

Math/EEB682 Advanced Mathematical Ecology: Agent-Based and Hybrid Modeling in Ecology, Spring 2022

University of Tennessee, Knoxville

Meeting Time and Place: In-person, Tuesdays and Thursdays 4:30-5:45PM in Ayres 112

Course Credit Hours: 3.0

Course Instructor: Louis J. Gross, Chancellor's Professor and Alvin and Sally Beaman Distinguished Professor of Ecology and Evolutionary Biology and Mathematics

Course website: Available linked through the Teaching section of the instructors webpage at http://lgross.utk.edu/math682_spring2022.html - please see the website for details on the course structure, participant expectations, links to references, etc.

Course Objectives and Expectations:

Our goal is to expand on the material presented in Math/EEB 581-2 by discussing in particular modeling methods and areas of research that were not included in that sequence but which are currently being actively pursued. The emphasis is on developing participants' appreciation for additional central questions in mathematical and theoretical ecology that were not addressed in the mostly deterministic dynamical systems coverage of 581-2. The focus of that course sequence is on population and some aspects of community ecology. We will expand on this by including some of the variety of methods used to account for individual behavior as they impact population and community processes. In particular, agent-based modeling methods have become tremendously influential for investigating both foundational and applied research questions across the range of biological scales. Similarly, hybrid modeling methods that mix and link different mathematical approaches have provided new insight for problems that involve interactions at multiple spatial and temporal scales. While the examples we will discuss are mostly derived from ecological systems, the same underlying modeling methods are being applied in essentially every level of biology as well as to human social systems.

We will be basing part of the course on the material in two books about agent-based approaches: *Individual-based modeling and ecology* by Volker Grimm and Steven Railsback, Princeton University Press (2005) and *Modeling populations of adaptive individuals* by Steven Railsback and Bret Harvey, Princeton University Press (2020). Both of these are ebooks available through the UTK library. For the hybrid modeling portion of the course, we'll start with the review Stephanou, V. V. (2016) Hybrid Modelling in Biology: a Classification Review. *Math. Model. Nat. Phenom.* 11: 37-48 and read through a variety of papers.

Participant Expectations:

The course presumes mathematical maturity at the level of advanced calculus with prior exposure to basic differential equations, linear algebra, and basic probability. We will not assume that you have previously had the 581-2 sequence or 681 but will de-emphasize the overlap in material associated with those courses. Regarding participant expectations – registered students will be expected, in addition to actively participating in class discussions, to choose an individual project

related to the topics that preferably would be connected to their research or to expand their modeling background. A written report on this individual project as well as an oral presentation to the class is expected of all registered participants. Each participant will be expected to make an appointment with the instructor in approximately the middle of the semester to discuss their individual project and draft a short summary of the objectives of the project.

Course Modality: This class is scheduled to be in-person. My overall objective is to ensure that the class is as safe as possible for all attendees under the constraints set by the University. There may be temporary circumstances therefore in which we will hold class meetings virtually. In this case, I may make a class-by-class instructional decision to hold class online so that ALL students can learn together. If I am ill or if I know that I have been exposed to an individual with Covid infection, class will be held virtually. If I am notified that a significant fraction of class participants are unable to attend in-person due to illness, class will be held virtually and I will so inform all class participants by email. I will be wearing a mask in class and encourage others to do so as well to help reduce the likelihood of infection spread, at least for the first few weeks of the semester. If you are ill, please do not attend in-person, and if appropriate complete the Covid form at <https://covidform.utk.edu/index.php>. As Volunteers, we commit to caring for one another and for the members of the communities in which we live, work, and learn. Please remember that Vols help Vols so please endeavor to support the campus efforts to limit the spread and negative impacts of Covid on our community. If you have any concerns about your safety in this class please contact me.

Information on campus response to Covid is at <https://www.utk.edu/coronavirus/>

Information on the student counseling center is at <https://counselingcenter.utk.edu/>

Information on help available from the Dean of Students is at <https://dos.utk.edu/974-help/>

Faculty Contact Information

The instructor is available for consultation with participants through email (lgross@utk.edu). Due to the pandemic, the instructor will not be holding in-person office hours at least at the start of the semester but will be happy to meet virtually with participants at times set up through email.

University Policies:

The honor statement is included on the Campus Syllabus available on the Provost website at <https://utk.instructure.com/courses/55015/pages/ut-knoxville-campus-syllabus-%7C-2021-2022>. This includes sections on Academic Integrity, Your Role in Course Assessment, Students with Disabilities, Accessibility Policies, Wellness, Emergency Alert System, and COVID-19 Guidelines.

Key Campus Resources for Students:

- [Center for Career Development](#) (Career counseling and resources; HIRE-A-VOL job search system)
- [Course Catalogs](#) (Listing of academic programs, courses, and policies)
- [Hilltopics](#) (Campus and academic policies, procedures and standards of conduct)

- [OIT HelpDesk](#) (865) 974-9900
- [Schedule of Classes/Timetable](#)
- [Student Health Center](#) (visit the site for a list of services)
- [Student Success Center](#) (Academic support resources)
- [University Libraries](#) (Access to library resources, databases, course reserves, and services)