ECOL496H/596H

Complex systems

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Course webpage:

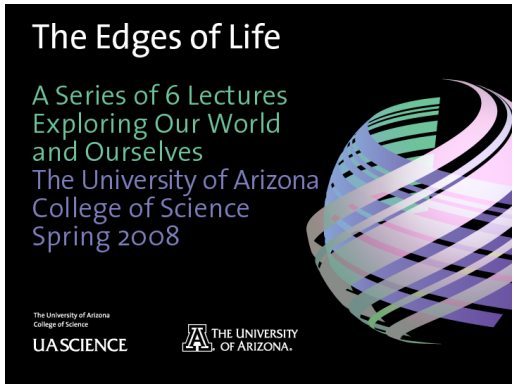
http://www.eebweb.arizona.edu/Faculty/Dornhaus/courses/ecol596h.html

Anna's research

Colony organisation

- Collective decision-making in ants
- Communication and pheromones in bumble bees
- Benefits of recruitment in honey bees
- Division of labor in ants and bees

http://cos.arizona.edu/edges/



Reading/Discussion group on Agent-based models:

http://www.u.arizona.edu/~jtmurphy/ABM/index.htm

Introduction round

- Say your name, grad/undergrad/postdoc, year, major/research area
- What are you hoping to learn in this class
- Which topic are you most interested in for your own talk

Some admin stuff

Highlights of the syllabus

- Check out the website http://www.eebweb.arizona.edu/faculty/dornhaus/courses/ecol596h.html
- Your grade will be determined by your talk/discussion leadership (40%), attendance and participation in discussions (40%), and handout and Wikipedia entry (20%).
- Please note that missing class without excuse more than 3x is a failing grade for participation. Remember to speak up in class!
- No class on March 5th.

Some admin stuff

Talks - general

- Four important requirements:
  - Pick a reading for everyone (no more than 1-2 papers), email me this before the seminar a week before yours
  - Write a handout for everyone
  - Prepare your slides, give your talk
  - Lead a discussion on your topic after your talk
- (Anyone), feel free to contact me with questions in advance, or for reading suggestions
- Undergrads 15 min, grads 30 min

Some admin stuff

Talks - general

- I'm hoping that each talk will teach us about a particular subfield of 'complex systems research', focusing on what it is that we can learn from that particular approach (over classical approaches)
- Talk about **what, why, and who** – throw in a short 'who's who' on one or two important names in the field, or authors of the paper(s) you read

Some admin stuff

Talks – making the slides

- If you are an undergraduate, make sure to send me your draft slides at least two days before the seminar
- Use at least 20 point font, preferably 32 point font. Use high contrast between text & background.
- Explain everything, avoid acronyms and jargon! Remember that other student may not have background in your area at all.

Some admin stuff

Wikipedia

- A great resource, but for anything important, double-check with references!
- Anyone can write and edit.
- For this class, you will write your own entry! (or improve an existing one, ideally a 'stub')
- Email me first which entry you propose to change, and print out the previous version.
- Make sure to add graphs or pictures and references wherever possible.

Complex systems

What is a complex system?

- No consistent definition
- My definition: A system in which multiple parts interact, producing interesting collective behavior not easily predictable from knowledge of the parts
- 'Anti-reductionism', 'Holistic approach', 'Emergence', 'Self-organization', 'Lack of centralized control'

