syllabus

SIO 216 Introduction to the Physics of Complex Systems

Winter Quarter 2015 Tu/Th 12:30-1:50PM Vaughn Hall 300
Weekly Homework/Discussion meeting will be scheduled so everyone can attend
(prior to or during the first class meeting)

20 Lectures/Discussion
Weekly Homework problems in Octave (open source matlab)
Group Project
30 min presentation plus 15 min questions at end of quarter on a topic related to complex systems

Graded S/U Only (except by exception - if you need a grade)

1. What is Complexity? Approaches to and History of Complex Systems

DYNAMICS APPROACH
2. Nonlinearity, Dissipation, Phase Space, Attractors, Maps and Feedbacks
3. Stability of Attractors and Bifurcations
4. Patterns, Feedbacks and Emergent Behavior
5. Self-organization, Slaving and Modeling

OPTIMIZATION AND UNIVERSALIST APPROACHES TO COMPLEX SYSTEMS
6. Nonlinear Optimization, Simulated Annealing
7. The Brain and Neural Networks
8. Complexity & Optimization in Natural Selection: Genetic Algorithms & Boolean Networks
9. Cellular Automata
10. Complex Adaptive Systems and Artificial Life

CHAOS, FRACTALS AND DATA ANALYSIS
11. Fractals and Networks
12. Routes to Deterministic Chaos, Chaotic Systems
13. Nonlinear Time Series and Spatial Forecasting

MULTI-SCALE COMPLEX SYSTEMS
14. The Tools of Complexity and Translations
15. Hierarchical Complex Systems

AGENT-BASED MODELING OF COMPLEX SYSTEMS
16. Agent-Based Modeling
17. The Stock Market
18. Societal Institutions and Behavior
19. Human-Environmental Interactions

20. Summary

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what do you need to know?

complexity is of interest across a broad range of disciplines, and so generally, this course is open to any graduate student at ucsd who wants to take it, and i will do my best to accommodate everyone.

however, some of our discussions will get a bit technical and sometimes mathematical and physicsy, so some background will help you get more out of the course, namely calculus thru ODEs, and some passing familiarity with PDEs would be helpful. if you do not have a familiarity with differential equations, you will probably find some of the homework problems and some of the lectures very difficult.

IMPORTANT: this is not a math course, so we will use various mathematical techniques at times, but we will not dwell on them - the concepts will be our central focus.

most of the homework problems will involve Octave, the open source version of Matlab. if you know Matlab, you are good. if you don't know matlab, but do have programming experience in another language, you should be able to pick up what you need to know very quickly. if you don't have any programming experience, you are going to find the homework very challenging - plan on spending some time the first few weeks of the quarter becoming familiar with Octave.

during the first homework/discussion meeting, i will go over downloading Octave, which is free and runs on windows, os x, and linux.

if you have any questions about what you need to know, don't hesitate to contact me!

course policies

Respect for all participants in SIO 216 and their varying backgrounds, knowledge and life experience is required. SIO 216 is a safe zone for people of color, womyn, queers, alternately abled folks, economically disadvantaged people, youth, elders, those who have experienced violence, undocumented people, religious minorities and anyone, individually or as a group, who has been oppressed.

Everyone is encouraged to commit to and participate fully in class discussions and group projects, and to honor, respect and make space for the disparate intellectual perspectives that might emerge. If you find that you are talking a lot, please step back; if you find you aren't contributing as much as others, please step up.

Please turn off cell phones, tablets, laptops and other low dissipation communications devices during class discussions.

Thank you!

grading

Evaluation of your learning experience in SIO 216 using a scalar is an absurd simplification completely at odds with the dynamics and complexity of that experience.

Feedback will be extensive, but at the end of the quarter university regulations require that we come up with a single letter grade (sigh!). This will be done by combining numerical evaluations of required work in the following approximate proportions:
--class participation and attendance 15%
--homework 40%
--group project 20%
--final project/presentation 25%