

HNR195I-005: COMPLEX SYSTEMS
In Biology, Engineering, And Social Science: Connectedness, Network Analysis, And An
Introduction To Modeling
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Class room and meeting times

The class will take place Mondays 2-2:50pm in ENR2 room S495.

Class topic and goals

The topic of the course are 'complex systems' across biology and other areas of science and engineering. 'Complex systems' are composed on multiple interacting units, and often show sophisticated behavior that is not easily predicted even knowing the capabilities of individuals. For example, how does our perception of the world result from just simple nerve cells sending essentially binary signals? How does an ant colony make a collective decision among nest sites that vary in a series of traits? How does a complex multicellular organism emerge from initially identical embryonal cells? The science of complexity studies how such collective behaviors emerge from the actions and interactions of individuals in a system. This research has generated both philosophical questions (what is emergence?) and engineering applications (how to manage an efficient internet).

We will read about and discuss these topics; students in the class will also complete two projects, one of which will involve writing scripts for network analysis (using 'R'), the other implementing an individual-based simulation (using 'Netlogo'). No prior programming experience is required. The goal of the class is to introduce students to these important skills (script writing and programming) in a stepwise fashion; both R and Netlogo provide a wealth of tutorials, some of which will be used in class. We will also discuss the role of modeling, mathematics, statistics, and computer simulations in science more generally. We will also talk about how science works and careers in science.

This is a colloquium, meaning it will be an interactive class in which the focus is on your active participation by thinking, reading, and speaking.

Course website

Before the semester starts, or if you are not enrolled, you can get information such as this syllabus on the course website http://socialinsectlab.arizona.edu/hons_coll3.

The website you will be actively using during the course is located on D2L, at d2l.arizona.edu. You will be able to access it when the semester starts. You have to check this site regularly to obtain readings and announcements for the class. You can also submit assignments and check your grades there. You can access the site from computers on campus if you don't have one at home. Note that student computer labs also offer printing services if you would like to print out readings. To access your course on D2L you must have a UA NetID and be officially enrolled in the course for at least 24 hours.

Readings & participation

There will be some readings made available on the D2L website. The dates for which the readings should be read are listed on the class schedule, also available on D2L. It is your

responsibility to check this website regularly for changes, and to get any reading assignments from there (they may or may not be mentioned in the class before they are due).

I expect you to think about topics in the class actively and independently. If you come across readings you think would be interesting for the class, or you just want to let me and your fellow students know what you've learned from such other sources, please do let me know in class or by email.

It is very important for almost any career that you may be working toward that you can and do voice your opinion, ask questions, and communicate your knowledge in a group context. Therefore, *in every class*, you should aim to participate in class discussions and have an active conversation with your teacher whenever you have the opportunity. If you do this, you will learn more from the class and acquire an important skill. It will also have a major effect on your grade. If you are having trouble expressing yourself in class, contact the instructor early on in the semester.

Grading

Your grade for this class will be determined from your participation in discussions in class (40%), the analysis project in R (10%) and the simulation project in Netlogo (50%). There are no exams in this class.

Class project 1: R network analysis

You will be introduced to R as a scripting language/tool for data analysis in class. Using a dataset provided in class or one you found in literature/online, you will graph an interaction network and compute some appropriate descriptive statistics, then discuss what they mean.

Grading rubric for the R class project: total 10 points

	These are things you might do to get full points:	Points
Formatting and clarity	Script is clearly explained (comments in script), you are using indentation and variable names to best effect.	2
Correctness	Values correctly calculated, script runs without error messages.	4
Originality	Find a network statistic, or combination of analyses, that was not directly addressed in class but is appropriate for your dataset.	1
Interpretation	Explain what might be concluded from your analysis.	3
In sum...		10

Class project 2: NETLOGO model

All students will program their own simulation of group behavior in Netlogo (<http://ccl.northwestern.edu/netlogo/>). This is a free downloadable tool for individual-based simulations. The simulation should include a list of behaviors agreed upon in class, as well as at least one output plot, a slider or button that you defined (in addition to 'go' and 'setup'), and extensive comments within the actual code (starting with ;) that explain what your program should do overall as well as what each part of it is doing. Accurate indentation is also a good programming habit.

Grading rubric for the Netlogo class project: total 50 points

	These are things you might do to get full points:	Points
Formatting and clarity	<ul style="list-style-type: none"> - Correct indentation - Clearly commented in code - Useful variable names - There is no code that is never executed - Generate a plot of what's happening in the Interface 	15

	tab	
Complexity of the model	Include some version of <ul style="list-style-type: none"> - Turtles following some other turtle - Turtle communication - Using patch variables - Food which turtles eat, and something that happens if they don't - Turtles belong to different types or groups which have different behavior 	25
Originality	Have something you came up with: either the way the elements above are put together, or what the overall goal is, or a new behavior we haven't talked about.	5
Interpretation	Within the code or in the Info tab there is a description of what you find interesting about your model, and what complex behavior/emergent behavior you observed.	5
In sum...	Everything works without error messages	50

General issues

Professional Communication

If you send any emails to the instructor or TA, make sure to mention the name of the class (HNRS195) in the subject line. Also, start your email by addressing the recipient, and end it with a greeting. A professional way to address persons with a PhD is, for example, "Dear Dr Dornhaus"; always end the email with your full name. Yes, that's also good form for replies in email chains. Re-read your email to check for spelling and grammar errors. Not adhering to these rules will mean that the addressee will get the impression that you are unused to professional communication, and this will probably result in them focusing on your communication style instead of your actual message; this is very detrimental in emails to future employers or mentors, so you should start practicing good habits now. Never assume an email will be answered in less than 3 days.

