Biological Modeling

Fall 2017 Syllabus for GEOG 468 /ANSC 449 / CPSC 448 / IB 491
MW, 10:00-12:20 – Second half of semester (Oct. 23 – Dec. 13)
338 Davenport Hall

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What is the goal of the course?

Just as universities have striven for centuries to teach us first how to become literate and later, numerate, this aim of this course is to teach you how to become "ecolate" or "system thinking"...how to develop the skill to state a dynamic problem, to deduce from this statement an interesting question, to answer that question skillfully, and finally to ask, "In what ways is this picture incomplete?"

What can you learn in the course?

We all have mental models of the way the world works but the truly effective of such models are for surviving, for short-term phenomena, such a crossing a busy street or ducking a flying rock. When there are time delays before the appearance of the effects of a certain action, when there are random events affecting the dynamics, when both positive and negative feedback loops are present and when the problem is so complex that it requires the knowledge of several people working together, our mental models need help. Just as the microscope and the telescope are aids to the eye, the dynamic modeling computer process is an aide to the mind.

I want you to learn to think about dynamic issues systemically. In this course, those issues are biological in nature--from models of the heart to models of ecosystems--you need to understand how the process of dynamic modeling works. The course is a tension between teaching you the methods of dynamic modeling (without reference to complex programming or high level math) and the need for exposure to many different modeling problems. To be an effective modeler, you must both master technique and acquire a library of solution types. With knowledge of the solutions to many different kinds of problems, you will have an experience base that allows you to form analogies to new problems based on the solutions to familiar problems--one of the truest forms of creativity. I encourage your contributions and creativity in suggesting possible solutions to the questions I pose in the course.

What is the value of what you could learn here?

No matter what you do latter in life I can promise you one thing here: If you work at learning the modeling process and build this repertoire of solutions, you are uniquely prepared to improve upon any situation you might encounter in professional life--as a researcher doing your thesis or in academic or private practice, in any field. You might someday be involved in the process of modeling industrial processes, the function of various body organs, the fate of endangered species, nearly any kind of problem. I cannot guarantee success--but this course will improve your chances for success.

How is the class taught?

There are no hour exams. Every class day (2.5 hours each--twice a week) is spent on building and elaborating the simulation of some dynamic biological process. Every week, there is a homework problem. At the end of the semester, a special project model is to be completed and presented to the class. Start work on your project immediately. I have some topics for you. The literature in your field should be a good source of dynamic problems. The homework and the project carry equal weight in grading. Students work in partnerships–usually a graduate student works with an undergraduate. I allow you to resubmit your homework if you missed the point of a modeling problem. I will ask you periodically how the teaching technique, homework and project preparation is proceeding.

Software and Format for the Course

The text: I use the book: Modeling Dynamic Biological Systems, Springer, Hannon and Ruth, 1997, 2nd Edition. It is available as an eBook free to students through the University Library. We will follow the book closely and try to cover as many different issues as possible, hopefully covering the entire book.

For one homework assignment, we use the program MADONNA that allows formal compiling of the STELLA equations for rapid running of any models. MADONNA (Runtime) is available free at: http://www.berkeleymadonna.com/download.html. A full copy of MADONNA is not necessary for this course but it might be useful for your project model or thesis.

The main operating program for the class is STELLA version 10.1.2. It is available free to use in the classroom and in the basement computers in the ACES Library, FLB 8 and all ATLAS sites. The ACES library version can be accessed on line anytime. You may purchase this program from ISEE over the web as a class member with a discount.

Homework: You must follow this format (grade reduced if you don't):

USE 9 pt. FONTS.

Your name(s) GEOG or IB or ... 468 Date.....

Homework # ....HW1, HW2, ...

GIVEN: [Here you describe the problem you wish to solve, in concise text.]

QUESTION(S): [Here you state in the form of a formal question(s), exactly what you are trying to learn from this modeling enterprise. Remember: questions end with a ?.]

SOLUTION: [Here you state how you constructed your model, why you made the assumptions that you did (give the complete references if there are any), and what the results are, referring to the specific graphs and tables by their number. Discuss concisely the meaning of these graphs and tables. Leave no act unexplained. Think of yourself, a year from now, trying to reconstruct how and why you made this model. Have you described this model so that you could do this, or better, so that someone else could do reconstruct it without further help?]

FURTHER QUESTIONS: [Here you state the questions that the modeling process revealed would be good ones to pursue further, if you had the time. Remember: questions always end with a ?. No modeling process is complete. Every thoughtful process produces more questions than it answers. Here is where you specifically note this fact.]

ANALOGIES: If necessity is the mother of invention, analogy is the father. To become a creative modeler, you must use analogy--in this case—ideas from previous models. Here is where you give, as closely as possible, another phenomenon or two that could use the same model structure as the one in the Homework model. For example, the population growth model could be transformed, with different parameters of course, into a model of water collecting in a reservoir that was also draining (more slowly). Birthing is Filling, Dying is Draining and the Population is the Water Storage.

In the class, we communicate (turn in homework, ask questions, mail others, etc.) across the net through a program called Compass. We use no paper in this course. Compass is available thru any browser over the Net: https://compass.illinois.edu/webct/entryPageIns.dowebct and Login by the usual method. There you should find an Assignment. Just send the homework from the first day **directly to that assignment**. No one but you and I have access to this information. I will send a weekly note back to you with the grade and comment on that homework. If you do your homework with another student in the class, list their name at the top of the HW and have them turn in an identical HW.

Email me directly if you have any specific questions or problems. **For example, tell me individually if your partnership is not working well or could be working better. Do not put up with a partner who does not supply half the needed effort. A well-functioning partnership should allow you both to learn more than you could alone.** A poorly working partnership might hurt the grades of both participants.