CS514: Advanced Topics in Network Science

Fall, 2024

Course Objective

Networks and graphs have become an indispensable ingredient in a variety of data mining and machine learning problems with numerous applications. This course will provide an in-depth understanding of network science, graph mining algorithms, and their applications in a variety of real problems. It aims to provide a comprehensive and in-depth introduction of the fundamental principles and techniques of network science.

- Be able to understand the key concepts and underlying principles of network analysis techniques, including graph proximity, matrix and tensor, graph neural networks, graph connectivity, network of networks.
- Be able to apply the key network science techniques to realistic setting, evaluate and analyze the analysis results.

Basic Information

Class meeting: 3025 CIF, 9:30am – 10:45am W/F
Instructor: Hanghang Tong (htong@illinois.edu)
TA:

- Xinyu He (xhe34@illinois.edu)

Office Hours: Check Canvas for details (for enrolled students only)

Online resources:

- Canvas & Piazza (check Canvas for the link)

Schedule (Tentative, subject to slight adjustment)

- Lecture 1: Logistics & Introduction (week 1)
- Lecture 2: Graph Proximity (week 1)
- Lecture 3: Matrix & Tensors (weeks 2 & 3)
- Lecture 4: Graph Neural Networks: Basics (weeks 3 & 4)
- Lecture 5: Graph Anomaly Detection (weeks 4 & 5)
- Lecture 6: Graph Neural Networks: Beyond Homophily (weeks 5 & 6)
- Lecture 7: Graph Connectivity Optimization (weeks 7 & 8)
- Lecture 8: Network Alignment (weeks 8 & 10)
- Lecture 9: Fair Network Mining (week 11)
- Lecture 10: Network of Networks, Network of X (week 12)
- Lecture 11: Knowledge Graphs (week 13)
- Lecture 12: Graphs & LLMs (week 15)
- Lecture 13: Optimal Deep Graph Learning (week 16)

Coursework, Grading and Key Dates

- **Two assignments: 40%**
  - First assignment (15%): 8/30/2024 out; 9/20/2024 due
  - Second assignment (15%): 9/25/2024 out; 10/23/2024 due
  - Third assignment (10%): 11/1/2024 out; 12/11/2024 due
- **Class project: 30%**
  - Proposal (2%): due on 9/25/2024
  - Mid-term report (8%): due on 10/30/2024
  - Final report (20%): due on 12/4/2024
  - Individual project or group project (3 members at most per group)
- **Midterm exam: 30%**
  - Date: 9:30-10:45am CT, 10/25/2024
  - Location: 3025 CIF

Textbooks

No required textbook for this course. We will mainly use research papers and slides for lectures.
Reference:

- Jiawei Han, Jian Pei and Hanghang Tong, Data Mining: Concepts and Techniques (**4th ed**), Morgan & Claypool, 2022
- Charu C. Aggarwal, Data Mining: The Textbook, Springer, 2015
- P.-N. Tan, M. Steinbach and V. Kumar, Introduction to Data Mining, Wiley, 2005 (2nd ed. 2016)
- Mohammed J. Zaki and Wagner Meira Jr., Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2014

Mental Health

Diminished mental health, including significant stress, mood changes, excessive worry, substance/alcohol abuse, or problems with eating and/or sleeping can interfere with optimal academic performance, social development, and emotional wellbeing. The University of Illinois offers a variety of confidential services including individual and group counseling, crisis intervention, psychiatric services, and specialized screenings at no additional cost. If you or someone you know experiences any of the above mental health concerns, it is strongly encouraged to contact or visit any of the University's resources provided below. Getting help is a smart and courageous thing to do -- for yourself and for those who care about you.

Counseling Center: 217-333-3704, 610 East John Street Champaign, IL 61820

McKinley Health Center:217-333-2700, 1109 South Lincoln Avenue, Urbana, Illinois 61801

Sexual Misconduct Reporting Obligation

The University of Illinois is committed to combating sexual misconduct. Faculty and staff members are required to report any instances of sexual misconduct to the University's Title IX Office. In turn, an individual with the Title IX Office will provide information about rights and options, including accommodations, support services, the campus disciplinary process, and law enforcement options.

A list of the designated University employees who, as counselors, confidential advisors, and medical professionals, do not have this reporting responsibility and can maintain confidentiality, can be found here: wecare.illinois.edu/resources/students/#confidential.

Other information about resources and reporting is available here: wecare.illinois.edu.

Academic Integrity

The University of Illinois at Urbana-Champaign Student Code should also be considered as a part of this syllabus. Students should pay particular attention to Article 1, Part 4: Academic Integrity. Read the Code at the following URL: http://studentcode.illinois.edu/.

Academic dishonesty may result in a failing grade. Every student is expected to review and abide by the Academic Integrity Policy: https://studentcode.illinois.edu/article1/part4/1-401/. Ignorance is not an excuse for any academic dishonesty. It is your responsibility to read this policy to avoid any misunderstanding. Do not hesitate to ask the instructor(s) if you are ever in doubt about what constitutes plagiarism, cheating, or any other breach of academic integrity.

Religious Observances

Illinois law requires the University to reasonably accommodate its students' religious beliefs, observances, and practices in regard to admissions, class attendance, and the scheduling of examinations and work requirements. You should examine this syllabus at the beginning of the semester for potential conflicts between course deadlines and any of your religious observances. If a conflict exists, you should notify your instructor of the conflict and follow the procedure at https://odos.illinois.edu/community-of-care/resources/students/religious-observances/ to request appropriate accommodations. This should be done in the first two weeks of classes.

Disability-Related Accommodations

To obtain disability-related academic adjustments and/or auxiliary aids, students with disabilities must contact the course instructor and the Disability Resources and Educational Services (DRES) as soon as possible. To contact DRES, you may visit 1207 S. Oak St., Champaign, call 333-4603, e-mail disability@illinois.edu or go to https://www.disability.illinois.edu. If you are concerned you have a disability-related condition that is impacting your academic progress, there are academic screening appointments available that can help diagnosis a previously undiagnosed disability. You may access these by visiting the DRES website and selecting “Request an Academic Screening” at the bottom of the page.

Family Educational Rights and Privacy Act (FERPA)

Any student who has suppressed their directory information pursuant to Family Educational Rights and Privacy Act (FERPA) should self-identify to the instructor to ensure protection of the privacy of their attendance in this course. See https://registrar.illinois.edu/academic-records/ferpa/ for more information on FERPA.

Assuring Non-Hostile Work Environment

In order to assure a non-hostile work environment for course staff, we will strictly enforce the following policy for the future assessment, including exams, assignments and course project. Any assessment containing language that conventionally would be judged as obscene, threatening violence, or of a clearly derogatory nature will be given a 0 without further grading.

Statement on CS CARES and CS Values and Code of Conduct

All members of the Illinois Computer Science department - faculty, staff, and students - are expected to adhere to the CS Values and Code of Conduct. The CS CARES Committee is available to serve as a resource to help people who are concerned about or experience a potential violation of the Code. If you experience such issues, please contact the CS CARES Committee. The instructors of this course are also available for issues related to this class.