Classroom Behavior Policy

To foster a positive learning environment, students and instructors have a shared responsibility. We want a safe, welcoming, and inclusive environment where all of us feel comfortable with each other and where we can challenge ourselves to succeed. To that end, our focus is on the tasks at hand and not on extraneous activities (e.g., texting, chatting, reading a newspaper, making phone calls, web surfing, etc.).

For this class, use of a laptop to complete programming exercises and post comments on D2L is highly recommended. However, I expect the laptop to be used almost exclusively for the current class-relevant task. If I notice that your laptop is distracting to other students I will ask you to shut it down.

This course supports elective gender pronoun use and self-identification; rosters indicating such choices will be updated throughout the semester, upon student request. As the course includes group work and in-class discussion, it is vitally important for us to create an educational environment of inclusion and mutual respect.

Absence Policies

The UA's policy concerning Class Attendance, Participation, and Administrative Drops is available at <http://catalog.arizona.edu/policy/class-attendance-participation-and-administrative-drop>.

The UA policy regarding absences for any sincerely held religious belief, observance or practice will be accommodated where reasonable: <http://policy.arizona.edu/human-resources/religious-accommodation-policy>.

Absences preapproved by the UA Dean of Students (or dean's designee) will be honored. See <http://policy.arizona.edu/employmenthuman-resources/attendance>.

If you are absent for any other reason, this may have negative effects on your grade: in particular, you will likely miss the class quizzes and you won't be able to participate, lowering your grade for participation. In addition, you will miss the instruction provided in class as well as your opportunity to actively engage with the material. If you are sick, send the instructor an email immediately (before you miss class).

Requests for incomplete (I) or withdrawal (W) must be made in accordance with University policies, which are available at <http://catalog.arizona.edu/policy/grades-and-grading-system#incomplete> and <http://catalog.arizona.edu/policy/grades-and-grading-system#Withdrawal> respectively.

UA Nondiscrimination and Anti-harassment Policy

The University is committed to creating and maintaining an environment free of discrimination; see <http://policy.arizona.edu/human-resources/nondiscrimination-and-anti-harassment-policy>. Our classroom is a place where everyone is encouraged to express well-formed opinions and their reasons for those opinions. We also want to create a tolerant and open environment where such opinions can be expressed without resorting to bullying or discrimination of others.

Accessibility and Accommodations

Our goal in this classroom is that learning experiences be as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, please let me know immediately so that we can discuss options. You are also welcome to contact the Disability Resource Center (520-621-3268) to establish reasonable accommodations. For additional information on the Disability Resource Center and reasonable accommodations, please visit <http://drc.arizona.edu>. Please plan to meet with me by appointment or during office hours to discuss accommodations and how my course requirements and activities may impact your ability to fully participate.

Please be aware that the accessible table and chairs in this room should remain available for students who find that standard classroom seating is not usable.

Code of Academic Integrity

Students are encouraged to share intellectual views and discuss freely the principles and applications of course materials. Students are also encouraged to give concrete tips for solving programming or scripting problems using the D2L Discussion board. The use of the internet or published works to help you solve problems in the assignments is also encouraged. Otherwise, graded work/exercises must be the product of independent effort. Students are expected to adhere to the UA Code of Academic Integrity as described in the UA General Catalog.

See <http://deanofstudents.arizona.edu/academic-integrity/students/academic-integrity>.

The University Libraries have some excellent tips for avoiding plagiarism, available at <http://www.library.arizona.edu/help/tutorials/plagiarism/index.html>.

Selling class notes and/or other course materials to other students or to a third party for resale is not permitted without the instructor's express written consent. Violations to this and other course rules are subject to the Code of Academic Integrity and may result in course sanctions. Additionally, students who use D2L or UA e-mail to sell or buy these copyrighted materials are subject to Code of Conduct Violations for misuse of student e-mail addresses. This conduct may also constitute copyright infringement.

Threatening Behavior Policy

The UA Threatening Behavior by Students Policy prohibits threats of physical harm to any member of the University community, including to oneself. See <http://policy.arizona.edu/education-and-student-affairs/threatening-behavior-students>.

Additional Resources for Students

UA Academic policies and procedures are available at <http://catalog.arizona.edu/policies>.
Student Assistance and Advocacy information is available at <http://deanofstudents.arizona.edu/student-assistance/students/student-assistance>.

Confidentiality of Student Records

<http://www.registrar.arizona.edu/ferpa/default.htm>

Subject to change

Please note that the information contained in the course syllabus, other than the grade and absence policies, may be subject to change with advance notice, as deemed appropriate by the instructor. This is particularly true of the details in the course schedule. The most up-to-date version of the class schedule (including assignment due dates) can always be found on D2L.