Syllabus - Fall 2018

Course CSCI-6250/4250 4cr: Frontier of Network Science
Monday - Thursday 12:00-13:40, J-ROWL 2C25
Office Hours: Tuesday 13:00 – 14:00, Thursday 10:45 – 11:45, MRC335A

Class Web-site

http://www.cs.rpi.edu/~szymansk/fns.18/index.php

Instructor

Prof. Boleslaw K. Szymanski, e-mail: szymansk@cs.rpi.edu, MRC335A

Textbooks

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

Course Description

This course offers the introduction to network science and review of current research in this new field. Classes will interchangeably present chapters from the textbook and the related current research. The emphasis will be on mathematical background of network science: graphs and networks; random networks and various types of scale-free networks; network properties such as assortatitivity, 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 Barabasi-Alert model.
- Mobility and networks
- Network robustness
- Social networks and communities
- Assortativity of networks
- Dynamic processes

Grading Criteria

One individual project (50%) for both graduate and undergraduate students, followed by one individual homework assignment for undergraduates (40%), and one 25 min presentation on network science topic of student's choice for graduates (40%) are due throughout the semester. The project will be handed out approximately after the end of the 5th week, while the assignment in the 9th week of the course. The project requires using network analysis tools (or programming) and analysis of the results obtained for the real and synthetic networks. The undergraduate students can replace the assignment with presentation. The remaining 10% of the grade will be assigned based on participation in discussions of project, assignment and presentations.

Graded projects/homework will be returned approximately one week after they are handed in; students will have these grades as their means to determine progress in the course by mid-semester and undergraduate student will be able to decide then to choose or not a presentation.

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 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 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 novelty of network science research projects and their relation to the state of the art in the field.

Course Assessment Measures

The student performance will be measured using three different methods: (i) project assignment for the entire class, (ii-u) homework assignments for undergraduate class, (ii-g) presentation that will include evaluation of slides and nodes prepared for presentations for graduate students, and (iii) contributions to in-class discussions.

The assignments will measure the student's ability to apply concepts of network science to network analysis.

The slides and notes prepared for presentation will measure student's skills in preparing summary material based on fundamental scientific concepts. The presentation will measure student's ability to communicate the concept and notions related to the research projects in which the student is involved.

The discussion in class will measure the student's skills to critically evaluate and objectively assess the presentations of other students.

Academic Integrity

Student-teacher relationships are built on trust. For example, students must trust that teachers have made appropriate decisions about the structure and content of the courses they teach, and teachers must trust that the assignments that students turn in are their own. Acts, which 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 make themselves familiar with these forms to avoid them.

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

If you have any question concerning this policy, please ask for clarification before preparing or 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.

Preliminary Schedule

The list indicates the basic topics and points which will be covered in classes, brown are lectures based on textbook, blue are research presentations.

Aug. 30: L01 Overview and Introduction
Sept. 06: L02 Introduction to Network Science/Graph Theory (chapters 1/2)
Sept. 10: L03 Graph Theory (chapter 2)
Sept. 13: L04 Random Networks (chapter 3)
Sept. 17: L05 Research: Communities in U.S. Senate Random Networks (chapter 3)
Sept. 20: L06 Small World Networks (chapter 3)
Sept. 24: L07 Small World and BA Networks (chapters 4/5) Introduction to Gephi
Sept. 27: L08 Workshop on Gephi, Introduction to Noe4j
Oct. 01: L09 Tools for assignments, advanced examples and Q&A session
Oct. 04: L10 **Homework 1 out;** Q&A session for H1;
Oct. 09: L11 Barabasi-Albert Model-Part (chapter 5)
Oct. 11: L12 CDR and Reciprocity in Networks (***Stephen Dipple***) Social Net Co-evolution (***Ashwin Bahulkar***)
Oct. 15: L13 Barabasi-Albert Model-Part II Evolving Networks (chapter 6)
Oct. 18: L14 Degree Correlation Part I (chapter 7)
Oct. 22: L15 Research: Predicting Human Behavior (***James Flamino***); Persistence (***Omark Malik***)
Oct. 25: L16 Degree Correlation Part II (chapter 7);
Oct. 29: L17 Net. Correlation & Robustness (ch, 7-8) Research: Dynamic Graph Mining (Dr Petko Bogdanov);
Oct. 31: **Homework 1 due;**
Nov. 01: L18 **Homework 2 out;** Network Robustness I (chapter 8)
Nov. 05: L19 **Homework 1 discussion;** Network Robustness II (chapter 8)
Nov. 08: L20 Research: News Media Cascades (***Xiaoyan Lu***); Social Routing Efficiency (***Amr Elsisy***);
Nov. 11: L21 Community Structure;
Nov. 15: L22 Presentations: Clique Percolation for Community Detection (***Christopher Jones***), Quantifying patterns of research-interest evolution (***Rosemonde Aussell***), Fast Algorithm for Community Detection (***Kousuke Tachi***).
Nov. 19: L23 Presentations: Limits of human mobility (***Rufeng Ma***), Parameter Tuning for Influence Maximization (***Manqing Ma***), Epidemic Modeling (***Mason Bradley***).
Nov. 26: L24 Student presentations (3)
Nov. 29: L25 Student presentations (3)
Dec. 03: L26 Student presentations (3); **Homework2 due**
Dec. 06: L27 **Homework2** discussion; Research: Naming Game Model of Opinion Evolution;
Dec. 10: L28 Research: Evolution of Global Risks (***Xiang Niu***) Opinion Change Thresholds (***Alex Meandzija***)