Fall 2016

PHYS 5116: Complex Networks

Lecturer: Prof. Albert-László Barabási
Co-Instructors: Dr. Sean P. Cornelius, Dr. Emma Towlson
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Lecture hours: Mondays, Wednesdays and, occasionally, Fridays, 5:30 PM - 7:20PM
Classroom: CCNR. You will need a photo ID or your husky card to access the building.
Office hours: By appointment only. Please discuss with either Dr. Towlson or Dr. Cornelius after class to schedule.

Textbook:
- Network Science, Albert-László Barabási (required)
- Networks – an Introduction, Mark Newman, Oxford University Press (recommended)

Other useful tools:
- Slides of the classes will be uploaded to the webpage: http://barabasilab.neu.edu/courses/phys5116/
- Class communications will be done through Blackboard.

Course description and objectives
The course is an interdisciplinary introduction to the emerging science of complex networks and their applications. Topics to be covered include the mathematics of networks (graph theory), data analysis, and applications to biology, sociology, technology, and other fields. Students will learn about the ongoing research in the field, and ultimately apply their knowledge to conduct their own analysis of a real network data set of their choosing as part of the final project.

Course organization
Lectures: Lectures will be given by Prof. Barabási, by Drs. Towlson and Cornelius

Homework: There will be three (3) homework assignments representing a mix of mathematical work and computational data analysis. Students are expected to turn in their source code for the computational exercises.

Examinations: Final project presentation — complete analysis of a real network. In place of a midterm exam, there will be an intermediate presentation to check your progress and provide feedback.
Evaluation and grading
Grade distribution
1) Homework: 45% (15% for each of 3)
2) Intermediate project progress presentation (on Wed., Sept. 28th. Guidelines for this evaluation will be given in lecture): 10%
3) Final project presentation (tentatively, on Dec. 7th and Dec. 9th): 35%
4) Class attendance and participation: 10%

Class participation
This is not a traditional course in which an instructor lectures while students take notes. We operate on the belief that true mastery of the course material occurs when one is able to explain that material to others. As such, the lectures will consist of students working in groups to answer questions posed by the instructors. Students are expected to read the appropriate textbook chapters/other assigned material beforehand, arriving fully prepared to discuss the answers to those questions with the rest of the class.

The co-instructors will determine the class participation grade based on each students’ attendance record and engagement in discussions. Occasional absences are, of course, understandable. If you can’t attend a class for any reason, please let either Dr. Towlson or Dr. Cornelius know in advance.

Final project
For the final project, students will collect data representing a real network of their choice and analyze it using the network measures and computational tools introduced in class. The goal is to craft a complete “story”: what does network science tell us about the system's organization and function?

Datasets: We will provide some suggestions in class. If none of these interest you, you are free to seek out your own data within the guidelines that will be provided in lecture.

Groups: Graduate students in either Network Science or in Physics specialized in Networks will perform the project on their own. All other students are required to work in pairs, with the two students come from different programs/academic departments.

Help: The final project is the largest single component of your grade, and in past years the primary determinant of a successful (vs. unsuccessful) project has been whether the student/group started early and asked for help often. The project is intended to be real research, and in real research there are unforeseen problems and things rarely work out the first time. Don’t wait until the last week to do your analysis; you are encouraged to use office hours proactively, to obtain feedback and fix problems early.

Computer programming
Network science is a fundamentally computational science. Although helpful, strong programming ability is not a requirement to enroll in the course. Nonetheless, the homeworks and your final project will necessarily involve significant computational work. You will be expected to build the required skills
as the course goes on through a series of hands-on lectures that will introduce some of the cutting edge software/libraries used for network and data science, supplemented by independent study. *Students are free to work in any computer language/network software they feel most comfortable*, but the hands-on lectures will be presented in Python using the NetworkX library ([https://networkx.github.io/](https://networkx.github.io/)).

**Academic misconduct**

Appropriate disciplinary action, potentially including failing the student, will be taken in the event of cheating, plagiarism, dishonesty, or other academic misconduct. The Northeastern University Policy on Academic Integrity can be found at [http://www.northeastern.edu/osccr/academicintegrity/](http://www.northeastern.edu/osccr/academicintegrity/).

Students in this course are encouraged (and indeed, for the final project *required*) to work in teams. With this in mind:

*It is not considered academic misconduct if you:*

- Work together on homework assignments, as long as you each work out and submit your own final answers. Here “final answers” includes such things as derivations, plots (where appropriate), written explanations, and source code (for computational exercises), etc.
- Get help from other professors, physics workshops, tutors, etc. on the homework assignments

*It is considered academic misconduct if you:*

- Submit work substantially similar to that done by others as your own.
- Don’t contribute equally to the final project (for those working in pairs)

The above lists are intended as examples and are *not exhaustive*. If in doubt, ask.

**Statement of non-discrimination**

Northeastern University is committed to social justice. As the instructors of the course, we expect to maintain a positive learning environment based upon communication and mutual respect. Any suggestions as to how to further such a positive and open environment in this class will be appreciated and given serious consideration. The university does not discriminate on the basis of race, sex, age, disability, religion, sexual orientation, color, or national origin. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise us and make appropriate arrangement with Disability Resource Center (617) 373-2675.

**Changes to syllabus and student responsibilities**

The instructors reserve the right to modify this syllabus as deemed necessary any time during the semester. Emendations to the syllabus will be discussed with students during a class period. Students are responsible for information given in class. There may be also details about PHYS 5116 not covered in this syllabus. *Do not assume something just because it is not specified in the syllabus.* If you are unsure about anything related to the rules guiding this course, consult with one of the instructors.