Syllabus, Fall 2020, for OIDD 325:
Thinking with Models
1:30-2:50 T & R, Room: Online
Canvas:
`https://canvas.upenn.edu/courses/1526582`

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Office hours: To be announced

July 27, 2020

1   Class Description

When a flu pandemic strikes, who should get vaccinated first? What's our best strategy for minimizing the damage of global climate change? Why is Philadelphia racially segregated? Why do most sexually reproducing species have two sexes, in roughly even proportions? These and many other scientific and practical problems require us to get a handle on complex systems. And an important part of deepening our understanding and sharpening our intuitions requires us to think with models, that is, to use models in our deliberations about what to believe and what to do.

Modeling is the construction and analysis of idealized representations of real-world phenomena. This practice is ubiquitous across the sciences, and enters into many practical decisions from setting international policy to making everyday business decisions. The principal aim of this course is to acquaint students with the modeling process and, especially, to help students learn how to think critically about modeling results, as well as how to construct, analyze, and verify such models.

Students who take this course will learn about the varied practices of modeling, and will learn how to construct, analyze, and validate models. Most importantly, students who take this course will learn how to critically evaluate the predictions and explanations generated by models, whatever the source of these results. While we will familiarize students with a variety of types of models, our primary focus will be on computer simulations, as they are increasingly relied upon for scientific research and practical deliberation. In addition to studying general methodological discussions about modeling, this will be a "hands on," laboratory-based course. Students will practice manipulating, modifying, and analyzing models, as well as constructing models from scratch.

As an essential feature of learning about modeling we will actually design and build (program) models, which we then study. NetLogo (`https://ccl.northwestern.edu/netlogo/`) will be the main programming environment. Students will learn to program in it and build agent-based models. NetLogo was designed to be easy to learn and we assume no prior programming experience. For approximately the first 2/3 of the course we will focus on learning NetLogo and building and analyzing models in it. During approximately the last 1/3 of the semester, students will work on their term projects and the course presentations will focus on modeling issues that transcend or extend the basics of modeling in NetLogo.

1.1 Teaching Philosophy

This course, "Thinking with Models," and the subject it names (thinking with models) is about building and interpreting models, for both scientific purposes and to support decision making. Thinking with models is practiced pervasively outside the academy. It is an important and much relied upon, even essential, skill in the modern world, whether in the public, private, or third sector of the economy.

Our main goal in the course is for students to become proficient in this practice. In consequence, we emphasize above all "learning by doing" and undertaking projects as fundamental to the educational goals of the course. A portion of the time and effort in the course will follow the more traditional mode of instructors presenting information on the subject matter. The majority of the time and effort, however, will be spent in apprenticeship (or internship) mode, in which students learn by working on projects, calling on the instructors for guidance and special knowledge as needed.

Completed projects will be evaluated, of course. Project development in apprenticeship mode, however, is inherently cooperative and supportive, rather than evaluative. We emphasize throughout that the class constitutes a community of learners with shared interests in learning how to think with models.

2 Texts and Software

- NetLogo. Free download from `http://ccl.northwestern.edu/netlogo/`.

- *NetLogo User Manual* (comes with NetLogo)

- *An Introduction to Agent-Based Modeling* (**?**). The textbook by Wilensky and Rand is available (for free) on JSTOR as a series of PDFs: `http://www.jstor.org/stable/j.ctt17kk851`. You need to log in through the Penn library system and then it's free.

- Other readings and handouts

3 Grades

The conduct of the course will be heavily influenced by teaching philosophy (above). As such, in many class meetings there will be a short lecture and Q&A session, followed by individual and group exercises, which will be discussed later in class. Grades will be based on in-class performance, short assignments, and four group projects. The classed is designed so that anyone who participates fully and takes it seriously should, with a normal level of effort ($\approx$ 2 hours of study per hour of class time), be able to successfully master the material.

Grading: In-class exercises and assignments (20%), plus the four course projects (20% each).

4 Other Admin and Relata

- Academic integrity

  Like cookies. If you take this course, I hold you to agreement with Penn's code of academic integrity. Violations of academic integrity are on a par with sexual harassment: don't do it. See me if you have questions.

- Wellness and well-being

  Major initiatives at Penn. The norm is one of mutual aid. Everyone is at risk and everyone has a duty to be helpful. You can talk with me; my door is open.

- Anyway, we want everyone to come see us (on-line!) sometime during the semester.

5 Fall 2020 Class Schedule

1. Introduction and overview of the course.

   Reading (after class): (**?**, chapter 0), "Why Agent-Based Modeling"

2. Getting started with ABM.

   Readings (before class): (**?**, chapter 1), "What Is Agent-Based Modeling?"; and from the *NetLogo User Manual*. "State of the Species" (**?**).

   - Learning NetLogo
     - Tutorial #1: Models
     - Tutorial #2: Commands
     - Tutorial #3: Procedures

   Recommended: **?**, chapters 1 and 2.

