

ANG5420: Social Network Analysis

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Social Network Analysis (SNA) is a set of analytical methods and theories that study the pattern of relations among actors. Actors can be individuals or collective units (households, organizations, nations). Relations can be interactions (“A talks with B”), flows (“A gives advice to B”), social roles (“A and B are coworkers”), common affiliations (“A is in the same church as B”), etc. Social networks are everywhere and play a role in substantive problems that cut across many subjects and disciplines. Any research problem that involves actors who have relations with each other, and relations that can be observed and measured, may benefit from Social Network Analysis.

There are two distinct types of Social Network Analysis. “Sociocentric” SNA studies “whole networks” that exist among all actors within a group. The group may be a club, a classroom of children, a rural village, or the executive board of a Fortune 500 company. The focus of sociocentric studies is the structure of relations within the group, and its association with individual or group outcomes. On the other hand, “egocentric” SNA studies “personal networks” that consist of people (Alters) linked to a central individual (Ego). Typically, respondents (Egos) are presented with questions or cues that elicit the names of people they know (Alters). These data are then analyzed by summarizing the characteristics of respondents’ personal networks, and correlating them with individual characteristics of the respondents themselves. Egocentric SNA has been used to study topics such as social support networks and mental health, the relationship between immigrants’ personal networks and assimilation, or the link between IV drug use and the transmission of HIV.

In this course you will be introduced to the research methods and theoretical approaches used in both types of Social Network Analysis. This will be a hands-on course where you will learn how to collect social network data, how to input them into the appropriate software and how to analyze them. By the end of the course you will have a good idea about how to apply SNA into your own work.

Readings and materials

Throughout the semester I will assign articles to be discussed in class. All readings and assignment materials will be distributed via [this web page](#). I am not going to assign a textbook for this class, however there are some books you might find helpful:

- [Wasserman, S., & Faust, K. \(1994\). Social Network Analysis: Methods and Applications](#). A classic, essential textbook on SNA.
- [Hanneman, R. \(2005\) Introduction to Social Networks](#). A free online textbook, a very good introduction to social network concepts, and a tutorial for the popular Windows SNA program UCINET.
- [Scott, J., & Carrington, P. J. \(2011\). The Sage Handbook of Social Network Analysis](#). A collection of essays on models, topics and applications in SNA.
- [Valente, T. W. \(2010\). Social Networks and Health: Models, Methods, and Applications](#). A recent textbook with emphasis on SNA applications in health.
- [Carrington, P., Scott, J., & Wasserman, S. \(Eds.\). \(2005\). Models and methods in social network analysis](#). More developments in SNA models and methods.
- [Borgatti, S. P., Everett, M. G., & Johnson, J. C. \(2013\). Analyzing social networks](#). A recently published handbook on how to do SNA research.
- [Freeman, L. C. \(2004\). The development of social network analysis: a study in the sociology of science](#). A small popular book on the history of SNA.

Software

You will be required to use some software in this course, therefore all students must have a laptop. If you have a Mac, it must be able to run Windows software. If it cannot, you will have to find a Windows laptop that you can use. The software programs we will use are [UCINET](#), [Egonet](#), [VennMaker](#), [Visone](#), and the [R programming language](#).

UCINET is perhaps the most popular program for Social Network Analysis. However, it only runs on Windows: to run it on a Mac, you need a virtual machine or a Windows partition. A complete version of UCINET can be downloaded [here](#)

and freely used for 60 days. After this trial time, you will need to register your copy to use it (\$40).

Egonet is a program for the collection and analysis of egocentric network data. It is Java-based and cross-platform, that is, it runs on multiple operating systems including Windows and Mac OS. It is available for free from [Sourceforge](#), and to run it you must install [Java](#), which is also free. **VennMaker** is also a cross-platform program for the collection and analysis of egocentric network data. You can download a free trial version [here](#). The trial version is time-limited and does not allow the export of network data.

Visone is a free Java-based program for the input, analysis and visualization of social networks. It is cross-platform and you can download it [here](#).

