

**INFO I606**

# **Network Science**

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TR 9:30am–10:45am

Info East 122

Office hours: Wed 10am-11am; <https://iu.zoom.us/my/yyahn>

## **Assistant Instructor**

Elise Jing (jingy@iu.edu); Office Hours: TBD

Vivek Gupta (vivgupta@umail.iu.edu); Office Hours: TBD

## **COURSE DESCRIPTION**

Networks, or graphs, provide a unifying framework to study complex systems, such as living organisms, societies, and technological systems. This graduate-level course focuses on the fundamental concepts and statistics as well as key applications of network science. The course will cover recent advancement of network science, with respect to statistical properties and models of real-world networks, network algorithms, and practical applications. Topics include: how information and diseases spread in our society, measures and algorithms for quantifying importance, link prediction, and community detection.

## **COURSE OBJECTIVES**

By the end of the course, students are expected to be able to identify, construct, and analyze networks by choosing and applying appropriate methods and algorithms.

Students are also expected to be able to explain, both mathematically and conceptually, the key network concepts and statistical properties, and their implications.

## COMMUNICATION

We will use Slack as the main communication channel. So the first thing you should do is to join the course slack. The URL for the course Slack site is: <https://iu-netsci-course.slack.com>. You can create an account by using one of the following IU email addresses: [indiana.edu](mailto:indiana.edu), [uemail.iu.edu](mailto:uemail.iu.edu), [iu.edu](mailto:iu.edu), [iupui.edu](mailto:iupui.edu). If you have any issues joining Slack, please contact the instructor.

## PREREQUISITES

The course will require a good foundation of mathematics and programming, although there is no formal prerequisite. Key prerequisite topics are: probability, statistics, linear algebra, data structures, and algorithms. Python is used as the main programming language and it will be very helpful to be proficient in Python. Please contact the instructor if you are uncertain about your background.

## REQUIREMENTS AND EVALUATION

Students are required to read assigned readings, attend (watch) the lectures, complete quizzes and assignments, and engage in (online) discussions.

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 discuss with the instructor about the project topics. For more information about the projects, please visit <https://github.com/yy/netsci-course/wiki/Projects>.

## BOOKS AND KEY MATERIALS

We will closely follow the [Network Science](#) by Albert-László Barabási and [Networks: An Introduction](#) by Mark Newman. The following books can be helpful:

*Python and data analysis*

1. [Dive Into Python](#) by Mark Pilgrim (available online): a good Python book.

2. [Learnpython.org](http://learnpython.org): A web-based interactive tutorial.
3. [An introduction to statistics](#) (with Python) by Thomas Haslwanter (available online): this book uses Python to explain basic statistics. It also contains a succinct tutorial for Python and data visualization using Python.
4. [Learning IPython for Interactive Computing and Data Visualization](#) by Cyrille Rossant: Introduction to IPython as well as lots of advanced analysis

## POLICIES AND ADVICES

1. *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>.
2. *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.

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 other's. 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 a 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 service such as Box, Dropbox, or Google Drive. Ideally, learn version control systems and use <https://github.iu.edu> or <https://github.com>. Loss of data, code, or papers (e.g. malfunction of your laptop) is not an acceptable excuse.
5. If you have any mental health issues, don't hesitate to contact [IU's Counseling and Psychological Services](#). They provide free and confidential counseling sessions.

## GRADING

- Participation (attendance, quiz, and discussion): 25%
- Assignments: 30%
- Exam: 15%
- Project: 30%

## COURSE SCHEDULE

(The schedule is subject to change)

*Week 1 (1/8-): Get ready! Why do we care?*

*Week 2 (1/15-): Friendship paradox: a life lesson*

*Week 3 (1/22-): "What a small world!"*

*Week 4 (1/29-): Strength of weak ties*

*Week 5 (2/5-): Scale-free networks—Power-law or not?*

*Week 6 (2/12-): Network centralities (Project proposal: 2/12)*

*Week 7 (2/19-): Network structure I: communities and other properties*

*Week 8 (2/26-): Network structure II: communities and other properties*

*Week 9 (3/5-): Theory of random graphs*

*Week 10 (3/12-): Spring break*

*Week 11 (3/19-): Network epidemics*

*Week 12 (3/26-): Social influence and information diffusion*

*Week 13 (4/2-): What makes it viral?*

*Week 14 (4/9-): Robustness (Exam: 4/10)*

*Week 15 (4/16-): Link prediction*

*Week 16 (4/23-): Final presentations (Final presentation: 4/24)*

*Week 17 (4/30-): Final Week. (Project paper: 5/4)*