



EN.500.111
HEART: Statistics and Data Science with Networks
Fall 2021 (1 credit)

Instructor

Joshua Agterberg, jagterberg@jhu.edu, jagterberg.github.io

Office: Clark 317b

Office hours: Immediately after class and by appointment

Meetings

Thursday, 5:00-6:15PM, Maryland 114

Recorded lectures can be accessed on the course Blackboard site

Textbook

N/A – Links to relevant papers will be posted to Blackboard and the course website:

Online Resources

Please log in to Blackboard for all materials related to this course. Links will also be posted to the course website.

Course Information

In this class we will survey how to use modern data science techniques to extract statistical insights from network data sets, such as social networks or citation graphs. Along the way, we will also introduce some methods in data science as needed, such as dimensionality reduction and clustering, and we will also cover implementations of these methods in Python or R. A primary theme of the course will be in exploring how network-specific problems such as community detection can be recast as classical statistical problems through dimensionality reduction.

Prerequisites – N/A

Course Goals

Specific Outcomes for this course are that

- Learn basic properties of network data and commonly used network datasets
- Learn how to analyze network data in a meaningful way
- Become familiar with state-of-the-art techniques in statistical network analysis

This course will address the following Criterion 3 Student Outcomes

- an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

- an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Course Topics

- **Week 1:** What are networks? What are some examples of network data? What are some network specific data science problems we might want to solve? Simple examples with data.
- **Week 2:** Basic graph theory and some common ways to represent networks, discussion of freely available network datasets and repositories.
- **Week 3:** Basic probability and statistics needed for the course.
- **Week 4:** Introduction to random graph models and their properties (Erdos-Renyi, Small-World Networks, Stochastic Blockmodels) with an emphasis on commonly used and interpretable models.
- **Week 5:** Network summary statistics from a single network observation (degree distributions, connected components, subgraph counts), simple methods for hypothesis testing and community detection, discussion of computational difficulties for big networks.
- **Week 6:** Data Science interlude: dimensionality reduction and clustering.
- **Week 7:** Network embedding techniques for community detection.
- **Week 8:** Network embedding techniques for hypothesis testing and estimation.
- **Week 9:** Methods to analyze multiple networks.
- **Week 10:** Open problems and future directions for statistical network analysis.

Course Expectations & Grading

Pass/Fail course – attendance and class participation are required (e.g., contributing to discussions, asking questions, and actively engaging in any way)

Assignments & Readings

Posted to Blackboard.

Ethics

The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition.

Report any violations you witness to the instructor. You may consult the associate dean of student conduct (or designee) by calling the Office of the Dean of Students at 410-516-8208 or via email at studentconduct@jhu.edu. You can find more information about university misconduct policies on the web at these sites:

- For undergraduates: <https://studentaffairs.jhu.edu/policies-guidelines/undergrad-ethics/>
- For graduate students: <https://homewoodgrad.jhu.edu/academics/policies/>

Personal Wellbeing

- Because of the ongoing COVID-19 pandemic special requirements will be in effect this term, and these may vary during the term. Please keep updated with these at the following sites:
 - University information: <https://covidinfo.jhu.edu/>
 - Whiting School of Engineering information: <https://engineering.jhu.edu/covid-19/>
- As of the start of the term all students, instructors and staff must complete health screening daily using the Prodensity app before coming to campus. **Masks must be worn properly at all times while in the classroom and other indoor spaces.** Vaccination is required unless an exception has been granted by the university for health or religious reasons. Periodic asymptomatic testing may be required. Please follow the university guidance faithfully.
- The Johns Hopkins COVID-19 Call Center (JHCCC), which can be reached at 443-287-8500 seven days a week from 7 a.m. to 7 p.m., supports all JHU students, faculty, and staff experiencing COVID-19 symptoms. Primarily intended for those currently within driving distance of Baltimore, the JHCCC will evaluate your symptoms, order testing if needed, and conduct contact investigation for those affiliates who test positive. More information on the JHCCC and testing is on the [coronavirus information website](#).
- If you are sick please notify me by email so that we can make appropriate accommodations should this affect your ability to attend class, complete assignments, or participate in assessments. The [Student Health and Wellness Center](#) is open and operational for primary care needs. If you would like to speak with a medical provider, please call 410-516-8270, and staff will determine an appropriate course of action. See also <https://studentaffairs.jhu.edu/student-life/student-outreach-support/absences-from-class/illness-note-policy/>
- All students with disabilities who require accommodations for this course should contact me at their earliest convenience to discuss their specific needs. If you have a documented disability, you must be registered with the JHU Office for Student Disability Services (101 Shaffer Hall; 410-516-4720; <http://web.jhu.edu/disabilities/>) to receive accommodations.
- Students who are struggling with anxiety, stress, depression or other mental health related concerns, please consider connecting with resources through the JHU Counseling Center. The Counseling Center will be providing services remotely to protect the health of students, staff, and communities. Please reach out to get connected and learn about service options based on where you are living this fall at 410-516-8278 and online at <http://studentaffairs.jhu.edu/counselingcenter/>.