R is not a program, it is a programming language. However, unlike other programming languages, it was specifically designed for data analysis and statistical modeling, and it is becoming increasingly popular for quantitative analysis in the social sciences as well as other disciplines. R is free and open-source, a characteristic that makes it always updated and cutting-edge, since its user community constantly contributes to it by adding more functions and packages. An increasing number of packages for SNA are available in R. You can freely download R [here](#). The main R packages for SNA that we will use in this course are [igraph](#), [Statnet](#), and [RSiena](#): you will learn how to download and install them in class. You may also want to download [RStudio](#), a popular Graphical User Interface for R.

Please make sure you visit the web pages linked above and install UCINET, Egonet, VennMaker, Visone and R. If you encounter problems, [contact me](#). During the first class, we will look at how to set up these programs once installed, and check that everyone is able to run them.

Schedule

Each class will be divided in two parts, a lecture and a lab. Labs will be devoted to the collection of network data, and to data analysis using the software programs mentioned above. Among the readings for each class, articles are always required. Textbook chapters are only required if marked by an asterisk (*).

Grading will mostly be based on homework assignments and a final proposal. The final proposal will incorporate the concepts we learned in class applied to your own work. This should be a ten page NSF style proposal. My office hours are by appointment –just [email me](#).

The following schedule is a guide.

Outline

January 9 th	Overview, mathematical foundations of SNA	Introductions. SNA history and resources. Mathematical foundations. Whole vs personal networks, one-mode vs two-mode network data.
January 16 th	Basic network metrics, two-mode networks	Basic metrics and definitions. Centrality and centralization. Key players. Two-mode networks.
January 23 rd	SNA research designs, network data collection (part 1)	Sociocentric and egocentric designs. Collecting network data (1).
January 30 th	Network data collection (part 2), network visualizations	Collecting network data (2). Informant accuracy. Network visualizations.
February 6 th	Cohesive subgroups	Cohesive subgroups, definitions and algorithms. Core/periphery structures.
February 13 th	Equivalence and blockmodeling	Equivalence. Blockmodeling.
February 20 th	Social capital and structural holes	Social capital. Structural holes, theory and measures. Position generators.
February 27 th	Egocentric networks	Egocentric design and applications.
March 13 th	The NSUM method, qualitative approaches	The Network Scale-Up Method. Qualitative approaches and mixed methods.
March 20 th	Network theorizing, SNA and social theory	Is SNA theory or methodology? Network theories and theories of networks. SNA and social theory.
March 27 th	Hypothesis testing, regression, QAP	Network metrics in regression models. QAP. Missing data
April 3 rd	Exponential Random Graph Models (ERGMs), Siena	ERGM. Siena.
April 10 th	Presentations and discussion	
April 17 th	Presentations and discussion	

1 January 9th Overview, mathematical foundations of SNA

Topics:

- Introductions —Each student will describe their interests and possible uses of SNA in their research.
- Overview of SNA: history and resources.
- Mathematical foundations: matrices and graph theory.
- Whole versus personal networks, one-mode versus two-mode network data.

Lab:

- Getting software installed.
- Collecting one-mode network data for class.
- UCINET and Netdraw: uploading data and visualizing networks.

Homework:

One-mode network assignment with UCINET.

Materials:

Articles:

Borgatti, S. P., Mehra, A., Brass, D. J., & Labianca, G. (2009). Network analysis in the social sciences. *Science*, 323(5916), 892-895.

Granovetter, M. (1990). The myth of social network analysis as a special method in the social sciences. *Connections*, 13(1-2), 13-16.

Marsden, P. V. (1990). Network data and measurement. *Annual review of sociology*, 16, 435-463.

Radcliffe-Brown, A. R. (1940). On social structure. *Journal of the Royal Anthropological Society of Great Britain and Ireland*, 70, 1-12.

Textbook chapters:

* Wasserman and Faust, Ch. 1.

Scott and Carrington, Ch. 2-3.

