Advanced Topics in Network Science (SSIE 641) - 3 credits

About the course

Networks are all around us, from the vast expanse of the Internet to the intricate web of social connections that we build in our daily lives. But networks aren't just limited to the human realm---they can be found in every corner of the natural world, such as the complex interactions between animals, proteins, viruses, and DNAs.

In recent years, we have witnessed remarkable advances in AI/ML and an ever-increasing volume and quality of data. Together, they offer an unprecedented opportunity to unlock the secrets of the world around us. This course is an introduction to network data analysis from the bottom up: through the interactions with network data and tools, we will learn how to store, manipulate, compute, and leverage network data in practice, as well as their underlying theoretical foundations.

When and where

- Wednesday 4:40-7:40 Eastern Time
- EB-J01

Course Objectives and Expected Student Learning Outcomes:

After completing this course, student will:

1. be able to interpret and evaluate modern network science literature, concepts, methodologies, tools, and recent research topics,
2. be able to conduct advanced network modeling, analysis and simulation using appropriate mathematical/computational means,
3. be able to design and conduct original research using network science methods and tools, and
4. be able to demonstrate integration of Systems Science and/or Industrial and Systems Engineering knowledge and techniques and advanced network modeling/analysis/ simulation skills in the form of a final project.

Communications

We use Slack for quicker informal communications, Q&A, team discussions, and other casual conversation. So join Slack if you haven't. Be sure to sign up with your BU email and join https://bu-adv-net-sci.slack.com. Feel free to NOT use your full name (e.g., "Jane D.")

Announcements will be sent via Brightspace and Slack. Many (but non-critical) course-related information will be shared on Slack. So you will miss a lot of information if you are not on Slack.

Prerequisite

- SSIE-523
- Python
- Basic understanding of mathematics and statistics

Faculty

- Dr. Sadamori Kojaku
- Assistant Professor, Department of Systems Science and Industrial Engineering
- Office hours: Tuesday 14:00 - 16:00 and Wednesday 13:00-16:00.
- Office location: EB-J19
- Zoom link: https://binghamton.zoom.us/my/skojaku.zoom
- skojaku@binghamton.edu

Teaching Assistant

TBD
Ph.D/MS student in Systems Science and Industrial Engineering

Reading materials

No text books are required for this course. The reading materials will be posted on the Brightspace for each topic.

Recommended readings

- Networks. Second Edition by Mark Newman. Oxford University Press. Full text is available online
- A First Course in Network Science by Menczer, Filippo, Santo Fortunato, and Clayton A. Davis. Cambridge University Press, 2020. Print. Cambridge, United Kingdom. link
- Clean Code: A Handbook of Agile Software Craftsmanship by Robert C. Martin. link

Course structure

To ensure active engagement and assess participation, In-Class quizzes will be given at the start of every class session. These quizzes serve as a tool for instructors to identify any misconceptions and offer timely feedback. Additionally, during each class meeting, students will be encouraged to engage in group discussions centered around network analysis, visualization, and their practical applications in scientific or engineering contexts. Homework assignments will provide hands-on exercises and will be made available on Brightspace and the course GitHub. The course will conclude with a final research project, which will involve a 10-min oral presentation (or recoded video in any format you prefer) and the submission of a final paper together with code to generate the results. Ideally, code will be in well-documented Jupyter notebooks (e.g. see Peter Norvig's notebooks or good Kaggle exploratory data visualization kernels)

Grading

Grade System:

- Attendance, Quiz, and Participation: 20%
- Assignments: 20%
- Exam: 30%
- Course project: 30%
- Credits: 3 credits

Grade Scheme:

Grade	Percentage
A	>= 90
A-	>= 85
B+	>= 80
B	>= 75
B-	>= 70
C+	>= 65
C	>= 60
C-	>= 55
F	< 55

Key date

- Project proposal due: 10/27
- Project final paper due: 12/04
- Presentation: 12/04
- Final exam: During the final week of the semester

Schedule

Academic Calendar - Academics | Binghamton University
Click here to view the academic calendar for Binghamton University. Including details for fall, winter, spring, and summer sessions.

Week	Date	Description
1	08/23	About the course & networks
2	08/30	Constructing & Manipulating network data
3	09/06	Collecting, Cleaning & Compiling network data and Data Ethics
4	09/13	Visualization Basics
5	09/20	Network Visualization
6	09/27	Quantifying networks
7	10/04	Tidy data and Data Types
8	10/11	Link prediction
9	10/18	(fall break)
10	10/25	Random networks
11	11/1	Representation learning I: Graph spectra
12	11/8	Representation learning II: word2vec, node2vec
13	11/15	Representation learning III: Graph neural networks
14	11/22	(No class)
15	11/29	Final project presentation

Week	Date	Description
16	12/6	Final project presentation
17	12/13	Final exam

- As per University policy for Fall 2023, in-person attendance is required. The attendance is counted by the in-class quiz at the beginning of the class.
- No rounding-up requests will be granted.

