

**INFO I606 (Spring 2022)**

# **Network Science**

**Yong-Yeol “YY” Ahn**

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**Time: TR 9:45am–11am** and Online

**Location: BH 008** (Ballantine Hall)

**Office hours:** Monday 12pm-1pm ET (also by appointment or anytime via Slack)

## **Assistant Instructor**

Vincent Wong (vmwong@iu.edu), Shubham Singh (shusingh@iu.edu), Marcus Skinner (marcskin@iu.edu), Andrew Huang (andhuan@iu.edu), Vedant Vachharajani (vevach@iu.edu), Ashutosh Tiwari (ashutiwa@iu.edu), Karthik Shathiri (kashat@iu.edu)

## **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. 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.

## **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 for day-to-day information sharing, Q&As, team discussions, and other casual conversations.

Announcements, Q&As, and other communication will be sent via Canvas and Slack. Although the most critical announcements will be sent via both platforms, a lot of course-related information (as well as questions and answers) will be shared on Slack and thus you will miss most of useful—although not *essential* in completing the course—course-related information if you are not on Slack. 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.

<https://iu-netsci-course.slack.com/>

by visiting the signup URL:

<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`, `uemail.iu.edu`, `iupui.edu`. If you have any issues joining Slack, please contact the instructor.

Email and Canvas will be much slower because the instructors are under a constant bombardment of emails about all kinds of things that you don't want to know. *If your communication contains sensitive information*, you should use the official channels (emails or canvas messages), but you can still use slack to *notify me* about your email or canvas message. Please expect the following response time:

- **Email or Canvas:** the instructors will be able to respond within *one week* (likely within several days).
- **Slack:** the instructors will be able to respond within *one day* (likely within several hours).

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 on slack, or anonymously share your opinion:

<https://forms.gle/9XrnrBn9faARDAsm7>

## PREREQUISITES

Although there is no formal prerequisite, the course will require a good foundation of mathematics, statistics, programming, algorithms, and data structure. Python is used as the main programming language. Please contact the instructor if you are uncertain about your background.

## REQUIREMENTS AND EVALUATION

Students are expected to read reading assignments, attend class meetings, and complete quizzes and assignments. This course is not driven by one-way lectures, but by your participation and engagement. So be prepared to think hard, do math with a pen & paper, and debate rigorously with classmates.

The main evaluation will be based on an exam and a class project. The project can be conducted individually or by forming a small team. Students may choose any network-related topics that involve network analysis or modeling, although it is strongly encouraged to seek guidance from the instructor. For more information about the projects, please visit <https://github.com/yy/netsci-course/wiki/Projects>.

## BOOKS AND KEY MATERIALS

We will sample from multiple sources. [Network Science](#) by Albert-László Barabási and [Networks: An Introduction](#) by Mark Newman, as well as some materials from the instructor. See also <https://yyiki.org/wiki/Network%20science/>

## POLICIES AND ADVICE

1. *Let's keep everyone safer together.* Let's not be a jerk. Free masks are available near the entrance of every building. If you are not feeling well, please stay home and rest. If you suspect any exposure, please get tested and stay home. There will be no penalty for missing classes due to COVID-19 or other health-related

reasons as long as you have informed the absence before the class. See the next item for more information about missing classes.

2. *Missing classes.* If you were to miss a class, you need to notify the instructor and TAs *before* the class begins to get an accommodation, except in extreme circumstances. The missing attendance will be treated as “excused” and will not be counted towards the final grade. You can use the videos and slides (and office hours) to catch up with the class.
3. *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*.
4. *You have the responsibility of backing up all your data and code.* Always use at least a cloud storage services such as Box, Dropbox, or Google Drive. Ideally, 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 any backup is not an acceptable excuse.
5. *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>.
6. *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](mailto:biasincident@indiana.edu) or to the Dean of Students Office at (812) 855-8188.

7. *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](http://stopsexualviolence.iu.edu) to learn more.

## GRADING

Note that there may be various adjustments (e.g., a curve) at the end of the class. Also, some grading may happen slowly. Therefore, don't trust the grade (percentage) that you see on the Canvas! It does not necessarily reflect your final grade.

- Participation (attendance, quiz, and discussion)<sup>1</sup>: 20% (30% for online section)
- Assignments: 20%
- Exam: 30% (20% for online section)
- Project: 30%

<sup>1</sup>There will be extra participation credits for sharing useful information and helping others.

## 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: **3/4**
- Project presentation and final paper due: **4/22**
- Project presentation (residential): **4/26** and **4/28**
- Final Exam: During the final week of the semester. TBD

### *Schedule*

Week	Date	Topic
01	1/10–	Get ready! Why do we care about networks?
02	1/17–	Friendship paradox: a life lesson
03	1/24–	“What a small world!”
04	1/31–	Strength of weak ties
05	2/07–	Scale-free networks? Steak-pun networks?
06	2/14–	ML with graphs and Network centralities: who are the most important?
07	2/21–	Graph embedding and Graph Neural Networks
08	2/28–	Network structure I: communities and other properties
09	3/07–	Network structure II: Communities and other properties
10	3/14–	Spring break
11	3/21–	Theory of random graphs I
12	3/38–	Theory of random graphs II
13	4/04–	Network epidemiology and robustness
14	4/11–	Social influence and information diffusion
15	4/18–	Project hackathon
16	4/25–	Project Presentation
17	5/02–	Final exam week