PH 252B: Infectious Disease Modeling

Course Syllabus (Fall 2023)

Course Information

Meeting Dates and Times: Thursdays 9am-midday, August 24th – November 30th, 2023

Location: 1204 Berkeley Way West

Instructor: John Marshall E-mail: john.marshall@berkeley.edu Office hours: Mondays 11am-1pm

bCourses Address: https://bcourses.berkeley.edu/courses/1526520/

Class Slack Channel: https://ph252bspring2023.slack.com

Calendly: https://calendly.com/johnmmarshall

Course Unit Value: 3 units

Course Description

In recent years, mathematical models have greatly enhanced our understanding of the epidemiology of infectious diseases, and public health officials have increasingly used models to design effective control strategies. The goal of this course is to lead students through the process of designing mathematical models of diseases, fitting them to data, and using them as public health tools. Examples will be drawn from HIV, influenza, TB, mosquito-borne diseases such as malaria and dengue fever, and recent outbreaks such as COVID-19, Zika, Ebola and SARS. Each class will consist of a lecture followed by a computer-based activity to apply the lecture material. Students will also work on a project in which they will design their own model and use it to answer a specific research question.

Prerequisites

There are no prior course requirements; however, students should be able to write and interpret ordinary differential equations, and to manipulate beginner-level code in R.

Course Learning Objectives

After successfully completing this course, you will be able to:

1. Design compartmental models of infectious diseases,
2. Understand the role of heterogeneity, especially in sexually-transmitted infectious,
3. Understand the importance of stochasticity in outbreak modeling,
4. Estimate parameters, such as the basic reproductive number, R_0, from epidemiological data,
5. Fit mathematical models to incidence and prevalence data,
6. Incorporate interventions into infectious disease models.

Instructor Information

John Marshall **Email:** john.marshall@berkeley.edu **Office hours:** Mondays 11am-1pm **Calendly:** https://calendly.com/johnmmarshall/ph252b-office-hours	
John is an infectious disease modeler with expertise in malaria epidemiology and mosquito control. He has a PhD in biomathematics from UCLA, and worked as a postdoc at the UCLA Institute for Society and Genetics, the Malaria Research and Training Center in Mali, the Division of Biology and Biological Engineering at Caltech, and the Department of Infectious Disease Epidemiology at Imperial College London. Here at UC Berkeley, he teaches mathematical modeling of infectious diseases, and consults generally in this field. He leads a research group focusing on the use of mathematical models to inform genetics-based strategies for mosquito control, and to support efforts to control and eliminate mosquito-borne diseases such as malaria, dengue and Zika virus broadly.	

Course Format

Course Schedule

Week	Dates	Topic	Chapter Readings*	Additional Readings†
1	8/24	Intro to compartmental models Activity: Compartmental model of Ebola (due 8/30)	1-3	Cassels & Abbeele (2021)
2	8/31	Dynamics of simple compartmental models Activity: SEIR model in Berkeley Madonna (due 9/6)	4	Camacho *et al.* (2014)
3	9/7	Incorporating heterogeneity, STIs Activity: Heterogeneity in a gonorrhea model (due 9/13)	8	Ma *et al.* (2021)
4	9/14	Intro to stochastic models Activity: Stochastic models of gonorrhea & Ebola (due 9/20)	6	
5	9/21	Estimating parameters from incidence data Activity: Parameter estimation for H1N1 outbreak (due 9/27)	7	Cauchemez *et al.* (2011)
6	9/28	Estimating parameters from seroprevalence data Activity: Estimating age-dependent FOI for rubella (due 10/4)	5	
7	10/5	Outbreak data analysis Activity: Model development using SARS data (due 10/11)	9	Lipsitch *et al.* (2003)
8	10/12	Vector-borne diseases, programming in R Activity: Malaria & Zika virus models in R (due 10/25)		Kucharski *et al.* (2016)
9	10/19	Midterm project presentations (write-up due 10/25)		
10	10/26	Intro to Markov chain Monte Carlo methods Activity: Coding the MCMC algorithm in R (due 11/1)		Hamra *et al.* (2013)
11	11/2	Application of MCMC methods Activity: MCMC model fitting for H1N1 data (due 11/8)		
12	11/9	Individual-based models Activity: Individual-based model of gonorrhea in R (due 11/15)	6.3	Zelner *et al.* (2021)
13	11/16	Sequential Monte Carlo & approx. Bayesian comp. Activity: MCMC, SMC & ABC model fitting in R (due 11/29)		Ionides *et al.* (2006)
14	11/23	*Thanksgiving (holiday)*		
15	11/30	Final project presentations (write-up due 12/8)		

* Chapter readings taken from Vynnycky E, White R (2010) An Introduction to Infectious Disease Modelling. Oxford University Press.
† Additional readings provided on the bCourses website.

Course Grading

Grading is based on the following:

- Weekly activities: 30%
- Mid-term project: 30%
- Final project: 40%

Weekly Activities

Weekly activities (referred to in the Course Schedule) are designed to reinforce the lecture material and equip you with the practical skills required to carry out the project. Assignments will be published on bCourses by 5pm the Tuesday before class and relevant material will be covered in class on Thursday. Assignments will be due on bCourses by 1pm the Wednesday before the next class. They will be graded for completion out of 3, with the top 10 scores each contributing 3% to the final grade.

