Network Science

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Time: Asynchronous
Location: Online
Office hours: See Canvas homepage for details.

Assistant Instructor
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COURSE DESCRIPTION

Network science is a unifying framework to study complex systems, such as living organisms, societies, and many techno-social systems. Therefore, understanding networks and network (graph) data is fundamental to numerous domains. This graduate-level course introduces the fundamental concepts as well as key applications of network science for a broad range of students. Topics include statistical properties and models of real-world networks, network data & algorithms, how information and diseases spread in our society, and machine learning with networks—e.g., community detection (clustering) and graph embedding.

Because *your* learning should be the primary focus, please engage actively by voicing your confusions, challenges, and intriguing digressions! Rather than merely watching lectures, think critically, engage in debates, and immerse yourself.

COURSE OBJECTIVES

By the end of the course, students are expected to be able to identify, construct, model, and analyze networks by choosing and applying appropriate methods and algorithms, as well as understanding ethical issues surrounding network data. Students are also expected to be able to explain, both mathematically and conceptually, the key network concepts, algorithms, models, and statistical properties, as well as their implications.

COMMUNICATION

We will use Canvas and Slack for communication. **Canvas** is for official announcements as well as for anything that contains private and sensitive information. **Slack** is a more casual space for everyone taking the course this semester. Although it is not required to use it, I'd highly recommend to use it. You can use it for sharing cool resources, Q&As, team discussions, and other casual conversations. AIs and I will be on Slack, so feel free to reach out anytime.

When joining the course Slack, feel free to avoid using your full name (e.g., use "John D." instead of "John Doe") to protect your privacy. Also never post your personal information or sensitive data (e.g., grades) anywhere outside Canvas or other approved IU services. The Slack site is:

https://iu-netsci-course.slack.com/ (sign up: https://iu-netsci-course.slack.com/signup)

You can create an account by using one of the following IU email addresses: `iu.edu`, `indiana.edu`, `umail.iu.edu`, `iupui.edu`. I can also invite you with any email address. If you have any issues joining Slack, please let me know.

In terms of getting a response, email (and thus Canvas) will tend to be slower than Slack because I'm under a constant bombardment of emails. Slack messages can bypass that. However, *if your communication contains any sensitive information*, you should use the official channels (emails or canvas messages), while you can still use slack to *notify me* about your email or canvas message.

Whenever you are not happy about the course or have a suggestion for improving the course, please share your thoughts! You can simply send a message to me, or anonymously share your opinion:

https://forms.gle/9XrnrBn9faARDAsm7

PREREQUISITES

Although there is no formal prerequisite, the course will assume that you already have basic working knowledge of mathematics (e.g., linear algebra and calculus), probability & statistics, programming (Python), algorithms, and data structure. If you do not have or are rusty with any of these foundations, there will be some reading materials that review necessary mathematical and computing concepts, as well as a notebook for reviewing basic Python programming. If you still do not feel ready, please talk to me or AIs so that we can provide resources that can help you learn and get prepared or catch up along the way.

A note for those without strong technical backgrounds Some course materials and assignments may present challenges if you do not have a strong technical background. That does *not* mean that you are not good enough or don't belong; it is completely natural and ok to feel this way! For context, despite majoring in Physics, my math proficiency was not very good and I struggled throughout. Much of what I teach in this class did not click for me for a while! The key is to persistently revisit the fundamentals and put extra effort!

REQUIREMENTS AND EVALUATION

For every module, there will be quizzes and assignments. The quizzes will test your understanding of the previous module or reading materials. If you fully understand the materials without developing substantial misconceptions, then the quizzes should be fairly straightfoward. If you are struggling with the quizzes, you may need to put more efforts at understanding the materials more deeply and may want to seek help from me, AIs, and your fellow classmates. The quizzes also let me identify common misconceptions and update the course materials and activities.

Most assignments will ask whether you can translate your understanding of the materials into a working code. Some assignments may be challenging if you do not have lots of programming experience or computing background. Please make use of office hours as much as you can and also practice programming skills.

The primary evaluation will be based on an exam and a class project. The exam will consist of online and written portions. The online portion will consists of true/false, multiple choices, and fill-in-the-blank types of questions. Because it is difficult to see your understanding of the materials via these types of questions, there will be a written portion of the exam where you submit a scanned or typed answers with intermediate steps, which allows a more detailed assessment of your understanding.

For your project, you'll be asked to produce a (or a series of) videos or shorts that explain cool network science. Your video can communicate your own research, dig into an interesting network data, explain a network science concept in creative ways, or anything that communicates intriguing topics of network science. I'd strongly encourage to discuss your ideas with me throughout the semester. The project can be conducted individually or by forming a small team. For more information about the projects, please visit https://github.com/yy/netsci-course/wiki/Projects.

