

SODA/SOC 497  
Spring 2023

## Applied Network Science

Tuesdays and Thursdays, 3:05-4:20 pm, Willard 067

### Instructor:

Daniel DellaPosta  
503 Oswald

Office Hours: Tuesdays and Thursdays 11:00 am-12:00 pm (or by appointment)

Contact: Canvas message (or [djd78@psu.edu](mailto:djd78@psu.edu))

### Teaching Assistant:

Yang Song

Office Hours Time: Wednesdays, 3-4 pm (or by appointment)

Office Hours Location: Zoom (see Canvas for link)

Contact: Canvas message (or [yangsong@psu.edu](mailto:yangsong@psu.edu))

### Course Overview and Goals:

The webs of social relationships around us—the social networks that we are part of—affect how we behave and think in fundamental ways. New and emerging sources of “big data” often contain traces of these social relationships that allow researchers and data scientists to answer fundamental questions about how things as different as smoking, social movement participation, political beliefs, and musical tastes can all spread contagiously through our social ties. Network science is a multidisciplinary perspective (drawing from sociology, mathematics, computer science, and other fields) that gives us both theoretical ideas and methodological tools for studying patterns of relationships and how they affect our behavior.

This course’s main **goal** is to give students the knowledge and skills needed to apply the tools of network science to answer social scientific questions, preparing students for future careers as data scientists or researchers. To accomplish these overarching goals, students will learn:

- What a *network* is, what *network science* is, and the types of questions that we can answer using the tools of network science
- How to *analyze network data* and calculate network statistics using R
- How to *apply network science reasoning* to explain specific aspects of human behavior in social, economic, and political contexts

## Course Pre-requisites:

Students taking this course will benefit from already having an understanding of introductory statistics (equivalent to the knowledge they would gain from PLSC 309 or STAT 200) and data science (equivalent to the knowledge they would gain from SODA 308). Some prior familiarity with R prior to taking this course would also be helpful. However, these are not absolute requirements, and students who do not satisfy one or more of these pre-requisites can still take the course if they have the willingness to learn and work hard to meet expectations.

## Course Expectations:

1. Attend classes and participate actively in group discussions and activities.
2. Complete assigned reading and any related homework for each session **before** coming to class. Arrive prepared to discuss the reading in detail.
3. Come to class prepared to carry out hands-on programming exercises using R (this means bringing a computer that already has R and RStudio installed on it).
4. Complete 4 mini-projects that require analyzing network data in R.
5. Complete take-home midterm and final exams.
6. Demonstrate willingness and ability to work with classmates when required; most research in network science is collaborative, and the ability to work collaboratively is a key skill.
7. Complete a group final project using knowledge and skills learned throughout the semester.

## Required Materials:

The **textbook** for this class is *Networks, Crowds, and Markets: Reasoning about a Highly Connected World* by David Easley and Jon Kleinberg. However, you do **not** need to purchase this book because it is freely available as an online resource through the Penn State Library. You can use this [link](#) to access the textbook and download PDFs of individual chapters.

Any other assigned readings besides those from the textbook will be available on Canvas.

Students will need a personal laptop with **R and RStudio** installed on it, and will need to bring this laptop to class. This software is free. Before the second week of class, please go to this [web site](#) and follow all instructions to download R and RStudio (note the different links for Mac and Windows systems).

Students should also enroll in **Top Hat**, which we will use for interactive lectures.

**Final Grades:**

A = 93.0-100%	A- = 90.0-92.99%
B+ = 87.0-89.99%	B = 83.0-86.99%
B- = 80.0-82.99%	C+ = 75.0-79.99%
C = 70.0-74.99%	D = 60.0-69.99%
F < 60.0 %	

**Graded Assessments:**

Attendance and Participation	10%
Reading-Based Homework Assignments	15%
Programming-Based R Mini-Projects	20%
Midterm Exam	20%
Final Exam	20%
Group Final Project	15%

**Assessment Breakdown:****1. Attendance and Participation**

- Since this class will involve group discussion and activities, students are expected to attend class and participate actively. In order to contribute to in-class discussion and activities, students will need to have completed the assigned reading **before** coming to class. This part of your grade will be based on my **overall assessment** at the end of the semester of both the quantity and quality of your contributions to class discussion and activities. Attending class is a pre-requisite for participating, and regularly missing classes will damage this portion of your grade; however, participation involves more than just attending. Participation also includes whether you come to class **prepared**—i.e. having already done the reading, responding to questions and discussions in a way that shows this preparedness, and being ready to take part in any in-class activities.

**2. Reading-Based Homework Assignments**

- During most weeks in which there is assigned reading from our textbook, there will also be a homework assignment accompanying that reading. Due dates for all such homework assignments can be found in the Course Outline below. These assignments will generally consist of one or a few short **questions or exercises** that will test your understanding of material from the textbook and in-class lectures. Assignment prompts will be made available at least one week before the assignment is due. All completed assignments must be uploaded to Canvas before the start of class on the due date in order to receive full credit. There will be 7 total homework assignments; each will be worth 3 points, and your 2 lowest assignment grades will be dropped.

