Syllabus - Fall2019
Course CSCI-6250/4250 4cr: Frontier of Network Science
Monday - Thursday 12:00-13:40, J-ROWL 2C25
Office Hours: Monday 10:45 – 11:45, Friday 13:00-14:00 MRC335A

Class Web-site

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 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
Undergraduates: one individual project (50%), followed by one individual homework assignment (40%), and questions and participation in discussion for at least two graduate students presentations (10%) 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. Graded projects/homework will be returned to undergraduate 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.
**Graduates:** Students will choose a topic for research and presentation either from the list of topics associated with textbook or seminal papers, or from their own current work, if approved by the instructor. Around 5th week of the course, the research plan will be due of 3-5 pages defining project part of presentation (40%) and the 40 min presentation will be due in November/December time frame (50%). The remaining 10% of the grade will be assigned based on participation in discussions of the presentations.

**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) projects for the undergrads and research plans for grads, (ii-u) homework for undergrads, (ii-g) presentation that will include evaluation of slides and research results for graduates, and (iii) contributions to in-class discussions.

The projects and plans will measure the student’s ability to apply concepts of network science to network analysis. The slides and research results will measure student’s ability to prepare summary material based on fundamental scientific concepts and basic research. 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. 29: L01 Overview and Introduction; Research: Detection of Source of Spreading, Prof. Krzysztof Suchecki, Warsaw Polytechnic University
Sept. 03: L02 Introduction to Network Science/Graph Theory (chapters 1/2)
Sept. 05: L03 Graph Theory (chapter 2)
Sept. 09: L04 Random Networks (chapter 3); Presentation topic posted for selection by grads
Sept. 12: L05 Scale Free Networks (chapter 4)
Sept. 16: L06 Research: U.S. Congress Polarization and Communities
Sept. 19: L07 Barabasi-Albert Model (chapter 5)
Sept. 23: L08 Introduction to Gephi + Examples;
Sept. 26: L09 Workshop on Gephi; Research plan for presentations by graduate students due
Sept. 30: L10 Research: A Reaction-Based Approach to Information Cascade Analysis, James Flamino, CS; Model of Polarization in Legislative Houses, Mon Ma, CS
Oct. 03: L11 Research: Persistence on Networks, Omar Malik, Physics; Chicago City Crime Dynamics, Amr Elsisy, CS
Oct. 07: L12 Homework 1 out; Q&A session for H1; Small World + BA Networks (chapters 4/5);
Oct. 10: L13 Barabasi-Albert Networks Part II Evolving Networks (chapter 6)
Oct. 17: L14 Research: Model of SI with Competing Pathogens, Michael Stobierski, Physics, Risk Network Control, Chenhungen Jiang, CS
Oct. 21: L15 Degree Correlation Part I (chapter 7)
Oct. 24: L16 Network Correlation & Robustness (ch, 7-8)
Oct. 28: L17 Network Robustness part II (chapter 8); Research: Global Risk Network Part I
Oct. 30: Homework 1 due
Oct. 31: L18 Homework 2 assignment; Research: Global Risk Network Part II
Nov. 04: L19 Discussion of Homework 1; Research: Community Detection for Bio-networks
Nov. 07: L20 Grad: Giant component and component sizes, Bowen Gong, second talk moved to L25
Nov. 11: L21 Grads: Comparing community detection algorithms, Rutvik Manohar; Measuring fitness of evolving networks, Brendan Cross
Nov. 14: L22 Research: Experimental Analysis of Heider Balance in Social Networks, Joanna Toruniewska, Warsaw Polytechnic University, 2nd talk moved to L28
Nov. 18: L23 Grads: Control principles of complex systems, Runyu Lai; A network framework of cultural history, Matthew Obetz
Nov. 20 Homework2 due
Nov. 21: L24 Grads: A cost function for PPI networks, Harrison Lee; Research: Evolving Social Networks, Part I
Nov. 25:L25 Grads: A recipe network, Dyia Li & Shengxuan Liu; Quantifying patterns of research-interest evolution, Chris J Tang; make up for lecture L20
Dec. 02: L26 Snow day – no classes
Dec. 05: L27 Grads: Epidemic modeling, Henry Grover; Human symptoms–disease network, Aamir Mandviwalla Quantifying the individual scientific impact, Clare Arrington
Dec. 09: L28 Grads: Weighted Random Graph Generation, Christopher Brissette; Immunization, Steven Haussmann; Limits of human mobility, Lorson Blair; make up for L22
Homework 2 solution;