Introduction to Mathematical Biology
Instructor: Professor Alexandria Volkening
Course Number: MA 59800BM, Spring 2023
Credits: Three
Time: 10:30–11:45 AM TuTh

Description

This course will introduce participants to mathematical biology with a mathematical modeling-centric perspective. We will discuss several research vignettes, including examples from epidemiology and developmental biology, and use biological questions to illustrate both classic approaches and emerging techniques. For example, we will discuss compartmental modeling, dynamics on and of networks, parameter estimation, reaction-diffusion equations, cellular automaton modeling, and agent-based modeling. We will also highlight how data-driven methods for equation learning and topological data analysis (especially persistent homology) are being used in new ways to address challenges in mathematical biology now.

Complementing this, we will talk about methods for reading biological papers, working with quantitative or qualitative data, and effectively communicating mathematics in written and oral form across disciplinary boundaries. We will use computation, analysis, and modeling. Throughout the course, we will point out biology–math feedback loops, looking for how math can suggest experiments and how taking a biological perspective can drive new math. The latter portion of this course will include student presentations and discussions of research papers, and students will each complete a mini research project.

Other notes: There will be no exams, and grades will be based on participation, presentations, a few homework assignments, and the mini research project. In terms of background, experience with linear algebra and differential equations at the undergraduate level will be assumed; I anticipate that most projects will involve some simulations.

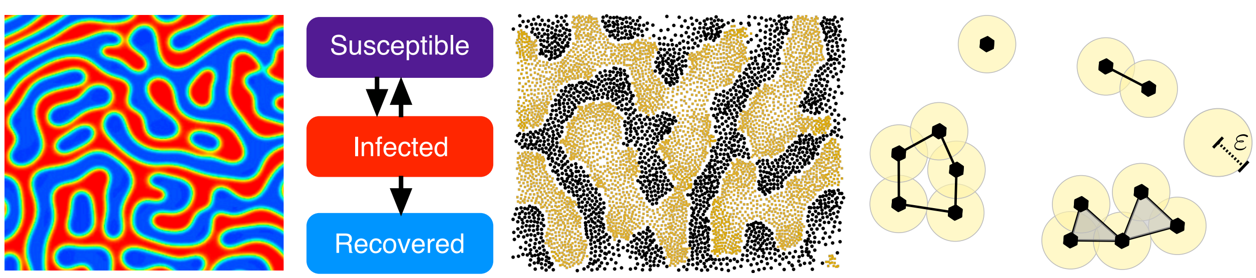

Figure 1: Mathematical biology. Examples shown here are drawn from ecology, epidemiology, and developmental biology and involve partial and ordinary differential equations, agent-based modeling, and topological data analysis. First image reproduced from “Phase separation explains a new class of self-organized spatial patterns in ecological systems” by Liu *et al.* in *PNAS* (2013); third image reproduced from “Modeling stripe formation in zebrafish: an agent-based approach” by Volkening *et al.* in *J Roy Soc Interface* (2015).