- Student Outreach & Support helps students manage physical and mental health concerns, personal and family emergencies, financial issues, and other obstacles that may arise during their college experience. Students can self-refer or refer a friend who may need extra support or help getting connected to resources. To connect with SOS, please visit this website: <https://studentaffairs.jhu.edu/student-life/student-outreach-support/> or email deanofstudents@jhu.edu, call 410-516-7857, or students can schedule to meet with a Case Manager by visiting the Student Outreach & Support website and filling out a referral form online.

Classroom Climate

As your instructor, I am committed to creating a classroom environment that values the diversity of experiences and perspectives that all students bring. Everyone here has the right to be treated with dignity and respect. I believe fostering an inclusive climate is important because research and my experience show that students who interact with peers who are different from themselves learn new things and experience tangible educational outcomes. Please join me in creating a welcoming and vibrant classroom climate. Note that you should expect to be challenged intellectually by me, the TAs, and your peers, and at times this may feel uncomfortable. Indeed, it can be helpful to be pushed sometimes in order to learn and grow. But at no time in this learning process should someone be singled out or treated unequally on the basis of any seen or unseen part of their identity.

If you ever have concerns in this course about harassment, discrimination, or any unequal treatment, or if you seek accommodations or resources, I invite you to share directly with me or the TAs. I promise that we will take your communication seriously and to seek mutually acceptable resolutions and accommodations. Reporting will never impact your course grade. You may also share concerns with the AMS Head Fadil Santosa (fsantosa9@jhu.edu) the Director of Undergraduate Studies Donniell Fishkind (def@jhu.edu), the Assistant Dean for Diversity and Inclusion (Darlene Saporu, dsaporu@jhu.edu), or the Office of Institutional Equity (oie@jhu.edu). In handling reports, people will protect your privacy as much as possible, but faculty and staff are required to officially report information for some cases (e.g. sexual harassment).

Family Accommodations Policy

You are welcome to bring a family member to class on occasional days when your responsibilities require it (for example, if emergency child care is unavailable, or for health needs of a relative). In fact, you may see my children in class on days when their school is closed. Please be sensitive to the classroom environment, and if your family member becomes uncomfortably disruptive, you may leave the classroom and return as needed.

University Policy on Incompletes

The university recognizes that the Fall 2021 semester is surrounded with uncertainty and many students may find themselves in unexpected situations where study is difficult if not impossible. Students who are confronted with extraordinary circumstances that

interfere with their ability perform their academic work may request an incomplete grade from the instructor. While approval of such a request is not automatic, it is expected that faculty will make every effort to accommodate students dealing with illness in the family and other pandemic-related hardships. The instructor and student must establish a timetable for submitting the unfinished work with a final deadline no later than the end of the third week of the Spring 2022 semester. Exceptions to this deadline require a petition from the instructor to the student's academic advising office before this date. When entering an Incomplete grade in SIS, faculty must include a reversion grade which represents the grade the student will receive if they do not complete the missing work by the agreed-upon deadline.

Deadlines for Adding, Dropping and Withdrawing from Courses

Students may add a course up to **September 10, 2021**. They may drop courses up until **October 10, 2021** provided they remain registered for a minimum of 12 credits. Between **October 11** and **November 12, 2021**, a student may withdraw from a course with a W on their academic record. A record of the course will remain on the academic record with a W appearing in the grade column to indicate that the student registered and then withdrew from the course.

For more information on these and other academic policies, see <https://e-catalogue.jhu.edu/engineering/full-time-residential-programs/undergraduate-policies/academic-policies/grading-policies/>