CocoNuTs

Complex Networks
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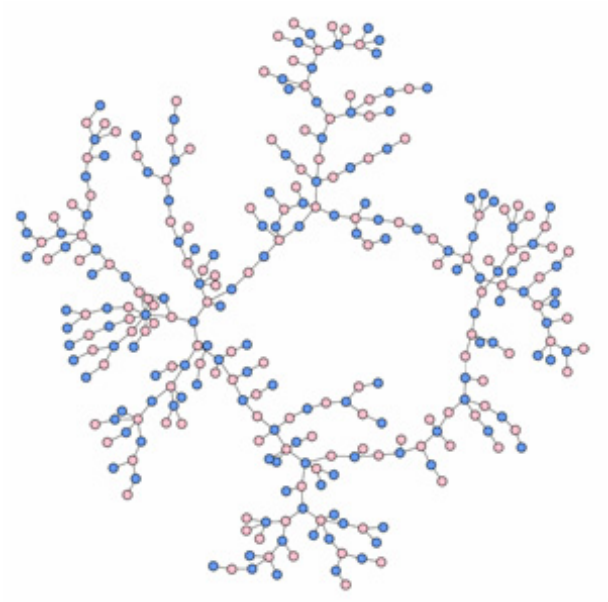
Complex Networks

CSYS/MATH 303; Deliverator: Prof. Peter Dodds
Tuesday and Thursday, 1:15 pm to 2:30 pm in Decision Theater, Far
Level: Graduate/Advanced Undergraduate
@networksvox #SpringCOcoNuTS2019

Basic stuff:

Instructor: Prof. Peter Dodds.
Lecture room: Decision Theater, Farrell Hall
Meeting times: Tuesday and Thursday, 1:15 pm to 2:30 pm
Office: Farrell Hall, second floor, Trinity Campus.
Office hours: TBSO.
Course website:
http://www.uvm.edu/pdodds/teaching/courses/2019-01UVM-303
Course hashtag: #SpringCOcoNuTS2019
Source material: Journal papers and book excerpts.
E-mail: pdodds+coconuts@uvm.edu
Suggested text: No official textbook.

If instructor's permission is required: Students are asked to please send a short email describing their interests (and their 950 student number) to Prof. Dodds at pdodds@uvm.edu.



Synopsis: Complex networks crucially underpin much of the real and synthetic world Networks distribute and redistribute information, water, food, and energy. Networks can be constituted by physical pipes, embodied in relationships carried in people's minds, or manifested by economic interdependencies.

Starting in the late 1990s and building on work in a wide range of disciplines, many (but certainly not all) advances have been made in understanding all manner of complex networks such as the World Wide Web, social and organizational networks, biochemical networks, and transportation networks. In this special topics course, we will explore this evolving field of complex networks by reading and discussing seminal and recent papers, and developing mathematical and algorithmic results where they exist.

Potential topics to be covered:

- Structure and form of complex networks including physical branching networks (river networks and cardiovascular networks), neural networks, social networks, the Internet, the world wide web, transportation networks, and organizations;
- distribution versus redistribution networks;
- properties of networks including degree distributions, clustering, motifs, various measures of betweenness, modularity, the role of randomness, network dynamics, and multiscale structures;
- multilayer networks;
- HOT networks;
- temporal networks;
- community detection algorithms;
- bipartite networks;
- weighted networks;
- partly random networks as models of real world networks;
- generating function techniques;
- universal models including scale-free networks, p-star networks, and generative models;
- small-world networks;
- impedance and flow in networks;
- connections between delivery networks and energy usage in organisms;
- search in networks as facilitated by network structure and search methods;
- generalized notions of contagion in networks;
- network epidemiology and fad spreading;
- computation considerations for analysing networks.

Prerequisites: Principles of Complex Systems, CSYS/MATH 300. Familiarity with differential equations, difference equations, standard calculus, linear algebra, and statistical methods. The course is a 3 credit course and is aimed at graduates and advanced undergraduates.

Computing: Proficiency in coding (e.g., C, Matlab, perl, python) will be beneficial (and indeed necessary) for certain projects but is not required.

Graduate Certificate in Complex Systems: This course is one of the electives available for obtaining a Graduate Certificate in Complex Systems at UVM. Please see `http://www.uvm.edu/complexsystems` for more information.