2 January 16th Basic network metrics, two-mode networks

Topics:

- Basic network metrics and definitions.
- Centrality and centralization.
- Key players.
- Two-mode networks.

Lab:

- Collect two-mode data from class.
- Input two-mode data into UCINET.
- UCINET and Netdraw: basic metrics and centrality measures.

Homework:

Two-mode network assignment with UCINET.

Materials:

Articles:

Borgatti, S. P. (2006). Identifying sets of key players in a social network. *Computational & Mathematical Organization Theory*, 12(1), 21–34.

Borgatti, S. P., Carley, K. M., & Krackhardt, D. (2006). On the robustness of centrality measures under conditions of imperfect data. *Social Networks*, 28(2), 124–136.

Borgatti, S. P., & Everett, M. G. (1997). Network analysis of 2-mode data. *Social Networks*, 19(3), 243–269.

Costenbader, E., & Valente, T. W. (2003). The stability of centrality measures when networks are sampled. *Social Networks*, 25(4), 283–307.

Freeman, L. C. (1978). Centrality in social networks. Conceptual clarification. *Social Networks*, 1(3), 215–239.

Pitts, F. R. (1978). The medieval river trade network of Russia revisited. *Social Networks*, 1(3), 285–292.

UCINET Quick Guide, available [here](#).

Textbook chapters:

Wasserman and Faust, Ch. 3-4.

Scott and Carrington, Ch. 23, 28.

3 January 23rd SNA research designs, network data collection (part 1)

Topics:

- Sociocentric and egocentric research designs.
- Collecting network data (part 1).

Lab:

Data analysis with R:

- Starting R, installing packages.
- Getting help.
- Using the console versus writing scripts.
- Creating, loading and saving objects.

Homework:

Centrality assignment with UCINET.

Materials:

Articles:

Bernard, H. R., Killworth, P., Kronenfeld, D., & Sailer, L. (1984). The problem of informant accuracy: The validity of retrospective data. *Annual Review of Anthropology*, 13, 495–517.

Brewer, D. D. (2000). Forgetting in the recall-based elicitation of personal and social networks. *Social Networks*, 22(1), 29–43.

Marsden, P. V., & Campbell, K. E. (1984). Measuring tie strength. *Social Forces*, 63(2), 482–501.

McCarty, C., Killworth, P. D., & Rennell, J. (2007). Impact of methods for reducing respondent burden on personal network structural measures. *Social Networks*, 29(2), 300–315.

Textbook chapters:

Wasserman and Faust, Ch. 2.

Scott and Carrington, Ch. 25.

4 January 30th Network data collection (part 2), network visualizations

Topics:

- Collecting network data (part 2).
- Informant accuracy.
- Network visualizations.

Lab:

Data analysis with R:

- Arithmetic and logical operations.
- Types of data, data management.
- Importing and exporting (network) data.

Homework:

R homework: creating objects, doing basic operations, loading and editing data.

Materials:

Articles:

Freeman, L. C. (2000). Visualizing social networks. *Journal of social structure*, 1(1), 4.

McCarty, C., Molina, J. L., Aguilar, C., & Rota, L. (2007). A comparison of social network mapping and personal network visualization. *Field Methods*, 19(2), 145–162.

McGrath, C., Blythe, J., & Krackhardt, D. (1997). The effect of spatial arrangement on judgments and errors in interpreting graphs. *Social Networks*, 19(3), 223–242.

Textbook chapters:

Scott and Carrington, Ch. 37.

Hanneman, Ch. 4.

5 February 6th Cohesive subgroups

Topics:

- Cohesive subgroups, bottom-up and top-down approaches.
- Core/periphery structures.

Lab:

Data analysis with R:

- Base graphics.
- ggplot2 graphics

Homework:

Visualize data sets.

Materials:

Articles:

Borgatti, S. P., Everett, M. G., & Shirey, P. R. (1990). LS sets, lambda sets and other cohesive subsets. *Social Networks*, 12(4), 337–357.

