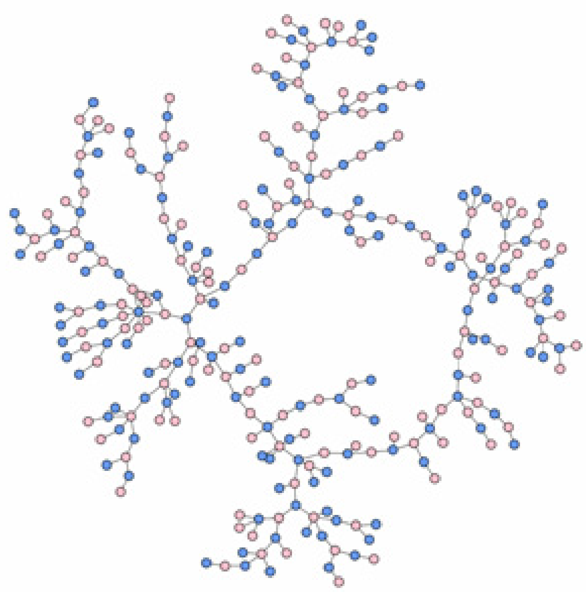
Complex Networks

CSYS/MATH 303; Deliverator: Prof. Peter Dodds
Tuesday and Thursday, 2:30 pm to 3:45 pm in 400 Lafayette
Level: Graduate/Advanced Undergraduate
@networksvox #SpringCoNKs2014

Basic stuff:

Instructor: Prof. Peter Dodds.
Lecture room: 400 Lafayette
Meeting times: Tuesday and Thursday, 2:30 pm to 3:45 pm
Office: Farrell Hall, second floor, Trinity Campus.
Office hours: 3:45 pm to 4:15 pm, Tuesday, and 12:45 pm to 2:15 pm, Wednesday.
Course website: http://www.uvm.edu/∼pdodds/teaching/courses/2014-01UVM-303
Course hashtag: #SpringCoNKs2014
Source material: Journal papers and book excerpts.
E-mail: peter.dodds@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; 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; folksonomy and tagging; generalized notions of contagion in networks; network epidemiology and fad spreading; computation considerations for analysing networks.

Prerequisites: 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 (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 (1/14 and 1/16)	overview	overview
2 (1/21 and 1/23)	overview, branching networks I	Guest lecture: Cathy Bliss, Gephi demonstration (plus online lecture)
3 (1/28 and 1/30)	branching networks I	branching networks II
4 (2/4 and 2/6)	branching networks II	branching networks II
5 (2/11 and 2/13)	optimal transportation	optimal transportation
6 (2/18 and 2/20)	optimal transportation	project presentations†
7 (2/25 and 2/27)	random networks (online)	random networks (online)
8 (3/4 and 3/6)	Spring Recess	Spring Recess
9 (3/11 and 3/13)	bipartite networks	contagion
10 (3/18 and 3/20)	contagion	contagion
11 (3/25 and 3/27)	contagion	contagion
12 (4/1 and 4/3)	contagion	chaotic contagion
13 (4/8 and 4/10)	assortativity	mixed random networks
14 (4/15 and 4/27)	centrality	structure detection
15 (4/22 and 4/24)	structure detection	structure detection
16 (4/29)	organizational networks	—

†: 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 8, 1:30 pm to 4:15 pm, 400 Lafayette. .

Times may adjusted based on class size.

Important dates:

1. Classes run from Tuesday, January 14 to Tuesday, April 29.
2. Add/Drop, Audit, Pass/No Pass deadline—Monday, January 27.
3. Last day to withdraw—Friday, March 28 (Never!).
4. Reading and Exam period—Thursday, May 1 to Friday, May 9.

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: First, in class there will be no electronic gadgetry, no cell phones, no beeping, no text messaging, etc. You really just need your brain, some paper, and a writing implement here (okay, and maybe Matlab). Those who beep in an annoying fashion will be fined one organic banana by the lecturer. Second, I encourage you to email me questions, ideas, comments, etc., about the class but request that you please do so in a respectful fashion. Finally, as in all UVM classes, **Academic honesty** will be expected and departures will be dealt with appropriately. See `http://www.uvm.edu/cses/` for guidelines.

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