

POL 2578 Network Analysis

WINTER 2024

PREREQUISITES: POL 2507 or equivalent; POL 2519 recommended

Lecture: Wednesdays 10-12 pm

Instructor: Professor Olga Chyzh, olga.chyzh@utoronto.ca

Office Hours: by appointment

Overview and Objectives

Social science data are inherently network data. Individuals are embedded within networks of friendships and professional relations; administrative units influence and are influenced by the nearby units; countries are nested within complex alliance and trade networks. The course will introduce the inferential tools for analyzing such data, including network causal inference, spatial statistics and graph models, the Exponential Random Graph models (ERGMs), and Latent Space Models (LSMs). For each model, we will work through the mathematical and theoretical foundations, discuss published social science applications of them, and utilize the models on example datasets.

Learning Outcomes

This course is designed as a series of weekly modules that build upon each other. Each module covers one or more state-of-the-art approaches to statistical analysis of network data. For each model covered, the objectives are that students will:

- Develop a firm grasp of the assumptions and formulation of the model.
- Understand how to interpret results.
- Understand how to evaluate the fit and assumptions of the model.
- Use software to apply the model.
- Read published substantive applications of the model.
- Evaluate the potential for application of the model to their own research.

Two overarching objectives are that students will (1) develop an ability to compare the relative merits of the various models covered for a given empirical application and (2) develop a comprehensive sense of the state of the literature on statistical models for social networks.

Requirements

Grades will be based on in-class participation (15%), three homework assignments (15% each), and a research project (40%).

Students have an option to re-submit assignments **within one week after the assignment was graded**. Students can only re-submit an assignment that received a grade lower than an “A-”. All assignments must be re-submitted via email to the instructor with a short description of how the assignment has been improved. This option is not available for missed assignments or assignments that received a grade of 0.

Research Project

The research project is short analytical paper (10 pages) that posits a research question, proposes a theoretical model, derives and tests a research hypothesis using one or more tools learned in class. Students will turn in a short research proposal, receive feedback, and revise their final project based on this feedback.

Deadlines

- Homework 1–Friday, Jan. 26, 5 pm.
- Homework 2–Friday, Feb. 16, 5 pm.
- Research Proposal–Friday, Mar. 9, 5 pm.
- Homework 3–Friday, Mar. 22, 5 pm.
- Research Project–April 5, 5 pm

Coding Sessions

For each method covered we will run through applications in R during class. Students are strongly encouraged to follow along during class and review/run through these examples after class. Students will be provided with data, but may also use their own datasets.

Course Schedule

The schedule below gives the required reading. The readings listed for a particular day should be read before class time that day.

Part 1: Introduction

- January 10: Course Overview and Introduction to Network Analysis
 - Michael D. Ward, Katherine Stovel, and Audrey Sacks. Network analysis and political science. *Annual Review of Political Science*, 14:245–264, 2011.
 - Stanley Wasserman and Katherine Faust. *Social Network Analysis: Methods and Applications*. Cambridge University Press, 1994. Chapters 1 and 2.
- January 17: Centrality, Reciprocity, Transitivity
 - John F. Padgett and Christopher K. Ansell. Robust action and the rise of the Medici, 1400-1434. *American Journal of Sociology*, 98(6):1259–1319, 1993.
 - Scott L. Feld. Why your friends have more friends than you do. *American Journal of Sociology*, 96(6):1464–1477, 1991.
 - Kupferschmidt, Kai. Why do some COVID-19 patients infect many others, whereas most don't spread the virus at all? *Science*, May 19, 2020.
 - Mark S. Granovetter. The strength of weak ties. *American Journal of Sociology*, 78(6):1360–1980, 1973, **Trigger Warning:** This article uses racial and gendered language common at the time of its writing.
- January 24: Communities, Homophily, **HW 1 due**.
 - Albert-László Barabási. *Network Science*. Cambridge university press, 2016. Chapter 9.
 - Wayne W Zachary. An information flow model for conflict and fission in small groups. *Journal of Anthropological Research*, 33(4):452–473, 1977.
 - Jonathan Renshon. Status deficits and war. *International Organization*, 70(3):513–550, 2016.
 - Roger V Gould. Multiple networks and mobilization in the Paris Commune, 1871. *American Sociological Review*, pages 716–729, 1991.
 - Cesi Cruz, Julien Labonne, and Pablo Querubin. Social network structures and the politics of public goods provision: evidence from the philippines. *American Political Science Review*, 114(2):486–501, 2020