Newman, M. E. J., & Girvan, M. (2004). Finding and evaluating community structure in networks. *Physical Review E*, 69(2), 026113–1 – 026113–15.

Textbook chapters:

* Hanneman, Ch. 11.

* Valente, Ch. 6.

6 February 13th Equivalence and blockmodeling

Topics:

- Equivalence, notions and measures.
- Blockmodels.

Lab:

Data analysis with R:

- Programming and control structures.
- Defining functions.
- The `apply` family of functions.

Homework:

R homework: defining functions, running them on multiple arguments with loops, running them on multiple arguments with functions in the `apply` family.

Materials:

Articles:

Borgatti, S. P., & Everett, M. G. (1992). Graph colorings and power in experimental exchange networks. *Social Networks*, 14(3-4), 287-308.

Burt, R. S. (1987). Social contagion and innovation: Cohesion versus structural equivalence. *American Journal of Sociology*, 92(6), 1287-1335.

Faust, K., & Wasserman, S. (1992). Blockmodels: Interpretation and evaluation. *Social Networks*, 14(1-2), 5-61.

Lorrain, F., & White, H. C. (1971). Structural equivalence of individuals in social networks. *The Journal of Mathematical Sociology*, 1(1), 49-80.

White, H. C., Boorman, S. A., & Breiger, R. L. (1976). Social Structure from Multiple Networks. I. Blockmodels of roles and positions. *American Journal of Sociology*, 81(4), 730-780.

Textbook chapters:

* Wasserman and Faust, Ch. 9.

Wasserman and Faust, Ch. 10, 12.

Scott and Carrington, Ch. 29.

7 February 20th Social capital and structural holes

Topics:

- Social capital, notions and measures.
- Structural holes, Burt's measures.
- Position generators.

Lab:

Data analysis with R:

- SNA with R: `igraph` and `statnet`.

Homework:

Load and visualize networks in R.

Materials:

Articles:

Burt, R. S. (2001). Structural holes versus network closure as social capital. In N. Lin & K. S. Cook (Eds.), *Social Capital: Theory and Research* (pp. 31–56). New Brunswick, NJ: Transaction Publishers.

Burt, R. S. (2004). Structural holes and good ideas. *American Journal of Sociology*, 110(2), 349–399.

Coleman, J. S. (1988). Social capital in the creation of human capital. *The American Journal of Sociology*, 94, S95–S120.

Granovetter, M. S. (1973). The strength of weak ties. *The American Journal of Sociology*, 78(6), 1360–1380.

Lin, N. (1999). Building a network theory of social capital. *Connections*, 22(1), 28–51.

Portes, A. (1998). Social Capital: Its origins and applications in modern sociology. *Annual Review of Sociology*, 24, 1–24.

Textbook chapters:

Scott and Carrington, Ch. 9.

8 February 27th Egocentric networks

Topics:

- Egocentric SNA, design and applications.

Lab:

- Egonet.

Homework:

Do your own 45-alter network and exchange networks with partner.

Materials:

Articles:

Lubbers, M. J., Molina, J. L., & McCarty, C. (2007). Personal networks and ethnic identifications. The case of migrants in Spain. *International Sociology*, 22(6), 721–741.

McCarty, C., Bernard, H. R., Killworth, P. D., Shelley, G. A., & Johnsen, E. C. (1997). Eliciting representative samples of personal networks. *Social Networks*, 19(4), 303–323.

Tucker, J., Kennedy, D., Ryan, G., Wenzel, S., Golinelli, D., Zazzali, J., & McCarty, C. (2009). Homeless women's personal networks: Implications for understanding risk behavior. *Human Organization*, 68(2), 129–140.

Wellman, B., & Wortley, S. (1990). Different strokes from different folks: Community ties and social support. *The American Journal of Sociology*, 96(3), 558–588.

Textbook chapters:

* Valente, Ch. 4.

Scott and Carrington, Ch. 8.

