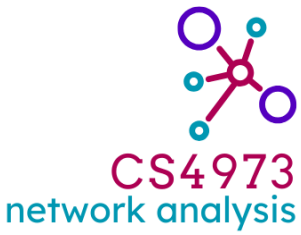

Mon, Wed, Thu, 1:35 pm - 2:40 pm, Dodge Hall 430

Instructor: Raj Venkat
Email: r.venkatesaramani@northeastern.edu
Office: Meserve 303

Course Webpage: venkat.prof/CS4973
Online Support & Discusssions: Campuswire (Group join code 6182)
Submissions: Gradescope (See individual HW instructions)

Contents

1 Overview

1.1 Course Description

This course explores network analysis, a cross-disciplinary field that studies the structure and dynamics of complex systems. The course will cover the mathematical concepts of graph theory including the study of network structure, information flow dynamics and the processes through which we model the evolution of networks over time. The course will also introduce students to state-of-the-art tools and software used for network analysis, with a focus on efficiently processing very large graphs. The syllabus covers:

- Graph theory & mathematical modeling
- Network measures
- Graph algorithms, proofs based on network structure
- Information propagation - ranking algorithms, epidemic models, viral marketing
- Community detection, and clustering algorithms
- Practical considerations - large graphs, efficient frameworks, and visualizations

1.2 Organization

In teaching a special topics course, I place a lot of emphasis on class participation. The goal is not for me to lecture at you for a whole semester. Rather, I think of this as an opportunity for you and me to discover new topics and applications and get familiar with the latest research in the field, together.

I expect students to come to class having gone through posted readings in advance. This will ensure that lecture time is used effectively to engage in deeper discussions and tailor the course to the class's interests. I will lecture in a somewhat traditional format for the first 2–3 weeks to cover the basic theory and set the pace, but will then transition to a more discussion-driven classroom.

Later in the semester, we will spend some time discussing research papers, where students will take turns leading these discussions. I expect you to come to these lectures prepared with summaries of your understanding of the paper (it is okay to not understand every detail - I'm here to help with that), some open questions, and perhaps some examples of related work that you may have found along the way.

1.3 Required Background

A strong background in linear algebra is recommended. We will be relying extensively on Python 3, learning many new packages; strong programming skills are a must.

1.4 Attendance Policies

While attendance is not formally recorded, in-class activities count toward 20% of your grade and are distributed throughout the semester. There is flexibility for occasional activities missed due to health concerns, emergencies, etc.; however, repeated or prolonged absence is bound to affect this portion of your grade.

Small classes are also an opportunity to work closely with your instructors, engage in deeper discussions, and receive personalized feedback to enhance your learning experience, and attendance is highly encouraged.

1.5 Support

In addition to being your instructor, I hope you also think of me as an advisor/mentor whom you can freely talk to for any reason[1]. I am open to questions about anything that has to do with your education, even if it does not strictly fall within the scope of CS4973. I strive to foster a nonjudgmental learning environment at all times, and I am never inconvenienced by a student reaching out for support.

1.6 Regrade Requests

Grading rubrics are designed with expected outputs and writing quality in mind. These rubrics are applied fairly and consistently across the class. Regrade requests are intended to address potential grading errors, and not as an avenue for negotiation. While effort is valuable, it is inherently subjective and varies greatly among students. There is no way for me to evaluate effort objectively. On the other hand, if there was an oversight in grading — such as missing points for a rubric item that your answer addressed, or if something was overlooked — please do not hesitate to submit a regrade request.

Please note that submitting a regrade request may result in the entire question being regraded from scratch by me. My experience often allows me to identify more nuanced mistakes that may have been overlooked during the initial round of grading. As a result, a regrade could lead to an increase in your score, but it could also result in a decrease if additional errors are found. I encourage you to carefully review your submission and the rubric before deciding to request a regrade.

1.7 Late Joiners

Please note that by joining the course late, you knowingly accept the responsibility of catching up on missed material and should not expect any preferential treatment or adjustments to deadlines. Please stop by my office hours, or book an appointment with me, and I will be more than happy to briefly review content and point you to the right resources.

[1] You should be aware that faculty are mandatory reporters at Northeastern. See section 4.2.

1.8 Textbook(s)

Network Science by Albert-László Barabási and Social Media Mining by Reza Zafarani, Mohammad Ali Abbasi and Huan Liu are my primary sources. These books are freely available online and are excellent introductory texts on network science.

If you are interested in developing a deeper mathematical understanding of graph theory, I highly recommend Introduction to Graph Theory by Douglas B. West. I would be happy to lend students my copy for a week at a time when I am not using it actively.

1.9 Tentative Plan

Tentative topics, slides, and readings will be posted on the the course website. Material will be updated as it is compiled during the semester.