BOOKS AND KEY MATERIALS

We will primarily use *Working with Network Data (WWND)* by James Bagrow and yours truly:

· https://cambridgeuniversitypress.github.io/WorkingWithNetworkData/

I will also use or refer some chapters from the following books (they are all great):

· *Network Science* by Albert-László Barabási (Cambridge University Press, 2016). http://networksciencebook.com

· *Networks* (2nd ed.) by Mark Newman (Oxford University Press).

· *Networks, Crowds, and Markets* by David Easley and Jon Kleinberg (Cambridge University Press, 2010).

GRADING

If you focus on the mastery of the science, you will be able to earn good grades. The other way around may not work as well! So please focus on the mastery and fun, rather than focusing too much on grades!

How well you are doing with quizzes will give you a good sense of how well you are understanding each module. I hope the feedbacks from quizzes and assignments will help you develop a good sense and knowledge about where you are, so that you have plenty of opportunities to keep improving your understanding of network science throughout the course.

Note that there may be some adjustments at the end of the class due to the introduction of new materials that have not been tested before. Also, note that some assignment grades may be related late by mistake. Therefore, the grade (percentage) that you see on the Canvas may not accurately reflect your final grade.

· Participation (attendance, quiz, and discussion)[1]: 20% (30% for online section)

· Assignments: 20%

· Exam: 30% (20% for online section)

· Project: 30%

COURSE SCHEDULE

The schedule may change due to unexpected circumstances. See also IU Official Calendar for holidays, breaks, etc.

Key dates

Mark your calendar and plan ahead!

· Project proposal due: **2/21**

· Project team self-evaluation: **4/11**

· Project final paper due: **5/2**

· Final Exam: **5/4–5/8**

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[1]You may receive extra participation credits for outstanding engagement (e.g., sharing useful information or helping peers).

Schedule

Week	Date	Topic	Project timeline
01	1/13–	M01: Why do we care about networks?	
02	1/20–	M02: Friendship paradox: a life lesson	
03	1/27–	M03: "What a small world!"	
04	2/03–	M04: Strength of weak ties	
05	2/10–	M05: Scale-free networks	
06	2/17–	Project week	Proposal: 2/21
07	2/24–	M06: Centralities	Project pitch: 2/28
08	3/03–	M07: Communities I	
09	3/10–	M08: Communities II	
10	3/17–	**Spring break**	
11	3/24–	M09: Random graphs	
12	3/31–	M10: Network epidemiology	
13	4/07–	M11: Social influence	Self-eval: 4/11
14	4/14–	M12: Information diffusion	
15	4/21–	M13: Machine learning with graphs	
16	4/28–	Project week	Presentation & paper: 5/2
17	5/05–	Final exam week	Exam: 5/4–5/8

POLICIES AND ADVICE

1. *Be honest.* 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. Feel free to discuss both online and offline, but you should not show your solution nor see others'. Any cases of serious academic misconduct (cheating, fabrication, plagiarism, etc) will be reported to the School and the Dean of Students, following the standard procedure. But more than anything, cheating will hurt you in the long term and *not cool*.

2. *You have the responsibility of backing up all your data and code*. Always back up your work with a cloud storage service such as Google Drive or One Drive. Learn version control systems and use https://github.iu.edu or https://github.com. The loss of data, code or papers due to the lack of backup is not an acceptable excuse.

3. *Late assignments*. There will be a 10% late penalty for the late assignments unless excused before the deadline.

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 Disability Services for Students. 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 http://disabilityservices.indiana.edu or 812-855-7578 as soon as possible if accommodations are needed. The office is located on the third floor, west tower, of the Wells Library (Room W302). Walk-ins are welcome 8 AM to 5 PM, Monday through Friday. You can also locate a variety of campus resources for students and visitors who need assistance at http://www.iu.edu/~ada/index.shtml.

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 to biasincident@indiana.edu or to the Dean of Students Office at (812) 855-8188.

6. *Sexual misconduct and Title IX.* As your instructor, one of my responsibilities is to create a positive learning environment for all students. Title IX and IU's Sexual Misconduct Policy prohibit sexual misconduct in any form, including sexual harassment, sexual assault, stalking, and dating, and domestic violence. If you have experienced sexual misconduct, or know someone who has, the University can help. If you are seeking help and would like to speak to someone confidentially, you can make an appointment with:

    a) The Sexual Assault Crisis Services (SACS) at (812) 855-8900 (counseling services)
    b) Confidential Victim Advocates (CVA) at (812) 856-2469 (advocacy and advice services)
    c) IU Health Center at (812) 855-4011 (health and medical 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 IU'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. I encourage you to visit *stopsexualviolence.iu.edu* to learn more.