Grading breakdown:

1. **Projects/talks (36%)**—Students will work on semester-long projects. Students will develop a proposal in the first few weeks of the course which will be discussed with the instructor for approval. A list of possible projects will be provided though individuals are encouraged and free to choose their own. Project content may range from novel research to a review of research relevant to the course. For the former, the hope here is for some work to percolate up to the level of journal publications.

   Students will give one introductory presentation in the fourth week of the semester and a longer one at the end. We will probably have 5 minutes for the first talk (plus around 10 minutes of discussion), and 15 to 20 for the final talk (exact length of talks will depend on class size). The goal of the first talk is to outline the project, explaining what it is, why it's interesting, and what you plan to do. The final talk should recap the project and then cover what was achieved. Projects are not expected to be amazing successes, and explaining approaches that failed and why they failed (if illuminating) is an acceptable part of the final talk.

   Students will also be required to hand in a report on their investigations. Reports should be written in the style of a journal paper (title, abstract, appropriate sections, bibliography, and appendices) and be at least 5 single-spaced pages.

   The grade breakdown will be 8% for the first talk, 14% for the final talk, and 14% for the written project.

2. **Assignments (60%)**—All assignments will be of equal weight and there will be approximately one per week. Clarity in writing and presentation will be taken into account in grading. In general, questions are worth 3 points according to the following scale:

   - 3 = correct or very nearly so.
   - 2 = acceptable but needs some revisions.
   - 1 = needs major revisions.
   - 0 = way off.

3. **General attendance/Class participation (4%)**—it is highly desirable that students attend class, and class presence will be taken into account if a grade is borderline.

Schedule:

Week number (dates)	Tuesday	Thursday
1 (1/15 and 1/17)	overview, branching networks I	branching networks I and II
2 (1/22 and 1/24)	branching networks II	optimal supply networks I and II
3 (1/29 and 1/31)	optimal supply networks II	optimal supply networks II
4 (2/5 and 2/7)	optimal supply networks II	optimal supply networks III
5 (2/12 and 2/14)	optimal supply networks III, random networks	random networks
6 (2/19 and 2/21)	generating functions	random bipartite networks
7 (2/26 and 2/28)	Town meeting day	project presentations†
8 (3/5 and 3/7)	Spring Recess	Spring Recess
9 (3/12 and 3/14)	random networks	bipartite networks
10 (3/19 and 3/21)	contagion	contagion
11 (3/26 and 3/28)	contagion	chaotic contagion
12 (4/2 and 4/4)	multilayer networks	multilayer networks
13 (4/9 and 4/11)	assortativity	mixed random networks
14 (4/16 and 4/18)	centrality	structure detection
15 (4/23 and 4/25)	structure detection	structure detection
16 (4/30 and 5/2)	organizational networks	special topics

†: 3-4 minutes each + 1 or 2 questions;

Final project presentations will likely be given in the final exam period which takes place on Thursday, May 10, 1:30 pm to 4:15 pm, Decision Theater, Farrell Hall. .

Times may adjusted based on class size.

Important dates:

1. Classes run from Tuesday, January 15 to Thursday, May 2.
2. Add/Drop, Audit, Pass/No Pass deadline—Monday, January 28.
3. Last day to withdraw—Monday, April 1 (Never!).
4. Reading and Exam period—Monday, May 6 to Friday, May 10.

Do check the course Twitter account, @networksvox, for updates regarding the course.

Academic assistance: Anyone who requires assistance in any way (as per the ACCESS program or due to athletic endeavors), please see or contact me as soon as possible.

Being good people: In class there will be no unnecessary electronic gadgetry, no cell phones, no beeping, no text messaging, etc. You really just need your brain, some paper, and a writing implement. I encourage you to email me questions, ideas, comments, etc., about the class but request that you please do so in a respectful fashion. Moreover, all interactions with classmates during lectures and office hours or in any way related to being part of PoCS should be respectful. As in all UVM classes, **Academic honesty** will be expected and departures will be dealt with appropriately. We will follow UVM's community standards and guidelines: See `http://www.uvm.edu/cses/`http://www.uvm.edu/cses/.

Late policy: Unless in the case of an emergency (a real one) or if an absence has been predeclared and a make-up version sorted out, assignments that are not turned in on time or tests that are not attended will be given 0%.

Grades:

A+	97–100	B+	87–89	C+	77–79	D+	67–69
A	93–96	B	83–86	C	73–76	D	63–66
A-	90–92	B-	80–82	C-	70–72	D-	60–62