BIOL 2400: Mathematical Models in Biology

Spring Semester 2015, 3 credits TR 9:35 – 10:55 am Location: CULC 102
This course fulfills the Biology Quantitative Requirement.

Instructors

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Overview

This is an active-learning class that explores mathematical models from several dom ains in biology, including epidemiology, ecology, and evolution. The course is built around a series of assignments that introduce 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
- 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. You will develop the skills to:

1. Graphically and verbally represent vague problems.
2. Represent hypotheses quantitatively.
3. Analyze models with basic techniques: simulation, equilibria, stability, assumptions, sensitivity analysis, validation.
4. Model stochastic processes.
5. Communicate model results in in written, graphical, and verbal forms to a target audience, combining mathematical concepts and textual or oral explanations of the model results.

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. Students will 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

Homework: 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 T-square for each homework assignment. We prefer that you submit your homework in-class as a printout. If you need to submit electronically, please submit as a pdf to reserve formatting (if needed, there is freeware at 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 (ICE) 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 (17-Feb) and Exam II (9-Apr)	30%
Group Project	15%

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

Resources

- 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 Office of Disability Services (http://www.adapts.gatech.edu).

Schedule of Topics and Assignments
Note: The schedule is subject to modification. Additional readings from the primary literature and other sources will be handed out in-class or posted on T-square.

Spring 2015	Topic	Assignment	Instructor
6-Jan	Introduction to Modeling		both
8-Jan – 15-Jan	Population growth (3)	HW1 due 1/22	CS
20-Jan – 29-Jan	Probability (4)	HW2 due 2/5	JL
3-Feb – 12-Feb	Statistical reasoning (4)		CS
17-Feb	Exam I		–
19-Feb	Group Project Intro	Proposal due 2/26	both
24-Feb – 10-Mar	Disease Dynamics (5)	HW3 due 3/12	CS
12-Mar	Project Workday		both
16-Mar – 20-Mar	SPRING BREAK		–
24-Mar – 31-Mar	Natural Selection (3)	HW4 due 4/2	JL
2-Apr – 7-Apr	Genetic Drift (2)		JL
9-Apr	Exam II		–
14-Apr – 16-Apr	Spatial Models (2)	HW5 in-class 4/14	JL
21-Apr – 23-Apr	Project Workdays		both
28-Apr (Tues) 8–10:50 am	Group Project Presentations		