   *** Instructor Notes: We want to make this a prototypical class, I think. Begin with Q&A and perhaps a 20 minute lecture/overview of the material for the day. Then onto SAILing. Perhaps both some NetLogo exercises (the first, very simple ones) and also some small group exercises, to be written down and handed in? Roughly: 20 minutes lecture, 30 minutes NetLogo exercises, 30 minutes small group exercises? ***

3. The Ants Model

   Reading (before class): (**?**, Chapter 1).

   Bring your NetLogo-enabled laptops to class and be prepared to use them.

4. BehaviorSpace

   Recommended: **?**, chapter 1, file Chapter1BAbook.pdf on Canvas.

5. Working with patches. Readings (before class): (**?**, Chapter 2, pages 45–68), "Life" and from the *NetLogo User Manual,*

   - Learning NetLogo
     - Tutorial #1: Models
     - Tutorial #2: Commands
     - Tutorial #3: Procedures

6. Working with turtles.

   Readings (before class):

   (a) **?**, Chapter 2, pages 68–87, "Heroes and Cowards."
   (b) *NetLogo User Manual* (http://ccl.northwestern.edu/netlogo/docs/ and installed on your computer with the NetLogo distribution):
      - Reference: Interface Guide
      - Reverence: Programming Guide

- Agents
- Procedures
- Variables
- Tick counter

(c) And review for mastery: *NetLogo User Manual* (`http://ccl.northwestern.edu/netlogo/docs/` and installed on your computer with the NetLogo distribution):

- Tutorial #1: Models
- Tutorial #2: Commands
- Tutorial #3: Procedures

7. Simple economy.

   Readings (before class): (**?**, Chapter 2, pages 87–99), "Simple Economy."

   Be sure to read, for the sake of doing the exercises, the "Agentsets" section of the "Programming Guide" in the *NetLogo User Manual*. Also, familiarize yourself with the commends in the "Agentset" category of the "Dictionary."

   In general, you should read the entire "Programming Guide" in the *NetLogo User Manual*.

8. Python Intro

9. Program Procedures: Python and NetLogo

10. Python and Pandas

11. Drift Models

    Guest lecturer: Robin Clark. Instructor handouts.

12. Evolution model

13. Hilltop Butterfly

    Lecturer: Robin Clark. Instructor handouts.

14. Exploring and Extending Agent-Based Models, 1: Fire

    Reading (before class): (**?**, chapter 3, pages 101–128), "Exploring and Extending Agent-Based Models", the Fire Model and the Diffusion-Limited Aggregation (DLA) Model.

    Model of the Week: Castello-Urtino-Catania. It's in NetLogo and it's in the Files/Readings/PedestrianBehavior/ directory on Canvas. But it only works with NetLogo version 5 (the automatic conversion to 6 fails, but you can download and install a version 5 of NetLogo). Skim the paper: **?**, "Agent-Based Simulation of Pedestrian Behaviour in Closed Spaces: A Museum Case Study."

15. Exploring and Extending Agent-Based Models, 2: DLA models

    And start on foraging and IFD.

16. Exploring and Extending Agent-Based Models, 2: Segregation

    Reading (before class): (**?**, chapter 3, pages 128–153), "Exploring and Extending Agent-Based Models", the Segregation model.

17. Exploring and Extending Agent-Based Models, 3: El Farol

    Reading (before class): (**?**, chapter 3, pages 128–153), "Exploring and Extending Agent-Based Models", the El Farol model.

18. Links

    TBD.

19. Wolf-Sheep Predation Model 1; Tour of NetLogo models
    Reading (before class): (**?**, chapter 4)

20. Wolf-Sheep Predation Model 2
    Reading (before class): (**?**, chapter 4)

21. Regression and analyzing BehaviorSpace files.

22. Spread of Disease,(**?**, Chapter 6)

23. Viral Marketing (Simple Viral Marketing model) (**?**, Chapter 8, pages 406-415)

24. Post-solution analysis with Pandas

25. Uncertainty analysis

26. Ideal Free Foraging

27. More Ideal Foraging

28. Even more; Recapitulation and Summary.

6   Course project

Students should form project teams for undertaking the course project. Later in the semester, the instructors will present a series of project ideas as candidates for consideration by the teams. These ideas will include analyzing in detail a complex existing NetLogo model, extending an interesting NetLogo model, as well as creating and analyzing a new model from scratch. In addition, teams may propose their own projects. In all cases, the teams should meet with the instructors and come to agreement about what will be done in their projects. The final projects should resemble the three group projects done earlier in the semester.

The team deliverables are:

1. A NetLogo model with good documentation in the Info tab on what the model is for and about and how to run it. Documentation in the NetLogo style we've seen throughout the semester. (Or, with permission of instructor, a model in some other programming environment.)

2. A completed documentation report of a form specified in class.

3. A description of your post-solution analysis of the model.

   (Presumably this will be done with BehaviorSpace. It could be presented in the PowerPoint presentation and/or in a separate document you hand in.)

4. A five-to-seven minute PowerPoint presentation with voice annotation.

5. Optionally, any other supporting or supplementary information you would like.

The term project is due on May 4, 2020.