This being a special topics course with a small class size, I have a lot of flexibility in course logistics. If there is a specific topic you would like me to cover, or work on a specific type of problem, please reach out to me, and I will happily tailor the course to your interests.

1.10 Software

We will use Python 3 for all programming assignments. These resources may be useful:

- Prof Felix Muzny's Computational Thinking in Python
- Learn Python 3

If you have limited or no Python experience, please reach out to me early in the semester. This will enable me to work with you and provide additional guidance in a timely manner.

1.11 Components & Grading

Grading will be based on the following split over deliverables:

- **3 Assignments, worth 30%**
- **Final Project, worth 50%**
  (proposal, progress report, final report and presentation)
- **In-class activities, worth 20%**
  (missing a total of 2-3 lectures is fine, prolonged absence will affect this grade)

For in-class activities, I will communicate participation expectations on a regular basis, as activities will vary. I will record a 'satisfactory' or 'unsatisfactory' level of participation for each student at the end of each of the 15 weeks in the semester. If no activities are held during a certain week, then class participation counts towards this score. At the end of the semester, I will drop the three lowest scores, and your remaining participation score will be normalized to be worth 10%. The remaining 10% will be graded based on the research paper discussion(s) you lead. I will lead the first discussion as an example.

Final Grades and Rounding Scheme

Final grades will be assigned based on the following scale (note open and closed intervals). Natural rounding will be used, i.e., percentages $\geq x.5$ get rounded up to the next integer, $x + 1$ (94.5 becomes 95, 94.4 does not).

A	[93, 100]
A-	[90, 93)
B+	[87, 90)
B	[82, 87)
B-	[80, 82)
C+	[77, 80)
C	[72, 77)
C-	[70, 72)
D	[62, 70)
D-	[60, 62)
F	[0, 60)

2 Class Policies

2.1 Homework Submissions & Grading

- All homework submissions and labs must be uploaded to Gradescope by 6:00 pm Eastern on the due date. Deadlines will typically be on a Friday. Written submissions must be in PDF format.
- All written solutions **must** be typed (i.e., no scans of handwritten assignments will be accepted). Scanned figures are only permitted where explicitly specified in the assignment instructions. Any such figures must be clear and perfectly legible.
- The use of LaTeX to typeset mathematical equations is highly encouraged. Overleaf is an excellent browser-based LaTeX editor with real-time compilation capabilities. Overleaf Professional is free to all Northeastern students.
- Discussions and collaborating on homework is encouraged! All I ask is that you disclose your collaborators, and write your solutions in your own words. Direct copying will, however, be treated as a violation of academic integrity and incur penalties.
- **Grading**: All grades will be released via Gradescope.
- **Regrade Requests**: All regrade requests must be submitted within 1 week of receiving your grade. Requests for all submissions must be submitted from within Gradescope. Requests submitted via email will almost certainly be missed.

2.2 Policy on the use of Generative AI

Generative AI may not be used to solve any assignments in this course. I also discourage relying on completion tools such as GitHub Copilot to get the most out of this course. Any indication of the use of generative AI in assignment submissions will be treated as an academic integrity violation, and penalties levied accordingly (see section below).

Generative AI tools, however, may be used to assist in understanding research papers - I often do this myself when a paper is overwhelming at first glance. Generative AI can help organize your reading by focusing on one section at a time, and acting as a ready reference for terms you may not be familiar with, with the following caveats:

a) You are expected to understand the content to a level where you can summarize and critique the paper, and contribute *meaningfully* to in-class discussions.

b) Be cautious of mistakes that gen AI tools may make in this process. Hallucinations are very commonplace when trying to use tools like ChatGPT with mathematically heavy content; sometimes, the outputs are brazen lies.

2.3 Academic Integrity

- Please familiarize yourself with Northeastern University's Academic Integrity Policy.
- Any discussions of assignment material held with classmates must be clearly disclosed in the submission by all parties.
- The use of generative AI should be limited to understanding research papers. Generative AI may not be used for assignments. See section 2.2.
- Any violation of academic integrity (as outlined by homework policies above) will result in the following penalties:
  - Academic penalties up to, and including, a grade of **F** for the course.
  - A report of the violation will be filed with OSCCR, where outcomes can range from warnings or academic probation to dismissal from the University.
- Recognize that most violations are easily avoided by simply acknowledging any difficulties you may be having with the course and seeking help from your professor in a timely fashion. We're here to help you learn.
- Remember that I was a student until not very long ago. I am happy to talk to you about any issues you may be facing, and offer you my support and guidance. However, it is imperative that these conversations happen in the absence of an academic integrity violation. Once a violation is identified, I will have no choice but to report it in the interest of fairness.

