is submitted for grades, to give false information to a faculty member, and to undertake any other form of academic misconduct. You also affirm that if you witness others violating the code you have a duty to report them to the honor council.

Course Schedule

Date	Topic	Lab	Assignment
1/12	Introduction		
1/19	Network Data		
1/26	Network Formation	Lab 1: Basic Analysis	Assignment I
1/31	Random Network Models	Lab 2: ERGM	Assignment II
2/7	Network Effects I		
2/14	Network Effects II	Lab 3: Positional Analysis	
2/21	Midterm Review		
2/28	No Class		Midterm
3/2	Dynamic Network Analysis	Lab 4: SAOM	Assignment III
3/14	Meta Network Analysis	Lab 5: Meta Network Analysis	
3/21	Special Networks	Lab 6: Special Networks	
3/28	Predictions		
4/4	Interventions	Lab 7: Network Interventions	Assignment IV
4/11	Project Group Meeting		
4/18	Project Presentations		
4/25	Extra Office Hour		Final Paper

Course Outline

0. Introduction

An overview of network analysis in the social sciences and some challenges and opportunities.

Readings:

- Borgatti, Stephen P., Ajay Mehra, Daniel J. Brass, and Giuseppe Labianca. 2009. "Network Analysis in the Social Sciences." *Science* 323: 892-895.
- Podolny, Joel M. and Karen L. Page. 1998. "Network Forms of Organization." *Annual Review of Sociology* 24: 57-76.
- Knoke, D. 2011. "Policy Networks". Pp. 210-222 in *The Sage Handbook of Social Network Analysis*, edited by John Scott and Peter J. Carrington. The Sage Publications.

Recommended:

- Freeman, Linton C. 2004. *The Development of Social Network Analysis: A Study in the Sociology of Science*. Vancouver: Empirical Press.
- Pescosolido, Bernice A. 2006. "Of Pride and Prejudice: The Role of Sociology and Social Networks in Integrating the Health Sciences." *Journal of Health and Social Behavior* 47(3): 189-208.
- VanderWeele, Tyler J. and Weihua An. 2013. "Social Networks and Causal Inference." Pp. 353-374 in *Handbook of Causal Analysis in Social Research*, edited by Stephen Morgan. New York: Springer.

1. Network Data

Measuring what and how to measure are two fundamental problems in network data collection.

Readings:

- Brewer, Devon and Cynthia Webste. 1999. "Forgetting of Friends and its Effects on Measuring Friendship Networks." *Social Networks* 21: 361-373.
- Fowler, J. 2006. "Connecting the Congress: A Study of Co-sponsorship Network." *Political Analysis* 14: 456-487.
- Marsden, Peter V. 2005. "Recent Developments in Network Measurement." Pp. 8-30 in *Models and Methods in Social Network Analysis*, edited by Carrington, Peter J., John Scott, and Stanley Wasserman. New York: Cambridge University Press.

Recommended:

- McPherson, J. Miller, Lynn Smith-Lovin, and Matthew E. Brashears. 2006. "Social Isolation in America: Changes in Core Discussion Networks over Two Decades." *American Sociological Review* 71(3): 353-375.
- Krackhardt, David. 1987. "Cognitive Social Structure." *Social Networks* 9: 109-134.

2. Network Formation

How social networks are formed? What role does social context, social status, cultural taste, perception, and local social processes each play in the formation of social networks?

Readings:

McPherson, Miller, Lynn Smith-Lovin and James M. Cook. 2001. "Birds of a Feather? Homophily in Social Networks." *Annual Review of Sociology* 27: 415-444.

Lizardo, Omar. 2006. "How Cultural Tastes Shape Personal Networks." *American Sociological Review* 71(5): 778-807.

Schneider, M., Scholz, J., Lubell, M., Mindruta, D., and Edwardsen, M. 2003. "Building Consensual Institutions: Networks and the National Estuary Program." *American Journal of Political Science* 47:143-158.

Recommended:

Desmond, Matthew. 2012. "Disposable Ties and the Urban Poor." *American Journal of Sociology* 117(5): 1295-1335.

An, Weihua and William McConnell. 2015. "The Origins of Asymmetric Ties in Friendship Networks: From Status Differential to Self-Perceived Centrality." *Network Science* 3(2): 269-292.

3. Random Network Models

The exponential random graph model (ERGM) is the state-of-the-art for modeling networks.

Readings:

Wimmer, Andreas, and Kevin Lewis. 2010. "Beyond and Below Racial Homophily: ERG Models of a Friendship Network Documented on Facebook." *American Journal of Sociology* 116(2):583-642.

Papachristos, Andrew V., David Hureau, and Anthony A. Braga. 2013. "The Corner and the Crew: The Influence of Geography and Social Networks on Gang Violence." *American Sociological Review* 78(3): 417-447.

Heaney, M. T. 2014. "Multiplex Networks and Interest Group Influence Reputation: An Exponential Random Graph Model." *Social Networks* 36(1): 66-81.