Part 2: Inferential Network Analysis

- January 31: Networks and Causal Inference

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- Olga V. Chyzh. How to stop contagion: Applying network science to evaluate the effectiveness of covid-19 vaccine distribution plans. *Journal of Politics*, 33(X):Forthcoming, 2024
 - Karthik Rajkumar, Guillaume Saint-Jacques, Iavor Bojinov, Erik Brynjolfsson, and Sinan Aral. A causal test of the strength of weak ties. *Science*, 377(6612):1304–1310, 2022
 - February 7: Spatial Autoregressive Models
 - Robert J Franzese and Jude C Hays. Spatial econometric models of cross-sectional interdependence in political science panel and time-series-cross-section data. *Political Analysis*, 15(2):140–164, 2007
 - Olga Chyzh. Keeping up with which Joneses: Spatial diffusion of rule of law through economic international organizations. *Foreign Policy Analysis*, 13(1):28–49, 2017
 - February 14: Models for Binary Dependent Variables, **HW 2 due**
 - J Scott Long. *Regression Models for Categorical and Limited Dependent Variables*, volume 7. SAGE, 1997 Chapter 3.
 - Robert J Franzese, Jude C Hays, and Scott J Cook. Spatial-and spatiotemporal-autoregressive probit models of interdependent binary outcomes. *Political Science Research and Methods*, 4(1):151–173, 2016
 - February 28: Local Structure Graph Models (LSGMs)
 - Emily Casleton, Daniel Nordman, and Mark S. Kaiser. A local structure model for network analysis. *Statistics and Its Interface*, 2(10), 2017.
 - Olga V. Chyzh and Mark S. Kaiser. Network analysis using a local structure graph model. *Political Analysis*, 27(4):397–414, 2019.
 - March 6: LSGM Applications
 - Carla Martinez Machain, Mark David Nieman, Olga V. Chyzh, and Sam R. Bell. An international game of risk: Troop placement and major power competition. *The Journal of Politics*, 2021. Forthcoming.
 - March 13: Exponential Random Graph Models
 - Skyler J. Cranmer and Bruce A. Desmarais. Inferential network analysis with exponential random graph models. *Political Analysis*, 19(1):66–86, 2011.
 - David R. Hunter, Mark S. Handcock, Carter T. Butts, Steven M. Goodreau, and Martina Morris. Ergm: A package to fit, simulate and diagnose exponential-family models for networks. *Journal of Statistical Software*, 24(3):1–29, 2008.
 - Emily Kalah Gade, Michael Gabbay, Mohammed M. Hafez, and Zane Kelly. Networks of cooperation: Rebel alliances in fragmented civil wars. *Journal of Conflict Resolution*, 63(9):2071–2097, 2019.

- March 20: ERGM Application, **HW 3 due**.
 - Steven M. Goodreau, James A. Kitts, and Martina Morris. Birds of a feather, or friend of a friend? using exponential random graph models to investigate adolescent social networks. *Demography*, 46(1):103–125, 2009.
- March 27: TERGM Introduction
 - Garry Robins and Philippa Pattison. Random Graph Models for Temporal Processes in Social Networks. *Journal of Mathematical Sociology*, 25(1):5–41, 2001.
 - Marina G Duque. Recognizing international status: A relational approach. *International Studies Quarterly*, 62(3):577–592, 2018.
 - Skyler J. Cranmer, Bruce A. Desmarais, and Justin H. Kirkland. Toward a network theory of alliance formation. *International Interactions*, 38(3):295–324, 2012.
- April 3: Latent Variable Models
 - Mark S. Handcock and Pavel N. Krivitsky. Fitting latent cluster models for networks with latentnet. *Journal of Statistical Software*, 24(05), 2008.
 - Shahryar Minhas, Peter D. Hoff, and Michael D. Ward. A new approach to analyzing coevolving longitudinal networks in international relations. *Journal of Peace Research*, 53(3):491–505, 2016.
 - Justin H Kirkland. Multimember districts’ effect on collaboration between us state legislators. *Legislative Studies Quarterly*, 37(3):329–353, 2012.
 - Cassy Dorff, Max Gallop, and Shahryar Minhas. Networks of violence: Predicting conflict in Nigeria. *The Journal of Politics*, 2020. Forthcoming.