Instructor:	Dr. Zachary Neal	**Email:**	zpneal@msu.edu
Office:	134B Psychology	**Office Hours:**	By appointment

COURSE DESCRIPTION

Most social science research treats each unit in a population (e.g. a person, an organization, a community) as independent. This is absurd: people interact with other people, organizations interact with other organizations, etc. Network analysis offers a solution by providing a set of theories and quantitative analytic techniques to explicitly capture the relationships between units in a population. This seminar will provide an introduction to these tools, with the semester split roughly in half between key concepts (August 30 – October 11) and putting them into practice using the R and Visone software platforms (October 18 – November 29).

OBJECTIVES: By the end of this course, you should be able to:
1. Understand the conceptual and mathematical foundations of network analysis
2. Read, interpret, and critique empirical research using network analysis
3. Open, manipulate, and analyze network data in R and/or Visone

NON-OBJECTIVES: There are also some things we will not be covering:
1. Ego Networks – Ego networks are social networks that immediately surround a single individual (e.g. one person's associates, and the relationships among them). In contrast, complete networks examine all the relationships among the entities in a population (e.g. all the people in a classroom, all the organizations in a city, etc.). We will briefly discuss ego networks, but will primarily focus on complete networks.
2. Networking – We will explore how networks form and dissolve, but will not be considering strategies for expanding or enhancing your own network.
3. Online social networks – We will see examples of many different types of networks, including online social networks, but this is not a seminar on social media.

EXPECTATIONS

This course will follow a seminar format in which we discuss and explore the readings each week. Therefore, it is essential that you actively participate in the course. I expect you to complete the reading assignments prior to class, and come prepared to talk about them. This will require more than simply reading. Plan to spend at least as much time outside of class *thinking* about the materials as actually reading them. For readings that deal with methodology, try to work through the examples presented. For readings that apply a method in an empirical context, try to critically evaluate its strengths and weaknesses.

PREREQUISITES

No prior experience with network analysis is necessary, however all students should be able to count to 10, add and subtract, multiply and divide. You should also be able to draw circles and connect them with lines. In addition, all students should have completed at least one graduate-level course in inferential statistics and one graduate-level course in research methods/design.

REQUIRED MATERIALS

All readings are posted on D2L.

R Software [available free from https://www.r-project.org/]

R Studio [available free from https://www.rstudio.com/] – Unless you're really hard-core, this is a helpful graphic interface that makes it easier to use R.

Visone software [available free from https://visone.info/] – This software has somewhat limited functions & documentation, but offers an easy point-and-click interface and yields nice looking visualizations. It's free and will run on both Mac and PC.

COURSE POLICIES

Academic Integrity: The General Student Regulations state that: "[1.00] The principles of truth and honesty are fundamental to the educational process and the academic integrity of the University; therefore, no student shall: [1.01] claim or submit the academic work of another as one's own, [1.02] procure, provide, accept or use any materials containing questions or answers to any examination or assignment without proper authorization, [1.03] complete or attempt to complete any assignment or examination for another individual without proper authorization, [1.04] allow any examination or assignment to be completed for oneself, in part or in total, by another without proper authorization, [1.05] alter, tamper with, appropriate, destroy or otherwise interfere with the research, resources, or other academic work of another person, [1.06] fabricate or falsify data or results." In accordance with the All-University Policy on the Integrity of Scholarship and Grades, any student found in violation of this regulation will receive a penalty grade of 0.0 for the course. This includes all instances of plagiarism. If you do not know what plagiarism is, please see me immediately.

Students with disabilities: Michigan State University is committed to providing equal opportunity for participation in all programs, services and activities. Accommodations for persons with disabilities, with documentation from the MSU Resource Center for Persons with Disabilities, may be requested by contacting me at the start of the term and/or two weeks prior to the accommodation date (test, project, etc). Requests received after this date will be honored whenever possible.

Attendance & Late Assignments: If you are unable to attend class, please let me know as early as possible. You may only make up assignments if you make arrangements with me in advance. Late assignments and requests for an "incomplete" will not be considered unless you have a documented emergency. Procrastination is not an emergency, even if you have documentation.

Limits to confidentiality. Essays, journals, and other materials submitted for this class are generally considered confidential pursuant to the University's student record policies. However, students should be aware that University employees, including instructors, may not be able to maintain confidentiality when it conflicts with their responsibility to report certain issues to protect the health and safety of MSU community members and others. As the instructor, I must report the following information to other University offices (including the Department of Police and Public Safety) if you share it with me:

- Suspected child abuse/neglect, even if this maltreatment happened when you were a child,
- Allegations of sexual assault or sexual harassment when they involve MSU students, faculty, or staff, and
- Credible threats of harm to oneself or to others.

