Syllabus - Fall2024

Course CSCI-6250/4250 4cr: Frontiers of Network Science
Monday - Thursday 10:00-11:40 Amos Eaton 216

Class Website

http://www.cs.rpi.edu/~szymansk/fns.24/index.php

Instructor

Prof. Boleslaw K. Szymanski, e-mail: szymab@rpi.edu

Teaching Assistant: Vijay, Sadashivaiah e-mail: sadasv2@rpi.edu
Office Hours: Monday, Thursday 15:00 – 16:00 by appointment by email either in the office (TBA) or by webex link https://rensselaer.webex.com/meet/sadasv2

Textbooks

Albert Laszlo Barabási ***Network Science,***
Cambridge University Press, 2016
The online version is available at http://barabasi.com/networksciencebook/
In addition, class notes will be used.

Course Description

This course introduces Network Science and reviews current research in this field. Classes will interchangeably present chapters from the textbook and related current research. The emphasis will be on the mathematical background of network science: graphs and networks, random networks, and various types of scale-free networks; network properties such as assortativity, mobility, and robustness; social networks and communities; and dynamics of processes on networks.

Prerequisites

CSCI-2300; a 4000 level algorithms-based CSCI (e.g., 4020, 4050, 4260, 4800), or MATH (4100, 4150, 4200, 4210, 4800) course; junior or senior level standing; some familiarity with probability theory, linear algebra, and calculus; or permission of the instructor.

Course Content

- Mathematical background of network science: graphs and networks.
- Random networks and their properties.
- Scale-free networks, small world networks, and Barabási-Albert model.
- Mobility and networks
- Network robustness
- Social networks and communities
- Assortativity of networks
- Dynamic processes

Grading Criteria

Undergraduates: One individual programming homework (40% of the total grade), followed by **one individual presentation** of the selected research paper (50% of the total grade), with questions and participation in discussions for at least two student presentations, will provide the remaining (10%) of the total grade.

The programming homework will be handed out approximately after the end of the fourth week, together with the choice of networks for experiments, and is due three weeks after that. The homework will require using network analytics tools, Gephi (or programming), and analyzing the results obtained for the real and synthetic networks. The graded homework will be returned to undergraduates approximately two weeks after it is handed in. Students will have these grades as their means to determine progress in the course by mid-semester.

Students will choose a topic for research and presentation from the list of issues associated with the textbook or seminal papers that need to be approved by the instructor in the 7th week. The 25-minute in-class presentation and 5-minute discussions of the assigned topic will be scheduled starting at the end of October.

Graduates: Students will choose a topic for research and presentation from the list of the issues associated with the seminal papers or from their current work if approved by the instructor during the first two weeks of the class. Around the 6th week of the course, the research plan will be due in 3-5 pages, defining the project part of the presentation on which the research will be based (25%). The 45-minute presentation + 5-minute discussion will be due starting at the end of October (40%), and a written report of 8-12 pages will be due at the last class (25%). The remaining 10% of the grade will be assigned based on participation in discussions of the presentations.

Grade ranges: A 96. A- 91, B 85, B- 80, C 70, C- 60, F <60.

Student Learning Outcomes

Upon completion of this course, all students will be able to:

1. Apply fundamental network science ideas to create models and understand the dynamics of networked systems;
2. Compare, contrast, and describe the similarities and differences of different kinds of networks and processes modeled on networks;
3. Critique the strengths and weaknesses of each of the models and types of networks based on them and these network types of performance in diverse network science applications;
4. Understand the principles of applying network science to disciplinary science and design and set up basic models for some specific applications.

Additionally, graduate students will also be able to:

5. Read, analyze, and critique published literature in the field of network science and social networks;
6. Assess the novelty of network science research and its relation to the state of the art in the field.

Course Assessment Measures

Undergraduates: The student's performance will be measured using four different methods listed below.

(i) Programming homework

(ii) After the selection of a current research paper or textbook problem for a presentation, each student will present the selected paper, including its content, and evaluate its scientific results.

(iii) Contributions to in-class discussions.

The programming homework and presentation plans will measure the student's ability to apply concepts of network science to network analysis.

The presentation slides and evaluation of the paper results will measure student's ability to prepare summary material based on fundamental scientific concepts and basic research.

Graduates: Again, students' performance will be measured using three different methods:
(i) After selecting a current research paper, each student will present the selected paper, including its content, and evaluate its scientific results.
(ii) Contributions to in-class discussions.
(iii) Independent and novel mini-project using different data or methods on the presentation topic.

The first two methods are the same as the undergraduate methods (i) and (ii), while the third method assesses students' ability to apply network science to novel problems.

Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the course structure and content, and teachers must trust that the assignments that students turn in are their own. Acts that violate this trust undermine the educational process. The Rensselaer Handbook of Student Rights and Responsibilities defines various forms of Academic Dishonesty, and all students should familiarize themselves with these forms to avoid them.

In this class, all assignments turned in for a grade must represent the student's own work. Submission of any assignment that violates this policy will result in a penalty of 0 points for the assignment and failing the course in case of repetition.

If you have any questions concerning this policy, please ask for clarification before preparing, submitting an assignment, or making a presentation.

The penalty for not adhering to these academic integrity rules is a failing grade for the assignment on the first offense, then failing the course and potential disciplinary actions by the Institute on any subsequent offenses.

Attendance Policy:

Attendance in classes is generally not required, but it is recommended because the material presented in classes includes topics beyond the textbook. However, attendance and active participation are required in at least two research presentations, and active participation is needed to receive a score for *active participation*.

A missed deadline for homework, unless justified by medical or personal reasons and approved by the instructor, will lower the achieved score by 10% for each week of delay.

Such a presentation can be rescheduled only in case of an emergent conflict with the scheduled presentation.