



# An Applied Mathematician’s Toolbox: Modeling, Data Science, and Applications

Mentors: Jennifer Paige, [jpaige@ucdavis.edu](mailto:jpaige@ucdavis.edu) & Kelli Gutierrez, [keloritsch@ucdavis.edu](mailto:keloritsch@ucdavis.edu)

Spring Quarter 2026, UC Davis

## Seminar Description

This seminar will be an exploratory introduction to mathematical modeling, covering different types of models, data incorporation into those models, and machine learning basics. Each topic will be paired with examples and applications from across disciplines to highlight their different strengths. Our goal is to give a broad perspective of the approaches available to applied mathematicians as they encounter modeling problems in the world. If you want to learn what mathematical models are, how to use them, and how to fit them to data, this is for you! Each week we will focus on a different topic, and we will blend each meeting with lecture and group work style format.

## Prerequisites

1. Calculus Sequence (MAT 21A-D)
2. Linear Algebra (MAT 22A)
3. Differential Equations (MAT 22B) (can be taken as a co-requisite)
4. Some coding experience in Python preferred, but not necessary.

No upper division courses required.

## Texts

Varies each week. See the week by week breakdown for details. Seminar notes, readings, and example code will also be provided via Google Drive.

(link: [https://drive.google.com/drive/folders/1SLMuRxKizhGDtgn54Vx7QeY2gE4\\_Av5j?usp=sharing](https://drive.google.com/drive/folders/1SLMuRxKizhGDtgn54Vx7QeY2gE4_Av5j?usp=sharing))

## Meeting Format and Expectations

We plan to meet for **60 minute** sessions once a week and we will try to pick a time that works for everyone! Each session will begin with a mini 20-30 lecture to introduce the topic and show some examples. We will then work collaboratively on a mini problem in groups for the second half of the meeting. Before each class there will be reading to familiarize yourself with the topic material.

## Learning Goals

Students will have a broader understanding of different techniques for mathematical modeling and dealing with data within mathematical applications. Students be introduced to several different applications and will learn how to apply skills to mini-projects. Finally, students will get experience working on hands-on projects in groups and gain coding experience.

## Tentative Seminar Schedule

- Meeting 1: Introductions and Crash Course in Mathematical Modeling and Data Science
  - No reading material.
- Meeting 2: Numerical Methods Overview and Coding Crash Course
  - Reading: Set up Python on computer and watch a getting started video on YouTube
- Meeting 3: Discrete vs. Continuous Models
  - Reading: Section 10.0-10.1 in **Nonlinear Dynamics and Chaos** by Steven Strogatz
- Meeting 4: Continuous/Compartmental Models (i.e. SIR model, Predator vs. Prey models, etc.)
  - Reading: **The Spread of the Disease: The SIR Model**, Notes from UColorado Boulder
  - *Optional paper: "An introduction to compartmental modeling for the budding infectious disease modeler" by Julie C. Blackwood & Lauren M. Childs*
- Meeting 5: Handling Data and Uncertainty Quantification (J)
  - Reading: Chapter 1 of **Uncertainty Quantification: Theory, Implementation, and Applications** by Ralph Smith
- Meeting 6: Regression
  - Reading: Sections 1.0 - 1.2 of **Applied Regression Analysis** by Norman R. Draper and Harry Smith (pages 15 - 28)
- Meeting 7: Regression in Context
  - No reading material.
- Meeting 8: Principal Component Analysis
  - Reading: Section 8.8 of **Applied Linear Algebra** by Peter J. Olver
- Meeting 9: Machine Learning: Neural Networks
  - Reading: Chapter 1 in **Hands-on machine learning with Scikit-Learn, Keras and TensorFlow : concepts, tools, and techniques to build intelligent systems** by Aurélien Géron
  - Video: But what is a neural network? by 3blue1brown (Link: [https://youtu.be/aircAruvnKk?si=fsS4rfvwKnwNiz\\_X](https://youtu.be/aircAruvnKk?si=fsS4rfvwKnwNiz_X))