**3. Programming-Based R Mini-Projects**

- During the semester, there will be a total of 4 additional assignments that will require using R to analyze network data and answer a set of questions. Due dates

for these programming “mini-projects” can be found in the Course Outline below. The mini-projects will test both your understanding of material from readings and lectures and your ability to **apply** this knowledge to analyze real data. Detailed prompts for each mini-project will be available at least one week before the due date. All completed assignments must be uploaded to Canvas before the start of class on the due date in order to receive full credit. Each of the 4 mini-projects will be worth 5 points.

#### 4. Midterm and Final Exams

- The midterm and final exams will cover material from lectures, readings, any activities done in class, and key points highlighted in class discussions. The exams will not be cumulative, although some key concepts from the first half of the semester will still remain relevant to material on the final exam. Both the midterm and final exam will be taken **remotely on Canvas**; students will have a 24-hour period in which they can choose to take the exam, but once they begin the exam they will only have 90 minutes to complete it. Accordingly, while students can use their notes while taking the exam, I still strongly recommend studying before beginning the exam.

#### 5. Group Final Project

- In the final weeks of the semester, students will work in groups to complete a final project. This project will involve analyzing a network data set in detail and presenting a thorough analysis of the network that makes use of key ideas and methods learned throughout the semester. Groups will report their findings in the form of an in-class presentation to take part in the final week of the semester. There will be time provided in class for groups to work together on their projects; however, there will also likely be a need for additional coordination among group members outside of that class time. More detailed instructions will be given in a separate prompt.

#### Other Policies and Resources:

- **Covid:** The course will be following [Penn State COVID-19 guidance for faculty and instructors](#).
- **Contacting Me or the TA:** If you have a general question regarding the class (for example, clarification about a due date or how to submit an assignment), please **post the question to the “General Questions” folder on the class Piazza** so that other students can also benefit from hearing the answer. When one student is confused, it is often the case that others are also confused and it will be helpful for us to have all of these questions and answers in one place. Either I or the TA will check the Piazza and answer questions at least once per day. If you have a **private question or concern**, you may contact me or the TA using Canvas message or email.
- **Attendance:** This is a course based on in-person instruction. Please note that instructors are **not** able to change the scheduled format of courses. As a result, you should not expect a remote option to be available as an alternative to in-person attendance

and participation. If you are not currently able to attend classes in person on the University Park campus, you should not take this course. You are expected to attend all scheduled sessions to the best of your ability. However, given the Covid situation, reasonable allowances can be made for absences due to illness. Missing one or two classes in such circumstances will not negatively impact your overall grade. If you are absent for a more extended period of time (i.e. more than 2 class sessions), you should get in touch with me in order to discuss your options for making up coursework. If you test positive for Covid, you are expected to follow all university requirements.

- **Due Dates:** Please make every effort to complete any assignments by the assigned dates and times. Unless otherwise noted in an assignment prompt and/or on Canvas, all assignments/projects are due before the start of class on the due date. If you contract an illness and are not able to complete coursework, please contact me by Canvas message so that we can discuss a plan for making up work. However, please note that you are **not** required or expected to share any personal health information with me.
- **Late Assignments:** All assignments should be completed by the assigned dates and times, barring unforeseen circumstances such as a serious illness or family emergency. Late assignments submitted up to 24 hours after the deadline will be graded with a **10% deduction** as a lateness penalty, and **additional 10% deductions** will apply for every additional day the assignment is late.
- **Responsibility for Missed Work:** Students are responsible for all missed work, regardless of the reason. Students are also responsible for regularly checking Canvas and this syllabus to make sure they are aware of due dates and other critical information about the course.
- **Office Hours:** You do not need to make an appointment to come to the scheduled office hours for myself or the course TA.
- **Academic Integrity:** Students with questions about academic integrity should visit [this site](#) and then click on “Academic Integrity.” Penn State defines academic integrity as “the pursuit of scholarly activity in an open, honest and responsible manner” (Senate Policy 49-20). Dishonesty of any kind will not be tolerated in this course. Dishonesty includes, but is not limited to, cheating, plagiarizing, fabricating information or citations, facilitating acts of academic dishonesty by others, having unauthorized possession of examinations, submitting work of another person or work previously used without permission from the instructor, or tampering with the academic work of other students. Students facing allegations of academic misconduct should not drop the course; those who do will be added to the course again and will be expected to complete course work and meet course deadlines. If the allegations are dismissed, then the drop will be permitted. Students found responsible for academic misconduct often receive academic sanctions, which can be severe, and put themselves at risk for disciplinary sanctions assigned by the University’s Office of Student Conduct (see Senate Policy G-9).
- **Disability Accommodation:** Penn State welcomes students with disabilities into the University’s educational programs. In order to receive consideration for reasonable

accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation. If the documentation supports your request for reasonable accommodations, your campus disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early as possible. You must follow this process for every semester that you request accommodations.