Complex systems

In ecology

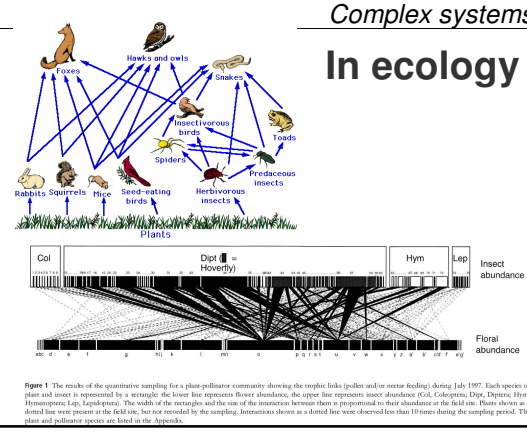
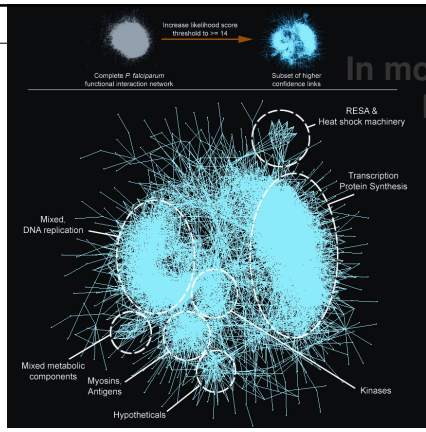


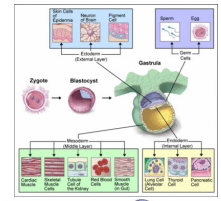
Figure 1 The results of the quantitative sampling for a plant-pollinator community showing the trophic links (pollen and/or nectar feeding) during July 1997. Each species of plant and insect is represented by a rectangle; the lower line represents flower abundance, the upper line represents insect abundance (Col, Coleoptera; Dipt, Diptera; Hym, Hymenoptera; Lep, Lepidoptera). The width of the rectangles and the size of the interaction between them is proportional to their abundance at the field site. Plants shown as a dotted line were present at the field site, but not recorded by the sampling. Interactions shown as a dotted line were observed less than 10 times during the sampling period. The plant and pollinator species are listed in the Appendix.

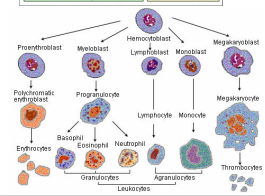


In molecular biology

Plasmodium interactome

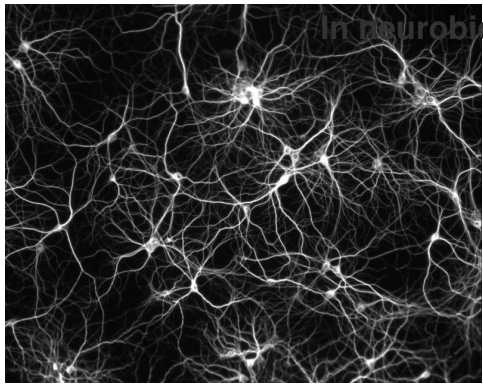
Complex systems





In developmental biology

Complex systems



In neurobiology

Complex systems

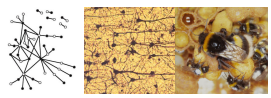
In societies

Formation of spore-carrying body in slime molds

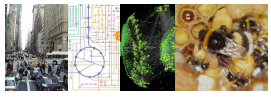
Complex systems

Common issues?

task allocation



information flow



minimization of delays

Complex systems

Common issues?

- How is order created? (pattern formation, task allocation, spatial form)
- How does information spread? (disease, material distribution)
- How robust is the system? (loss of parts, extinction, individual errors)

Common issues?

- How is order created? (pattern for
- How (di
- How parts, extinction, individual errors)

Are there maybe only a few mechanisms that work? Is the particular shape of the network/system an adaptation?

"Physics and stamp-collecting"

- "everything is physics"
- - but this may not help: complex systems cannot be understood on the basis of understanding the parts – atoms – alone
- Is this what makes biology special?
- Can there be general laws in biology?

Approaches

- Networks theory & Graph theory
- Agent-based modeling & simulation
- Experimentation at the individual/part or at the collective/system-level

Next time – networks?

Sign-up for talks/dates

- Pick a topic from the list or make up your own!
- Indicate date conflicts
- I'll try to sort it out and let everyone talk on their first or second choice of topic; we have 13 slots and 16 students signed up!