BIOL 2400: Mathematical Models in Biology

Spring Semester 2012, 3 credits

TR 9:35 – 10:55 am
Clough Commons 102

Instructors

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Overview

This is an active-learning class that explores mathematical models from several domains in biology, including epidemiology, ecology, and evolution. The course is built around a series of assignments that introduces students to:
techniques such as model prototyping, sensitivity analysis, evaluation of trade-offs, and how to communicate using models; *computational simulations* with the software Microsoft Excel, and exercises that support a thorough understanding of the *concepts and practices* of stochastic and dynamic modeling.

Prerequisites

One year of calculus (differential and integral) and one year of biology are required for the course. We assume you are comfortable with basic use of Microsoft Excel. Familiarity with simple probability and statistics concepts is helpful but neither assumed nor required.

This is not a course in probability and statistics, nor does it require extensive mathematics. We will use some differential and integral calculus, simple matrix algebra and linear algebra, and simple statistics as needed. We will teach you the mathematics and software implementation that you need for the course.

Learning Objectives

By the end of the course, you will develop several skills that will serve you as a scientist and responsible citizen, no matter which profession you choose. These skills include:

1. Graphically and verbally representing vague problems.
2. Quantitative representation of hypotheses.
3. Basic model analysis: simulation, equilibria, stability, assumptions, sensitivity analysis, validation.
4. Modeling stochastic processes.
5. Communicating model results to a target audience in the most economic and efficient ways possible.

Instructional format
Three hours each week are scheduled for the class. Class time will be approximately equally divided among short "mini-lectures" and group problem-solving exercises or discussions.

The course is designed around students formulating and solving problems in small cooperative groups. The following rules apply to all group work:

1. Everyone is responsible for making sure that all group members contribute.
2. Assist each other in understanding the material and in developing skills such as translating scenarios to equations, using computer software, and designing figures and tables.
3. Because of the heavy emphasis on group work, it is important that you attend each and every class, that you arrive on time, and that you stay for the entire class period.

Some class days will be devoted to in-class computer modeling exercises. These days will be announced at least one day in advance. You will be asked to bring laptop computers to class to work on these assignments.

Course policies and assignments
Homeworks: Each homework assignment will be prepared as a single report or a composite of 2-3 short reports. Please read and refer to the Report Guidelines posted on Tsquare for each homework assignment. Homework is due at the beginning of class. We prefer that you submit your homework in-class as a printout. If you need to submit electronically, please submit in pdf format (if needed, there is freeware CutePdf.com). You may work collaboratively with other members of the class on the conceptualization, development, and interpretation of the homework, but **collaboration is not permitted for the written write-up** of the homework. If you use any sources other than class notes or your own original ideas, you must cite the source(s). Supporting statements in your introduction or summary should include citations to the same degree that any biological lab report requires. Violation of these policies will be in violation of the GT Honor Code. **Late homework assignments** will be accepted up to 5 days late, with 10% deducted per 24 hour period that it is late.

Participation: There will be frequent in-class exercises that will constitute part of your participation grade. These will assess your comprehension of lecture material and can take place in any class.

Exams: There will be two non-cumulative exams in this course. Exams will represent the work of the individual and no collaboration or outside resources (notes, textbook, internet) will be permitted during the examinations.

Group Project: The last unit of the course will focus on a project that you will develop in groups of 3-4 students. You will be able to choose a problem from a common theme, identify a specific goal, and create a model to accomplish that goal. Each group will give an oral presentation during the final exam period. Each student in a group will earn the same base grade for the group's presentation. Confidential peer evaluations will be submitted and may be used to adjust an individual's grade on the project. You may not discuss your peer evaluations with any classmate at any time. Violation of this policy is a violation of the GT Honor Code and will result in a failing grade for the project.

Important: In-class use of cell phones or computers for purposes unrelated to course activities is not allowed. Any violations of the GT Honor Code will result in referral to the Office of Student Integrity with a penalty ranging from no credit for the assignment in question, to a grade of "F" for the class. We don't want to see you fail, and we will be glad to answer questions about class activities and the Honor Code.

Evaluation

Homework assignments	40%
Class participation (in-class exercises)	15%
Exam I (21 Feb) and Exam II (12 Apr)	30%
Final Group Project	15%

Final grades will be assigned using a 90-80-70-60 scale.

Resources

- Allman, E.S. and J.A. Rhodes. 2004. Mathematical Models in Biology. Cambridge University Press.
- Short papers and book excerpts, as assigned.
- Microsoft Excel (Windows XP/Vista/7 or Mac OS X).
- Tsquare — http://tsquare.gatech.edu

Academic Integrity: Students are reminded of the obligations and expectations associated with the Georgia Tech Academic Honor Code and Student Code of Conduct, available online at:
http://www.deanofstudents.gatech.edu/integrity/policies/honor_code.php
http://www.deanofstudents.gatech.edu/codeofconduct.

Learning Accommodations: If needed, we will make classroom accommodations for students with disabilities. These accommodations must be arranged in advance and in accordance with the ADAPTS office (http://www.adapts.gatech.edu).

Schedule of Topics and Assignments

Note: The schedule is subject to modification. Readings from the primary literature and from other textbooks will be handed out in-class or posted on T-square.

Date	Topic	Assigned Reading	Assignment	Instructor
10-Jan	Introduction to Modeling	A&R p. 1–11		JSW
12–19 Jan	Population growth (3)	A&R p. 11–40, p. 85–105	HW1 due 1/26	JSW
24-Jan – 2-Feb	Probability (4)	A&R p. 113–155, p. 228–243	HW2 due 2/9	JSW
7–16 Feb	Statistical reasoning (4)	A&R p. 345–361		JSW
21-Feb	Exam I			JSW
23-Feb	Group Project Intro		Proposal due 3/1	CS
28-Feb – 13-Mar	Disease Dynamics (5)	A&R p. 279–307	HW3 due 3/15	JSW & CS
15-Mar	Project Workday			CS
20–22 Mar	*Spring Break*			-
27-Mar – 3-Apr	Tree Construction (3)	A&R p. 171–208; Review p. 138–155	HW4 due 4/5	CS
5-Apr – 10-Apr	Selection Models I (2)	Optional: A&R p. 261–271		CS
12-Apr	Exam II			CS
17–19 Apr	Selection Models II (2)		HW5 in-class 4/19	CS
24–26 Apr	Project Workdays			CS
2-May @ 8 am	Project Presentations			-