These reports may trigger contact from a campus official who will want to talk with you about the incident that you have shared. In almost all cases, it will be your decision whether you wish to speak with that individual. If you would like to talk about these events in a more confidential setting you are encouraged to make an appointment with the MSU Counseling Center.

Questions or concerns: I want to see each of you succeed in this course. If you have any questions or concerns, please contact me and we can set up a time to talk. Please let me know as soon as possible if you experience any problems in the course. By letting me know early, we can work out a plan to make sure you do not fall behind.

ASSIGNMENTS & EXAMS

WEEKLY DISCUSSION QUESTIONS (10 weeks @ 1 point each)

Each week, you will email me (zpneal@msu.edu) one question you had about the readings by 5pm on Wednesday. You can use regular email or D2L email to send your question, but please just put your question in the body of the email, not in an attachment. Your question may concern something that was unclear, something that you'd like to talk about further in class, or that otherwise captured your attention. These questions will help me address the issues of greatest interest to those in the class, and will help guide our discussion. I will compile the questions and circulate them in class. NOTE: You will receive 1 point for each week that you submit a question; after the first 10, any additional questions submitted are extra credit.

ARTICLE SUMMARY (15 POINTS, DUE 9:10AM ON OCTOBER 4)

You will (A) select a peer-reviewed journal article reporting a network analysis on a topic related to your area of interest, (B) identify the key features of the study, (C) summarize them the "Article Summary Form," and (D) share what you found in a brief presentation. The article you select must involve the collection and analysis of quantitative whole network data. If network analysis is uncommon in your area of interest, you may need to cast a wide net to find a suitable article.

You will (A) obtain a network dataset, (B) compute the five-number summary described by Luke (2015, chapter 2), (C) create a visualization of the network, and (D) interpret the five metrics and visualization in no more than 3 pages (not including the visualization). You are encouraged but not required to use the data from the article you summarized on October 4, so think about this early. In addition to submitting your assignment on November 8, please bring with you to class a printed copy of your visualization (or send me a copy to print). The class will vote on the best looking visualization; the winner gets an extra credit point.

Here are some suggestions on locating a dataset:
- Browse one of these repositories:
  - https://snap.stanford.edu/data/
  - http://networkrepository.com/
  - https://networkdata.ics.uci.edu/
- Email an author, asking very nicely
- If an article displays a sociogram, you may be able to reconstruct the underlying network data
- Look on D2L; I have posted some datasets from papers I have written in the past
- Note: You may not use the data bundled with Luke (2015) and used for examples in that book, but you may use other material we discuss in class.

For the final assignment, you have three options:
- Write a *critique* of the article you summarized on October 4. Your critique should take the form of a 10 page paper (1" margins, 12 pt. font, double-spaced; excluding references & title page). What you discuss in your critique will depend on what the study did, but should reflect on such things as the clarity of the research questions or hypotheses, the quality of the data collection, and the accuracy of the interpretation of results.
- Conduct a *replication* of the analysis reported in the peer-reviewed journal article & data you summarized in the earlier assignments. Your goal is to use the original data to reproduce the findings in the original article. In addition to the output, you will submit a brief 2-3 page narrative explaining what you learned by conducting the replication. This might involve reflecting on how the original authors could have run the analyses differently, or why you believe you were unable to replicate their findings.
- Conduct a new analysis that represents an *extension* of the analysis originally reported in the peer-reviewed journal article & data you summarized in the earlier assignments. You will submit a brief 4-5 page research note that describes (A) what you did, (B) what you found, and (C) why it is an important extension.

- All assignments are due at 9:10am on the respective due date, and should be submitted via email to zpneal@msu.edu. Submitting papers in MS Word format is preferred so that I can easily add comments and return them to you.
- The assignments build on one another, so you will do best if you think about them together and get started early.
- The assignments are designed to be adapted to your comfort level with network analysis and vary in terms of complexity and payoff. If you are new to network analysis and/or generally uncomfortable with quantitative analysis, you may want to consider (A) summarizing an article that conducts a straightforward analysis, (B) summarizing a small dataset, and (C) selecting the *critique* option. If you have a bit of experience with network analysis or want to challenge yourself, you may want to consider (A) summarizing a more technical article, (B) summarizing a larger or more complex dataset, and (C) selecting the *replication* or *extension* option. The potential advantage of the replication & extension options is that they may lead to a conference or journal paper.

- There are many more varieties of network analysis than we will cover in class. As a result, there is a good chance your article will involve a type of analysis we do not cover. For these assignments, be prepared to do some off-syllabus reading, but feel free to get in touch if you need help.
- Whether you select the *critique*, *replication*, or *extension* option, do not include a lengthy literature review in your paper. Your paper may include a brief (up to 1 page) background section that situates your article/topic in the broader literature, but should mainly focus on the methodological aspects.