Project

The goal of the project is to design a model, fit it to data, and use it to answer a specific research question. You may work either as individuals or in small groups on an infectious disease of your choice. The data set may be sourced from bCourses or from an online or other resource. A marking schedule for the project presentations and write-ups will be provided separately.

Course Materials

bCourses Website

To access the course website, go to bCourses at bcourses.berkeley.edu. Here you will find links to the syllabus, lecture notes, practical notes, data sets, sample code, project descriptions, recommended readings, and additional course resources. Any course changes and updates will be reflected on this site.

Textbook

Vynnycky E, White R (2010) An Introduction to Infectious Disease Modelling. Oxford University Press.

Software

In the first half of the class, a modeling program called Berkeley Madonna (https://berkeley-madonna.myshopify.com/) will be used to code differential equations, and will be taught in-class. In the second half of the class, models will be coded and fitted in R (https://www.r-project.org/). A primer for coding mathematical models in R will be provided in the first week of class.

Course Communication

As we move through the course, we want to hear how it's going for you. During class, your questions and personal and professional experiences add to our conversation. During practical sessions, we encourage you to work together to take advantage complementary skills. We welcome group work in the midterm and final projects, but please speak to the instructors if you intend to form a group of 3 or more students.

Announcements

Announcements will be posted on the Announcements page of the bCourse site and sent out by email through Canvas notification system. Announcements will usually be made within a day of each class.

Slack Channel

A class Slack channel will be available at: https://ph252bspring2023.slack.com. Class materials and announcements will be posted here on a weekly basis. The Slack channel also provides a means for you to work on assignments and projects together outside of class. The instructors will be available on Slack, and Slack direct messages provide an alternative communication channel to emails.

Office Hours

The course instructor, John Marshall, will hold office hours on Mondays 11am-1pm. These will be bookable on Calendly (https://calendly.com/johnmmarshall) and take place on Zoom. GSI office hours are TBD.

Policies

Late Assignments

Any request for an extension on an assignment should be made to the instructors in advance of the posted due date. If an emergency event prevents submitting an assignment by the deadline, please contact the instructors as soon as reasonably possible.

Attendance

Attendance is not graded, but is highly recommended, especially to benefit from instructor assistance during the activity sessions. Attendance is required for the outbreak data analysis practical in week 7, and for the midterm and final project presentations in weeks 9 and 15, respectively. Please contact the instructors if you have a time conflict or are unable to make any of these sessions.

Technology

Laptops will be required for the activity sessions each week, with the exception of the first class. Please contact the instructors if you do not have access to a personal laptop. Laptops may be used during class for note-taking. Power strips and extension cords will be provided during practical sessions.

Correspondence

Grades and feedback on evaluated material will be provided within 1 week. For email correspondence please put PH 252B in the subject heading. We aim to answer your query within 2 business days.

SPH Course Policies

Descriptions of and relevant campus links to SPH school-wide course policies on Disability Support Services, Accommodation of Religions Creed, Course Evaluations, Academic Integrity can be found at: https://berkeley.box.com/s/knh3rbk9ikgvmca4ymy93msgj9bkebq5

Commitment to Antiracism

We commit to teaching this course, to the best of our ability, with an antiracist, racial justice, and equity-minded lens. We acknowledge that we will make mistakes as we are all learning together. We invite you to take this journey with us by being fully present and committing to upholding the values of racial equity. We are interested in your perspectives and in the value and knowledge you bring to help make this an enriching learning environment for all participants.

We view this syllabus as a dynamic document oriented toward learning and not just coverage of material; thus, we may add or modify topics covered, assignments, and resources (e.g., recommended readings) slightly, based on the needs and interests of students, and on current events. We welcome input at any time and invite constructive feedback on any suggested modifications that may help improve the course now or in the future.

As your instructor team, we agree that:

- At least 10% of course content will address the experiences of people from Black, Indigenous, and other People of Color (BIPOC) communities, and other marginalized communities. This will include lecture content, readings, practical activities and class projects;
- Students are the experts of their own experiences. Your world lens is welcomed; and as students, you are invited to lift up information and/or data that is relevant to the course material. Everyone is a teacher and everyone is a student;
- We cannot speak on behalf of all groups, or fully understand the issues, concerns and history of all BIPOC and other marginalized identities. However, we are willing to listen and learn, admit mistakes and engage in the ongoing work of cultural humility;
- Racism and injustice are perpetuated by silence. We commit to leading, to the best of our ability, the uncomfortable conversations and turn them into teachable moments; and invite all students to do the same even though we may not all be confident or fully-skilled in doing so;
- We will disrupt harmful power dynamics and engage in active bystander intervention to uncover and dismantle prejudice, bias, and other harmful practices;
- Language or comments that alienate, demean, and denigrate other students in the classroom will not be tolerated, and may result in removal from class;
- We understand that exposure to these topics is uncomfortable; we commit to providing an environment that best supports the mental and emotional well-being of the class;
- We welcome feedback and input at any time during the course without fear of reprisal.