VMB 631
Mathematical Modeling of Biological Systems
Spring Quarter 2020
T 2:00PM–3:20PM & Th 2:00PM–4:40PM
Dryden 104

Instructor: Prof. Jan Medlock
Email: jan.medlock@oregonstate.edu
Phone: 541-737-6874
Office: Dryden 209
Office hours: TTh 10:30AM–12:00AM and by appointment
Textbook: None, but see below for suggested reference books
Prerequisites: Graduate standing or permission of instructor
Course credits: 3 total
Discussion: 1 1/2 hours per week, usually on Tuesdays
Computer lab: 2 3/4 hours per week, usually on Thursdays

Description

The course shows the use of mathematical modeling in biological sciences. A variety of modeling techniques are covered, including implementing the methods computationally.

Content

The course will introduce students to mathematical modeling to advance biological sciences. We will examine outstanding examples from the research literature across a broad range of biological disciplines. We will focus both on the contribution the modeling makes to the scientific application and on the modeling methods themselves. Substantial time will be devoted to implementing the models in the Python programming language.

Each student will need a computer to use for the programming portion of the course. Please let me know if this is a problem and we will make other arrangements.

During the last week of class, each student will give a short presentation of a paper from the literature that illustrates the use of mathematical modeling in biological sciences.

Objectives

By the end of the quarter, students will:

• Apply mathematical modeling to problems in the biological sciences.
• Chose appropriate modeling frameworks for biological problems, e.g. discrete vs. continuous and deterministic vs. stochastic.

• Implement basic models in Python.

• Perform basic mathematical analysis of models, e.g. find equilibrium points and their stability.

Computer labs

Roughly every week we will spend a large chunk of class time implementing the mathematical models that are used in papers we read. You may finish in class or you may finish later. Either way, you will turn in the result of these labs to me.

_I encourage you to work in groups, but the maximum group size is 3._

Presentations

During the last week of class, 2 & 4 June, you will give a short presentation of a paper from the literature that illustrates the use of mathematical modeling in biological sciences. The presentation can be from a published article or, if you are really ambitious, from your own research.

I will ask for some intermediate milestones to make sure things are progressing towards the presentation.

Attendance

There will be project presentations during the last week of class, 2 & 4 June. Attendance those days is _mandatory_, even on the days that you are not presenting.

Evaluation

Final grades will be determined by:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Computer labs</td>
<td>40%</td>
</tr>
<tr>
<td>Class participation</td>
<td>20%</td>
</tr>
<tr>
<td>Presentation</td>
<td>40%</td>
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</tbody>
</table>

Letter grades will then be assigned by:

\[
A \geq 90\% > B \geq 80\% > C \geq 70\% > D \geq 60\% > F
\]

*Note that the grade is not rounded: e.g. a grade of 89.9 is a B!*
Resources

Suggested reference books:

- Mathematical modeling for biology
  - Bolker, *Ecological Models and Data in R*, ISBN 9780691125220
- Python
  - https://www.python.org/
  - Pilgrim, *Dive Into Python 3*, http://www.diveintopython3.net/

Students with disabilities

Accommodations for students with disabilities are determined and approved by Disability Access Services (DAS). If you, as a student, believe you are eligible for accommodations but have not obtained approval, please contact DAS immediately at 541-737-4098 or at https://ds.oregonstate.edu/. DAS notifies students and faculty members of approved academic accommodations and coordinates implementation of those accommodations. While not required, students and faculty members are encouraged to discuss details of the implementation of individual accommodations.

Diversity

Carlson College of Veterinary Medicine strives to create a collegial, professional working and learning environment that is supportive of all; one that both values and demands respectful communication; encourages collaborations and allows students, faculty, and staff to contribute their best at all times.

Our College is committed to actively promoting diversity and inclusion that embraces the value of varied cultural backgrounds, ethnicities, gender identity and expression, sexual orientations, age, religions, and physical and mental abilities.

Our commitment to diversity and inclusion is a shared responsibility among our faculty, staff, students, alumni, and others who are part of the community.
We choose to be a culture that values diversity, inclusion, respect, empathy, and equity for all.

**Religious holidays**

Oregon State University strives to respect all religious practices. If you have religious holidays that are in conflict with any of the requirements of this class, please let me know and we will make other arrangements.

**Reach out for success**

University students encounter setbacks from time to time. If you encounter difficulties and need assistance, it is important to reach out. Consider discussing the situation with an instructor or academic advisor. Learn about resources that assist with wellness and academic success at [https://oregonstate.edu/ReachOut](https://oregonstate.edu/ReachOut). If you are in immediate crisis, please contact the Crisis Text Line by texting OREGON to 741-741 or call the National Suicide Prevention Lifeline at 1-800-273-TALK (8255).

**Student conduct**

[https://beav.es/codeofconduct](https://beav.es/codeofconduct)
## Speculative schedule

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Readings</th>
<th>Project</th>
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<tbody>
<tr>
<td>31 March &amp; 1 April</td>
<td>Introduction to mathematical modeling in biological sciences.</td>
<td>Chapter 1 of Otto &amp; Day.</td>
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<tr>
<td>7 &amp; 9 April</td>
<td>Introduction to Python.</td>
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<td>14 &amp; 16 April</td>
<td>Scalar discrete-time deterministic models.</td>
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<tr>
<td>21 &amp; 23 April</td>
<td>More on matrix models e.g. eigenvalues.</td>
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<td>Proposal</td>
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<td>28 &amp; 30 April</td>
<td>Parameter estimation.</td>
<td></td>
<td>Progress report</td>
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<tr>
<td>26 &amp; 28 May</td>
<td>Individual-based models.</td>
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<tr>
<td>2 &amp; 4 June</td>
<td>Modeling ethics.</td>
<td></td>
<td>Project presentations</td>
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