*Student Disability Resources:* 814-863-1807 (<http://equity.psu.edu/student-disability-resources/>)

- **Counseling and Psychological Resources:** Many students at Penn State face personal challenges or have psychological needs that may interfere with their academic progress, social development, or emotional wellbeing. The university offers a variety of confidential services to help you through difficult times, including individual and group counseling, crisis intervention, consultations, online chats, and mental health screenings. These services are provided by staff who welcome all students and embrace a philosophy respectful of clients' cultural and religious backgrounds, and sensitive to differences in race, ability, gender identity and sexual orientation.

*Counseling and Psychological Services (CAPS):* (814) 863-0395

(<http://studentaffairs.psu.edu/counseling/>)

*Penn State Crisis Line* (24 hours/7 days/week): 877-229-6400

*Crisis Text Line* (24 hours/7 days/week): Text LIONS to 741741

- **Educational Equity:** Penn State takes great pride to foster a diverse and inclusive environment for students, faculty, and staff. Acts of intolerance, discrimination, or harassment due to age, ancestry, color, disability, gender, gender identity, national origin, race, religious belief, sexual orientation, or veteran status are not tolerated and can be reported through Educational Equity via the Report Bias webpage (<http://equity.psu.edu/reportbias/>).

# Course Outline

*\*Subject to later change.*

*\*\*Unless otherwise noted, readings are from the Easley and Kleinberg text.*

<b>Week Of:</b>	<b>Content:</b>
Jan. 10	<b>Tuesday:</b> Review syllabus on Canvas <b>Thursday:</b> Read Chapter 1
Jan. 17	<b>Tuesday:</b> Read Chapter 2 (2.1-2.3) <b>Thursday:</b> Read “Network Analysis and Visualization with R and igraph” (1.1-1.11)
Jan. 24	<b>Tuesday:</b> Read Chapter 3 (3.1-3.3; 3.5), Chapter 4 (4.1) <b>Thursday:</b> Complete Homework Assignment 1
Jan. 31	<b>Tuesday:</b> Read “Network Analysis and Visualization with R and igraph” (2.1-4.2); work on Mini-Project 1 <b>Thursday:</b> Complete Mini-Project 1
Feb. 7	<b>Tuesday:</b> Read Chapter 5 (5.1-5.3), Chapter 12 (12.1) <b>Thursday:</b> Complete Homework Assignment 2
Feb. 14	<b>Tuesday:</b> Read Chapter 13 (13.1-13.4), Chapter 14 (14.1-14.3) <b>Thursday:</b> Complete Homework Assignment 3
Feb. 21	<b>Tuesday:</b> Read “Network Analysis and Visualization with R and igraph” (5.1-5.3); work on Mini-Project 2 <b>Thursday:</b> Complete Mini-Project 2
Feb. 28	<b>Tuesday:</b> No reading assignment; study for Take-Home Midterm <b>Thursday:</b> Complete Take-Home Midterm
Mar. 7	<b>SPRING BREAK – NO CLASS</b>
Mar. 14	<b>Tuesday:</b> Read Chapter 16 (16.1-16.2), Chapter 17 (17.1-17.2) <b>Thursday:</b> Complete Homework Assignment 4
Mar. 21	<b>Tuesday:</b> Read Chapter 18 (18.1-18.6) <b>Thursday:</b> Complete Homework Assignment 5

<b>Week of:</b>	<b>Content:</b>
Mar. 28	<p><b>Tuesday:</b> Read “Network Analysis and Visualization with R and igraph” (6.1-6.8); work on Mini-Project 3</p> <p><b>Thursday:</b> Complete Mini-Project 3</p>
Apr. 4	<p><b>Tuesday:</b> Read Chapter 19 (19.1-19.4)</p> <p><b>Thursday:</b> Complete Homework Assignment 6</p>
Apr. 11	<p><b>Tuesday:</b> Read “Network Analysis and Visualization with R and igraph” (7-9); work on Mini-Project 4</p> <p><b>Thursday:</b> Complete Mini-Project 4</p>
Apr. 18	<p><b>Tuesday:</b> Read Chapter 20 (20.1-20.4), Chapter 21 (21.1-21.2)</p> <p><b>Thursday:</b> Complete Homework Assignment 7</p>
Apr. 25	<p><b>Tuesday:</b> No reading assignment; work on Group Final Projects</p> <p><b>Thursday:</b> Complete and present Group Final Projects</p> <p><b>TAKE-HOME FINAL EXAM DUE DATE TBD</b></p>