GRADING
All grades will be posted on D2L. Final grades will be assigned based on your total accumulated points according to the following system:

100 – 90 points	4.0	70 – 74 points	2.0
85 – 89 points	3.5	65 – 69 points	1.5
80 – 84 points	3.0	60 – 64 points	1.0
75 – 79 points	2.5	59 – 0 points	0.0

Point totals will be rounded up to the nearest whole point at the end of the semester. Any concerns about your grade or progress in class should be brought to my attention as early as possible.

COURSE SCHEDULE
AUGUST 30 – INTRODUCTION: WHAT IS A NETWORK
Borgatti S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science, 323*, 892-895.

Butts, C. T. (2009). Revisiting the foundations of network analysis. *Science, 325,* 414-416.

Marin, A. & Wellman, B. (2011). Social network analysis: An introduction. Pp. 11-25 in *The Sage Handbook of Social Network Analysis*, edited by Scott, J. & Carrington, P. J. Thousand Oaks, CA: Sage.

Prell, C. (2012). A brief history of social network analysis. Pp. 19-58 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

SEPTEMBER 6 – N^1: NODE-LEVEL ANALYSIS
Borgatti, S. P. & Everett, M. G. (2006). A graph-theoretic perspective on centrality. *Social Networks, 28*, 466-484.

Burt, R. (2001). Structural holes versus network closure as social capital. Pp. 31-56 in *Social Capital: Theory and Research*, edited by Lin, N., Cook, K. S., & Burt, R. S. New York: Aldine de Gruyter.

Cook, K. S., Emerson, R. M., Gillmore, M. R., & Yamagishi, T. (1983). The distribution of power in exchange networks: Theory and experimental results. *American Journal of Sociology, 89*, 275-305.

Prell, C. (2012). Actor level in complete networks. Pp. 95-117 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

SEPTEMBER 13 – N^2 & N^3: DYAD-LEVEL AND TRIAD-LEVEL ANALYSIS
Hipp, J. R. & Perrin, A. J. (2009). The simultaneous effect of social distance and physical distance on the formation of neighborhood ties. *City and Community, 8*, 5-25.

Prell, C. (2012). Dyad and triad levels. Pp. 134-150 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

Yap, J., & Harrigan, N. (2015). Why does everybody hate me? Balance, status, and homophily: The triumvirate of signed tie formation. *Social Networks, 40*, 103-122.

SEPTEMBER 20 – N^0: NETWORK-LEVEL ANALYSIS
Barabási, A.-L. & Albert, R. (1999). Emergence of scaling in random networks. *Science, 286*, 509-512. [short & technical]   **OR**   Barabási, A.-L. & Bonabeau, E. (2003). Scale free networks. *Scientific American, May*, 50-59. [long & non-technical]

Fortunato, S. & Castellano, C. (2012). Community structure in graphs. Pp. 490-512 in *Computational Complexity: Theory, Techniques, and Applications*, edited by Meyers, R. A. New York: Springer-Verlag.

Neal, Z. (2014). The devil is in the details: Differences in air traffic networks by scale, species, and season. *Social Networks, 38*, 63-73. [empirical example of major N^0 analyses; focus on Section 4 and 5.0]

Prell, C. (2012). Network level. Pp. 166-174 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

Watts, D. J. & Strogatz, S. H. (1998). Collective dynamics of 'small-world' networks. *Nature, 393*, 440-442. [short & technical]   **OR**   Watts, D. J. (2003). Small worlds. Pp. 69-100 in *Six Degrees: The Science of a Connected Age*. New York: W. W. Norton. [long & non-technical]

SEPTEMBER 27 – DATA COLLECTION & STUDY DESIGN

Borgatti, S. P., Everett, M. G., & Johnson, J. C. (2013). Research design and Data Collection. Pp. 24-61 in *Analyzing Social Networks*. Thousand Oaks, CA: Sage.

Kadushin C. 2012. *Understanding Social Networks*. New York: Oxford. (Chapter 11)

Light, J. M., Greenan, C. C., Rusby, J. C., Nies, K. M., & Snijders, T. A. B. (2013). Onset to first alcohol use in early adolescence: A network diffusion model. *Journal of Research on Adolescence, 23*, 487-499. [Focus on the data collection & design: What did they report? What did they do well? What is problematic?]

Neal, Z. P. & Neal, J. W. (2017). Network analysis in community psychology: Looking forward, looking back. *American Journal of Community Psychology, 60*, 279-295.

