Network Science

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TR 9:30am–10:45am
Lindley Hall 328 (LH 328)
Office hours: Wed 10am-11am (or message me anytime on Slack)

Assistant Instructor
Residential: Elise Jing (jingy@iu.edu); Office Hours: Monday 2pm-3pm
Online: Jaehyuk Park (jp70@iu.edu); Office Hours: Friday 2pm-3pm

COURSE DESCRIPTION

Network science is a unifying framework to study complex systems, such as living organisms, societies, and many techno-social systems, because complex systems are often defined by interactions between their elements. This graduate-level course focuses on the fundamental concepts as well as key applications of network science. The course will explore 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, models, and statistical properties, as well as their implications.

COMMUNICATION

We will use Slack as the main communication channel. Thus, *the very first thing you need to do is to join the course slack*:

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`, `umail.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 even want to know. Please expect the following response time:

· **Email or Canvas**: the instructors will respond within *one week* (likely within several days).

· **Slack**: the instructors will 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

The course will require a good foundation of mathematics, statistics, and programming, although there is no formal prerequisite. Key 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

This course is not driven by the lectures, but by your participation and engagement. So be prepared to lead your own learning! Bring pen and papers; be prepared to discuss and write things down. And of course, you need to read reading assignments, attend the classes, complete quizzes and assignments, and actively participate.

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 closely follow the Network Science by Albert-László Barabási and Networks: An Introduction by Mark Newman. The following books can be also helpful:

Network science

1. Networks, Crowds, and Markets: Reasoning about a Highly Connected World by David Easley and Jon Kleinberg.

2. Linked: How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life by Albert-László Barabási.

Python and data analysis

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

2. 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. Mining the Social Web: Data Mining Facebook, Twitter, LinkedIn, Google+, GitHub, and More by Matthew A. Russell.

5. 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. *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, acknolwedge 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*.

2. *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.

3. *Inform your excused absences prior to class.* Please contact the instructor *prior* to the class that you cannot attend.

4. *Late assignments.* There will be 10% late penalty for the late assignments unless excused.

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, ethinicity, 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.

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* to learn more.

GRADING

Note that there may be various adjustments at the end of the class and the grade (percentage) that you see on the Canvas does not necessarily reflect your final grade.

· Participation (attendance, quiz, and discussion)[1]: 30%

· Assignments: 20%

· Exam: 20%

· Project: 30%

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[1]There will be extra participation credits for sharing useful information and helping others on slack

COURSE SCHEDULE

(The schedule is subject to change)

Week 1 (1/13-): Get ready! Why do we care?

Week 2 (1/20-): Friendship paradox: a life lesson

Week 3 (1/27-): "What a small world!"

Week 4 (2/3-): Strength of weak ties

Week 5 (2/10-): Scale-free networks? Steak-pun networks?

Week 6 (2/17-): Network centralities

Week 7 (2/24-): Network structure I: communities and other properties

Week 8 (3/2-): Network structure II: communities and other properties

Week 9 (3/9-): Theory of random graphs (Project proposal due: 3/13)

Week 10 (3/16-): Spring break

Week 11 (3/23-): Theory of random graphs

Week 12 (3/30-): Network epidemics and robustness

Week 13 (4/6-): Social influence and information diffusion

Week 14 (4/13-): Exam and Exam Review

Week 15 (4/20-): Project hack week

Week 16 (4/27-): Final presentations (Final presentation due: 4/26)

Week 17 (5/4-): Final Week (Project paper due: 5/8)