Introduction to Network Science

PHYS 1125, Fall 2023

Instructor: Prof. Dima Krioukov, 177 Huntington Ave, 2nd floor, Rm. 227, x2934, dima@northeastern.edu
Office Hours: By appointment
Credits: 4
Course Schedule: WF 11:45am-1:25pm, Sep 6 – Dec 6, 2023
Course Location: Hastings Suite 210

Textbooks:
Main: F. Menczer, S. Fortunato, and C. A. Clayton,
A First Course in Network Science, Cambridge University Press, 2020.
Complementary (optional deeper coverage): V. Latora, V. Nicosia, and G. Russo,
Complex Networks: Principles, Methods and Applications, Cambridge University Press, 2017

Course Description and Learning Objectives: Networks pervade all aspects of our lives. Social networks, the Web and Internet, transportation networks are examples of networks that we use every day, while the brain cells, genes, and proteins in our body form networks that determine our intelligence and survival. Representing even small and simple systems as networks can often help to solve difficult problems that these systems may pose. The network representation of large and complex systems is even more powerful and helpful in a variety of disciplines. Represented as networks, many different complex systems exhibit striking similarities whose precise characterization and explanation are a part of this course.

This introductory course explores the basic concepts, ideas, and results in network science that studies networks in general and individual real-world networks in particular, to help us understand the complex patterns of connections and relationships that shape our lives. The major areas of network science that this course covers are:

- Basic concepts: network representations, network size, network density, degree distribution, clustering, assortativity, centrality, shortest-path distance
- Properties of real-world networks: sparse, scale-free, strongly clustered small worlds
- Network models: random graphs, configuration models, preferential attachment, stochastic block models, latent space models
- Applications: dynamics of and on networks: link prediction, spreading processes (rumors, epidemics), information routing in the Internet and the brain

Upon the successful completion of the course, the students gain the basic hands-on experience and knowledge of the core concepts in network science that are required in a variety of career tracks in data science in industry and academia.

Course Organization, Homework, Exams, and Grading: Many lectures are highly interactive and discussion-based with active student involvement and experiential learning. There are several homework assignments consisting of problems from the textbook, one in-class midterm, and one final journal-club-style presentation of a paper of student's choice. The grades are determined as follows:

- **30%** Homework
- **30**% Midterm
- **40%** Final

Class Policies:

- Announcements in the class that are in conflict with the material in this syllabus override the syllabus
- Students who cannot attend a class are required to notify the instructor beforehand, and are responsible for finding out about any announcements and assignments that they might have missed
- No electronic device use is allowed during the class, other than for taking notes or when explicitly allowed by the instructor for experiential learning activities
- The points earned on late submissions of assignments are multiplied by:
    - 0.75, if submitted 0-1 hours late
    - 0.50, if submitted 1-24 hours late
    - 0.25, if submitted 24-48 hours late
    - 0.00, if submitted >48 hours late
- All the students are required to review and follow the Northeastern University Academic Integrity Policy available at https://osccr.sites.northeastern.edu/academic-integrity-policy/