Policies

1. *Be honest*. Don't be a cheater. Your assignments and papers should be your own work. If you find useful resources for your assignments, share them and cite them. If your friends helped you, acknowledge them. You should feel free to discuss both online and offline (except for the exam), but do not show your code directly. Any cases of academic misconduct (cheating, fabrication, plagiarism, etc) will be reported to the School and the Dean of Students, following the standard procedure. Cheating is not cool.

2. *Attendance*. If you are not able to attend the class in persons, please request us the excuse over emails one day before the class. We may not accept the excuses for reasons other than illness, accidents, job interviews, and conference travels. If you are not able to attend in person for more than two weeks due to illness or some other legitimate reason, please request us over emails to determine an acceptable accommodation.

3. *Credit hours*. **This course is a 3-credit course**, which means that in addition to the scheduled lectures/discussions, students are expected to do at least 6.5 hours of course-related work each week during the semester. This includes things like: completing assigned readings, participating in lab sessions, studying for tests and examinations, preparing written assignments, completing internship or clinical placement requirements, and other tasks that must be completed to earn credit in the course.

4. *Generative AI*. You may use artificial intelligence tools as learning aids for understanding of course materials. However, the final submitted assignment must be original work produced by the individual student alone. If the part of the assignments are produced by generative AIs, you must indicate the generated parts and cite the source AIs. Refer to this format guideline: https://style.mla.org/citing-generative-ai/

5. *Data backup*. You have the responsibility of backing up all your data and code. Always back up your code and data. You should at least use Google Drive or Dropbox at the minimum. You can also use cloud services like Google Colaboratory. Ideally, learn version control systems and use https://github.com. Loss of data, code, or papers (e.g. due to malfunction of your laptop) is not an acceptable excuse for delayed or missing submission.

6. Binghamton University's Graduate Academic Consultants can help you with projects in this course. This a free service. https://www.binghamton.edu/grad-school/academic-support/graduate-academic-consultants/

7. *Disabilities*. Every attempt will be made to accommodate qualified students with disabilities (e.g. mental health, learning, chronic health, physical, hearing, vision, neurological, etc.). You must have established your eligibility for support services through Services for Students with Disabilities. Note that services are confidential, may take time to put into place, and are not retroactive. The office is located in the University Union, room 119. Captions and alternate media for print materials may take three or more weeks to get produced. Please contact Disability Services for Students at https://www.binghamton.edu/ssd/index.html or 607-777-2686 as soon as possible if accommodations are needed.

8. *Bias-based incidents*. Any act of discrimination or harassment based on race, ethnicity, religious affiliation, gender, gender identity, sexual orientation, or disability can be reported at https://www.binghamton.edu/diversity-equity-inclusion/reportbias.html or to the Binghamton University Affirmative Action Officer at 607-777-4775.

9. *Sexual misconduct and Title IX*. Title IX and BU's Sexual Harassment Policy regard any form of sexual harassment as a violation of the standards of conduct required of all persons associated with the institution. If you have experienced sexual misconduct or know someone who has, you can ask support from the University Counseling Center at 607-777-2772 (counseling, advocacy, and advice services). It is also important that you know that Title IX and University policy require me to share any information brought to my attention about potential sexual misconduct with the campus Deputy Title IX Coordinator or BU's Title IX Coordinator. In that event, those individuals will work to ensure that appropriate measures are taken and resources are made available. Protecting student privacy is of utmost concern, and information will only be shared with those that need to know to ensure the University can respond and assist. Visit https://www.binghamton.edu/counseling/resources/faculty/assault.html and https://www.binghamton.edu/services/title-ix/index.html to learn more.

10. *Mental health*. If you are experiencing undue personal or academic stress at any time during the semester or need to talk with someone about a personal problem or situation, you are encouraged to seek support as soon as possible. The instructor is available to talk with you about stresses related to your work in class. Additionally, you can reach out to any one of a wide range of campus resources, including
    - Dean of Students Office: 607-777-2804
    - Decker Student Health Services Center: 607-777-2221
    - University Police: On campus emergency, 911
    - University Counseling Center: 607-777-2772
    - Interpersonal Violence Prevention: 607-777-3062
    - Watson Advising: 607-777- 6203
    - Office of International Student & Scholar Services:607-777-2510