Recommended:

Hunter, David R., Mark S. Handcock, Carter T. Butts, Steven M. Goodreau, and Martina Morris. 2018. "ergm: A Package to Fit, Simulate and Diagnose Exponential-Family Models for Networks." *Journal of Statistical Software* 24(3): nihpa54860.

Park, Hyun Hee and R. Karl Rethemeyer. 2014. "The Politics of Connections: Assessing the Determinants of Social Structure in Policy Networks." *JPART* 24:349-379.

4. Network Effects I: Relational effects

The literature on relational effects can be divided into two groups. The social capital literature shows how a person's social networks provide access to social resources or emotional support. The social contagion model shows social norms and behaviors can transmit through networks.

Readings:

Mouw, Ted. 2003. "Social Capital and Finding a Job: Do Contacts Matter?" *American Sociological Review* 68: 868-898.

Fernandez, Roberto M. and Nancy Weinberg. 1997. "Sifting and Sorting: Personal Contacts and Hiring in a Retail Bank." *American Sociological Review* 62(6): 883-902.

Podolny, Joel M. and James N. Baron. 1997. "Resources and Relationships: Social Networks and Mobility in the Workplace." *American Sociological Review* 62: 673-693.

An, Weihua. 2015. "Instrumental Variables Estimates of Peer Effects in Social Networks." *Social Science Research* 50: 382-394.

Recommended:

Granovetter, Mark S. 1973. "The Strength of Weak Ties." *American Journal of Sociology* 78: 1360-1380.

Lin, Nan. 1999. "Social Networks and Status Attainment." *Annual Review Sociology* 25: 467-487.

Bian, Yanjie. 1997. "Bringing Strong Ties Back In: Indirect Ties, Network Bridges, and Job Searches in China." *American Sociological Review* 62:266-285.

An, Weihua. 2011. "Models and Methods to Identify Peer Effects." Pp. 514-532 in *The Sage Handbook of Social Network Analysis*, edited by John Scott and Peter J. Carrington. London: The Sage Publications.

5. Network Effects II: Positional and structural effects

Both network positions and network structures can affect individuals' outcomes. Understand the concepts of structural holes and structural equivalence.

Readings:

Burt, Ronald S. 2004. "Structural Holes and Good Ideas." *American Journal of Sociology* 110: 349-399.

Alderson, Arthur S. and Jason Beckfield. 2004. "Power and Position in the World City System." *American Journal of Sociology* 109:811-851.

Baldassarri, Delia and Mario Diani. 2007. "The Integrative Power of Civic Networks." *American Journal of Sociology* 113(3): 735-780.

Bearman, Peter S., James Moody and Katherine Stovel. 2004. "Chains of Affection: The Structure of Adolescent Romantic and Sexual Networks." *American Journal of Sociology* 110: 44-91.

Recommended:

Cornwell, Benjamin. 2009. "Good Health and the Bridging of Structural Holes." *Social Networks* 31:92-103.

Greenberg, Jason. 2021. "Social Network Positions, Peer Effects, and Evaluation Updating: An Experimental Test in the Entrepreneurial Context." *Organization Science* 32(5):1174-1192

Burt, Ronald S. 1987. "Social Contagion and Innovation: Cohesion Versus Structural Equivalence." *American Journal of Sociology* 92(6): 1287-1335.

Uzzi, Brian. 1997. "Social Structure and Competition in Interfirm Networks: The Paradox of Embeddedness." *Administrative Science Quarterly* 42: 35-67.

Morgan, Stephen L. and Aage B. Sørensen. 1999. "Parental Networks, Social Closure, and Mathematics Learning: A Test of Coleman's Social Capital Explanation of School Effects." *American Sociological Review* 64: 661-681.

Chase, Ivan D. 1991. "Vacancy Chains." *Annual Review of Sociology* 17: 133-154.

6. Dynamic Network Analysis

Longitudinal network data help estimate causal peer effects. Compare the advantages and disadvantages of the dynamic logit model and the stochastic actor-oriented model.

Readings:

Christakis, Nicholas A. and James H. Fowler. 2007. "The Spread of Obesity in a Large Social Network Over 32 Years." *New England Journal of Medicine* 357(4): 370-379.

Cohen-Cole, Ethan and Jason M. Fletcher, 2008. "Is Obesity Contagious? Social Networks vs. Environmental Factors in the Obesity Epidemic." *Journal of Health Economics* 27: 1382–1387.

Aral, Sinan, Lev Muchnik, and Arun Sundararaja. 2009. "Distinguishing Influence-based Contagion from Homophily-driven Diffusion in Dynamic Networks." *PNAS* 106(51): 21544-21549.

Schaefer, David R., Olga Kornienko, and Andrew M. Fox. 2011. "Misery Does Not Love Company: Network Selection Mechanisms and Depression Homophily." *American Sociological Review* 76(5): 764-785.

Recommended:

Steglich, Christian, Tom A.B. Snijders, and Michael Pearson. 2010. "Dynamic Networks and Behavior: Separating Selection from Influence." *Sociological Methodology* 40(1): 329-393.