9 March 13th The NSUM method, qualitative approaches

Topics:

- The Network Scale-Up Method.
- Qualitative approaches and mixed methods in SNA.

Lab:

- Vennmaker.
- Present each other's personal networks.
- Look at ego-network data across class in R.

Homework:

Upload and batch process multiple personal networks with R.

Materials:Articles:

Bernard, H. R., Hallett, T., Iovita, A., Johnsen, E. C., Lyerla, R., McCarty, C., ... Stroup, D. F. (2010). Counting hard-to-count populations: The network scale-up method for public health. *Sexually Transmitted Infections*, 86(Suppl 2), ii11–ii15.

Hill, R. A., & Dunbar, R. I. M. (2003). Social network size in humans. *Human Nature*, 14(1), 53–72.

Killworth, P. D., McCarty, C., Bernard, H. R., Shelley, G. A., & Johnsen, E. C. (1998). Estimation of seroprevalence, rape, and homelessness in the United States using a social network approach. *Evaluation Review*, 22(2), 289–308.

Small, M. L. (2009). How many cases do I need? On science and the logic of case selection in field-based research. *Ethnography*, 10(1), 5.

Textbook chapters:

Scott and Carrington, Ch. 27.

10 March 20th Network theorizing, SNA and social theory

Topics:

- Is SNA theory or methodology?
- Network theories and theories of networks.
- SNA and social theory.

Lab:

- Visone.

Homework:

Draw and analyze networks in Visone.

Materials:

Articles:

Boissevain, J. (1979). Network analysis: A reappraisal. *Current Anthropology*, 20(2), 392–394.

Butts, C. T. (2009). Revisiting the foundations of network analysis. *Science*, 325(5939), 414–416.

Erikson, E. (2013). Formalist and relationalist theory in social network analysis. *Sociological Theory*, 31(3), 219–242.

Wellman, B. (1997). Structural Analysis: From method and metaphor to theory and substance. In B. Wellman & S. D. Berkowitz (Eds.), *Social structures: a network approach* (pp. 19–61). Cambridge: Cambridge University Press.

Textbook chapters:

* Scott and Carrington, Ch. 4.

11 March 27th Hypothesis testing, regression, QAP

Topics:

- Using network metrics in regression models.
- QAP and hypothesis testing.
- Missing data.

Lab:

- Cohesive subgroups and hypothesis testing in UCINET.

Homework:

Cohesive subgroups and egocentric metrics in R.

Materials:

Articles:

Kossinets, G. (2006). Effects of missing data in social networks. *Social Networks*, 28(3), 247–268.

Krackhardt, D. (1992). A caveat on the use of the quadratic assignment procedure. *Journal of Quantitative Anthropology*, 3(4), 279–296.

Textbook chapters:

* Hanneman, Ch. 18.

12 April 3rd Exponential Random Graph Models (ERGMs), Siena

Topics:

- ERGM.
- Siena.

Lab:

Data analysis with R:

- ERGM with the statnet suite of packages.

Homework:

Estimate ERGMs with Statnet.

Materials:

Articles:

Faust, K., & Skvoretz, J. (2002). Comparing networks across space and time, size and species. *Sociological Methodology*, 32(1), 267–299.

Lubbers, M. J., Molina, J. L., Lerner, J., Brandes, U., & Ávila, J. (2009). Longitudinal analysis of personal networks. The case of Argentinean migrants in Spain. *Social Networks*, 32(1).

Schaefer, D. R., Light, J. M., Fabes, R. A., Hanish, L. D., & Martin, C. L. (2010). Fundamental principles of network formation among preschool children. *Social Networks*, 32(1), 61–71.

Wimmer, A., & Lewis, K. (2010). Beyond and below racial homophily: ERG models of a friendship network documented on Facebook. *American Journal of Sociology*, 116(2), 583–642.

Textbook chapters:

Scott and Carrington, Ch. 32-33.

Valente, Ch. 9.

**13 April 10th Presentations and discussion of projects
from class**

**14 April 17th Presentations and discussion of projects
from class**