2.4 Late Policy

- Assignment and problem set deadlines will typically be on Fridays at 6:00 pm Eastern. Students will receive an automatic extension until Sunday 6:00 pm, without penalty. Deadlines for submissions related to the final project are absolute, and no extensions will be provided for those deliverables.
- Treat the automatic extensions as a fallback for genuine emergencies - assignments in this course will take a significant amount of time to complete due to high runtimes. I prioritize my personal life on the weekends, and will likely be very slow to respond during the extension period.
- Requests to submit assignments after the late deadline due to last-minute difficulties will be ignored. It is your responsibility to ensure that the correct files are properly uploaded, submitted, and reflected in Gradescope well in advance of the deadline.
- Beyond the automatic late deadline, I will not grant further extensions, except in the case of limited and verifiable emergency situations, or University and DRC-sanctioned accommodations. It is imperative that you communicate with me early on when circumstances permit.
- In case you are close to the late deadline, and feel that you will be unable to submit an assignment in time, please reach out to me. Depending on your circumstances, I may not be able to give you an extension, but I will certainly offer you the right resources to help you make the most of your assignment.

2.5 Classroom Environment

- Digital devices are permitted for note-taking purposes and to engage with course material such as lecture slides, or in-class activities as instructed. However, any use of laptops/tablets must not be disruptive to your classmates. No phones please.
- To create and preserve a healthy classroom atmosphere that facilitates teaching and learning, all participants share a responsibility in creating a civil, nonjudgmental, and non-disruptive forum for the discussion of ideas. Students are expected to conduct themselves at all times in a manner that does not disrupt teaching or learning.
- Your comments to others should be constructive and free from any harassing or disrespectful statements. You are welcome to disagree with other students and the instructor, but such disagreements need to be respectful, and based on facts, evidence and documentation (rather than prejudices and personalities).
- The instructor reserves the right to interrupt conversations that deviate from these expectations. Repeated unprofessional or disrespectful conduct will be treated as a violation of the Code of Student Conduct.

3 Office Hours

Campuswire is a Piazza alternative that we will be using as the class forum, and for online support. I will be very active on Campuswire throughout the semester. All course announcements will be posted on Campuswire.

My office hours will be right after class, every Monday, and I will be available for up to an hour. We can walk over to my office, Meserve Hall 303, if you wish to discuss anything with me in private - please let me know ahead of class time in such a situation so you are not forced to bring it up in front of your classmates.

Generally, it may be easier for us to just talk somewhere in or around Dodge Hall after class. Depending on my schedule, I may also be able to chat after class on some Wednesdays. Appointments outside these hours may be booked through my website.

4 Campus Resources

4.1 Healthcare, Counseling, and Wellness

Your health and well-being are paramount, above any and all course deliverables. There is a wide range of support services on campus to ensure your success, and I encourage you to reach out to these resources as appropriate. If I can help connect you, please don't hesitate to reach out to me!

- University Health and Counseling Services
- Find@Northeastern
- WeCare
- Support Groups and Workshops

4.2 Title IX

- Title IX of the Education Amendments of 1972 protects individuals from sex or gender-based discrimination, including discrimination based on gender identity, in educational programs and activities that receive federal financial assistance.
- Northeastern's Title IX Policy prohibits Prohibited Offenses, which are defined as sexual harassment, sexual assault, relationship or domestic violence, and stalking. The Title IX Policy applies to the entire community, including students, faculty, and staff of all genders.
- If you or someone you know has been a survivor of a Prohibited Offense, confidential support and guidance can be found through University Health and Counseling Services staff and Center for Spiritual Dialogue and Service clergy members. By

law, those employees are not required to report allegations of sex or gender-based discrimination to the University.

- Alleged violations can be reported non-confidentially to the Title IX Coordinator within The Office for University Equity and Compliance (OUEC) by either filling out the Discrimination Complaint Form, via email to the OUEC (less secure) at titleix@northeastern.edu and/or through NUPD (Emergency 617-373-3333; Non-Emergency 617-373-2121). Reporting Prohibited Offenses to NUPD does NOT commit the victim/affected party to future legal action.
- Faculty members are considered "responsible employees" at Northeastern, i.e., they are **required** to report all allegations of sex or gender-based discrimination to the Title IX Coordinator. Note that faculty are mandatory reporters, but not arbiters of situations that may arise. In case of an emergency, please call NUPD's emergency line (617-373-3333) or 911 as appropriate. Please visit the Title IX webpage for a complete list of reporting options and resources both on-campus and off-campus.

4.3 Disability Accessibility Services

Students with disabilities who wish to receive academic services and/or accommodations should visit Disability Accessibility Services at 20 Dodge Hall, or call 617-373-2675. If you have not already done so, please have the accommodations letter sent to me early in the semester so that I can best serve your needs.