Perry, B.L. and B.A. Pescosolido. 2012. "Social Network Dynamics and Biographical Disruption: The Case of First-Timers with Mental Illness." *American Journal of Sociology* 118(1): 134-175.

Liu, Ka-Yuet, Marissa King, and Peter S. Bearman. 2010. "Social Influence and the Autism Epidemic." *American Journal of Sociology* 115(5): 1387–1434.

7. Meta Network Analysis

Introduce meta network analysis for combining multiple network models and big network analysis.

Readings:

An, Weihua. 2015. "Multilevel Meta Network Analysis with Application to Studying Network Dynamics of Network Interventions." *Social Networks* 43: 48-56.

An, Weihua. 2022. "Friendship Network Formation in Chinese Middle Schools: Patterns of Inequality and Homophily." *Social Networks* 68: 218-228.

An, Weihua. 2016. "Fitting ERGMs on Big Networks." *Social Science Research* 59: 107-119.

Recommended:

Snijders, T. A.B. and Baerveldt, C. 2003. "A Multilevel Network Study of the Effects of Delinquent Behavior on Friendship Evolution." *Journal of Mathematical Sociology* 27: 123-151.

8. Special Networks

Introduce methods for analyzing weighted networks, two-mode networks, and text networks.

Readings:

Krivitsky, Pavel N., Carter T. Butts, and the Statnet Development Team. 2015. "Modeling Valued Networks with statnet."

Leifeld, Philip and Sebastian Haunss. 2012. "Political Discourse Networks and the Conflict over Software Patents in Europe." *European Journal of Political Research* 51: 382-409.

An, Weihua and Ying Ding. 2018. "The Landscape of Causal Inference: Perspective from Citation Network Analysis." *The American Statistician* 72(3): 265-277.

Recommended:

McMillan, Cassie. 2022. "Worth the Weight: Conceptualizing and Measuring Strong versus Weak Tie Homophily." *Social Networks* 68: 139-147.

Wang, Peng, Ken Sharpe, Garry L. Robins, and Philippa E. Pattison. 2009. "Exponential Random Graph (p^*) Models for Affiliation Networks." *Social Networks* 31(1): 12-25.

Snijders, Tom A.B., Alessandro Lomi, and Vanina Jasmine Torló. 2013. "A Model for the Multiplex Dynamics of Two-mode and One-mode Networks with an Application to Employment Preference, Friendship, and Advice." *Social Networks* 35: 265-276.

9. Networks and Predictions

There are two kinds of predictions related to networks. One is to infer network ties based on attributes or alter reports. The other is to use networks to predict or monitor social behaviors.

Readings:

Eagle, Nathan, Alex (Sandy) Pentland, and David Lazer. 2009. "Inferring Friendship Network Structure by Using Mobile Phone Data." *PNAS* 106 (36): 15274-15278.

Christakis, Nicholas A. and James H. Fowler. 2010. "Social Network Sensors for Early Detection of Contagious Outbreaks." *PLOS ONE* 5(9).

An, Weihua. 2022. "You Said, They Said: A Framework on Informant Accuracy with Application to Studying Self-Reports and Peer-Reports." *Social Networks*.

Salganik, Matthew J. and Douglas D. Heckathorn. 2004. "Sampling and Estimation in Hidden Populations Using Respondent-Driven Sampling." *Sociological Methodology* 34: 193-239.

Recommended:

An, Weihua and Sam Schramski. 2015. "Analysis of Contested Reports in Exchange Networks Based on Actors' Credibility." *Social Networks* 40: 25-33.

An, Weihua and Long Doan. 2015. "Health Surveillance through Social Networks." *Social Networks* 42: 8-17.

10. Network Interventions

Network interventions may occur at three levels. (1) At the ecological level, they aim to change the ecology of a social network and examine the adaptation of the network. (2) At the structure level, they attempt to shape the structure of a social network in order to facilitate information diffusion or behavior changes. (3) At the individual level, they aim to utilize social network information to more strategically select seed subjects to facilitate social contagion.

Readings:

Valente, Thomas W. 2012. "Network Interventions." *Science* 337: 49-53.

Paluck, E. L., H. Shepherd, and P. M. Aronow. 2016. "Changing Climates of Conflict: A Social Network Experiment in 56 Schools." *PNAS* 113(3): 566-571.

Centola, Damon. 2011. "An Experimental Study of Homophily in the Adoption of Health Behavior." *Science* 334: 1269-1272.

Valente, Thomas W. and Patchareeya Pumpuang. 2007. "Identifying Opinion Leaders to Promote Behavior Change." *Health Education and Behavior* 34: 881-896.

Recommended:

Borgatti, Stephen P. 2006. "Identifying Sets of Key Players in a Network." *Computational, Mathematical and Organizational Theory* 12(1): 21-34.

An, Weihua and Yu-Hsin Liu. 2016. "keyplayer: An R package for Locating Key Players in Social Networks." *The R Journal* 8(1): 257-268.