

Advanced Topics in Network Science (SSIE 641)

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.

Course objectives

You will learn how to organize, manipulate, and analyze network data using visualization techniques and basic statistics. Participants are expected to understand and explain how to define a network, visualize network data, use basic statistics, and rank & cluster nodes. They will also learn how to incorporate non-network data using graph neural networks. Furthermore, the course covers data ethics, privacy, and bias in network data and algorithms.

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 course-related information will be shared on Slack. So you will miss a lot of information if you are not on Slack.

Prerequisite

- Python
- Basic understanding of mathematics and statistics

Grading

- Attendance, Quiz, and Participation: 20%
- Assignments: 20%
- Exam: 30%
- Course project: 30%
- Credits: 3 credits
- Grading: Normal grading; A through F

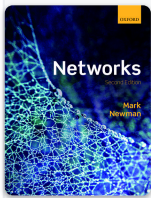
Readings

- **A First Course in Network Science: Menczer, Filippo, Fortunato, Santo, Davis, Clayton A.: 9781108471138: Amazon.com: Books**

Buy A First Course in Network Science on Amazon.com ✓ FREE SHIPPING on qualified orders

- **Clean Code: A Handbook of Agile Software Craftsmanship: Robert C. Martin: 9780132350884: Amazon.com: Books**

Clean Code: A Handbook of Agile Software Craftsmanship [Robert C. Martin] on Amazon.com. *FREE* shipping on qualifying offers. Clean Code: A Handbook of Agile Software Craftsmanship



Networks

The study of networks, including computer networks, social networks, and biological networks, has attracted enormous interest in the last few years. The rise of the Internet and the wide availability of inexpensive computers have made it possible to gather and analyze network data on an unprecedented scale, and the development of new theoretical tools has allowed us to extract knowledge from networks of many different kinds.

Final project

You will need to submit your code and a report on your work. Ideally, your code will be in well-documented Jupyter notebooks (e.g. see [Peter Norvig's notebooks](#) or good Kaggle exploratory data visualization kernels). Also, you will create a 10-minute video (please adhere to the time limit) and upload it to YouTube. You have the option to either publish it or make it unlisted. The video can be in any format you prefer.

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 1: 08/23 About the course & networks
- Week 2: 08/30 Constructing & Manipulating network data

- Week 3: 09/06 Collecting, Cleaning & Compiling network data and Data Ethics
- Week 4: 09/13 Visualization Basics
- Week 5: 09/20 Network Visualization
- Week 6: 09/27 Quantifying networks
- Week 7: 10/04 Tidy data and Data Types
- Week 8: 10/11 Link prediction
- Week 9: 10/18 (fall break)
- Week 10: 10/25: Random networks
- Week 11: 11/1 Representation learning I: Graph spectra
- Week 12: 11/8 Representation learning II: word2vec, node2vec
- Week 13: 11/15 Representation learning III: Graph neural networks
- Week 14: 11/22 (No class)
- Week 15: 11/29 Final project presentation
- Week 16: 12/6 Final project presentation
- Week 17: 12/13 (12/08) Final examination

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. 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.
3. 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.iu.edu> or <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.
4. 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. 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.
5. 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.
6. 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.

7. If you have any mental health issues, don't hesitate to contact BU's [University Counseling Center](#), which provides free counseling sessions. Also, please contact Disability Services for Students at [Services for Students with Disabilities](#) or 607-777-6893 as soon as possible if accommodations are needed.
8. You may use artificial intelligence tools for creating an outline for an assignment, but the final submitted assignment must be original work produced by the individual student alone.

Resources:

- **Virtual Computing | Thomas J. Watson College of Engineering and Applied Science | Binghamton University**

Two virtual desktop environments available on campus.