OCTOBER 4 – NUTS & BOLTS (**ARTICLE SUMMARY ASSIGNMENT DUE @ 9:10AM**)

Prell, C. (2012). Becoming familiar with social networks. Pp. 7-18 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

https://www.mathsisfun.com/algebra/matrix-introduction.html

https://www.mathsisfun.com/algebra/matrix-multiplying.html

Start working on installing R, R Studio, and Visone (see instructions on D2L)

➔ Article summary presentations

OCTOBER 11 – NETWORK THEORY AND SIMULATION MODELS /WSG DR. KEN FRANK & DR. RAN XU (VIRGINIA TECH)

Frank, K. A., Xu, Ran, & Penuel, W. R. (In press). Implementation of an evidence-based practice in human service organizations: Implications from agent-based models. *Journal of Policy Analysis and Management*.

Frank, K. A. & Xu, Ran. (In preparation for submission). Polarization through generalized balance in networks.

OCTOBER 18 – INTRODUCTION TO NETWORK ANALYSIS SOFTWARE

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapters 1 – 3]

Optional: Browse these sites to see what else is available:
- Gephi: https://gephi.org/
- UCINET: https://sites.google.com/site/ucinetsoftware/home
- ORA: http://www.casos.cs.cmu.edu/projects/ora/
- NodeXL: https://www.smrfoundation.org/nodexl/

OCTOBER 25 – VISUALIZATION

Look again at some of the visualizations used in the empirical papers we've already read. Are they any good?

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapters 4 – 6]

Huang, W., Hong, S.-H., & Eades, P. (2007). Effects of sociogram drawing conventions and edge crossings in social network visualization. *Journal of Graph Algorithms and Applications, 11*, 397-429.

Pfeffer, J. (2013). Fundamentals of visualizing communication networks. *IEEE China Communications, 10*, 82-90.

NOVEMBER 1 – CENTRALITY & PROJECTIONS

Breiger, R. L. (1974). The duality of persons and groups. *Social Forces, 53*, 181-190. [Focus on pp. 181-185]

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapters 7 & 9]

Neal, Z. P. (2014). The backbone of bipartite projections: Inferring relationships from co-authorship, co-sponsorship, co-attendance, and other co-behaviors. *Social Networks, 39*, 84-97.

NOVEMBER 8 – "NETWORK SCIENCE" (**DATA SUMMARY ASSIGNMENT DUE @ 9:10AM**)

Broido, A. D. & Clauset, A. (2018). Scale-free networks are rare. arXiv:1801.03400.
- Also see the R code he uses at http://tuvalu.santafe.edu/~aaronc/powerlaws/
- Optional: Barabási, A.-L. (2018). Love is all you need: Clauset's fruitless search for scale-free networks.

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapters 8 & 10]

Neal, Z. P. (2017). How small is it? Comparing indices of small worldliness. *Network Science, 5*, 30-44.

Zachary, W. W. (1977). An information flow model for conflict and fission in small groups. *Journal of Anthropological Research, 33*, 452-473.

NOVEMBER 15 – STATIC MODELS (PERMUTATION & ERGM)

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapter 11]

Prell, C. (2012). Statistical models for social networks. Pp. 199-220 in *Social Network Analysis: History, Theory, & Methodology*. Thousand Oaks, CA: Sage.

Robins, G., Pattison, P., Kalish, Y., & Lusher, D. (2007). An introduction to exponential random graph (p*) models for social networks. *Social Networks, 29*, 173-191.

NOVEMBER 22 – THANKSGIVING (NO CLASS)

NOVEMBER 29 – DYNAMIC MODELS /WSG DR. JENNIFER WATLING NEAL (SIENA)

Light, J. M., Greenan, C. C., Rusby, J. C., Nies, K. M., & Snijders, T. A. B. (2013). Onset to first alcohol use in early adolescence: A network diffusion model. *Journal of Research on Adolescence, 23*, 487-499. [We discussed the design on September 27; now focus on the analysis & interpretation of results.]

Luke, D. A. (2015). A user's guide to network analysis in R. New York: Springer. [Chapter 12]

Veenstra, R., Dijkstra, J. K., Steglich, C., and van Zalk, M. H. W. (2013). Network-Behavior Dynamics. *Journal of Research on Adolescence, 23*, 399-412.

Rullison, K. L., Gest, S. D., and Loken, E. (2013). Dynamic social networks and physical aggression: The moderating role of gender and social status among peers. *Journal of Research on Adolescence, 23*, 437-449.

DECEMBER 6 – FINAL PRESENTATIONS (**CRITIQUE, REPLICATION, OR EXTENSION DUE @ 9:10AM**)
➔ FINAL PAPER PRESENTATIONS