Syllabus, Spring 2020, for OIDD 325:
Thinking with Models
3:00–4:20 T & R, Room: JMHH F70
Canvas:
https://canvas.upenn.edu/courses/1493538

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Office hours: 565 JMHH, 9:00–10:30 Tuesdays and Thursdays, and by appointment

January 2, 2020

Provisional syllabus, subject to changes, but due dates are set. April 2, for the exam. April 29 is last day of class. May 4, the course projects are due at 5:00 p.m.

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.

The conduct of the course will be heavily influenced by SAIL (structured active in-class learning) ideas. As such, in most class meetings there will be a short lecture and Q&A session, followed by individual and group exercises, which will be discussed later in the class.

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.

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* (Wilensky and Rand, 2015). 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 SAIL (structured active in-class learning) ideas. 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, an in-class exam, and a term project. 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 exam (25%), exercises and assignments (25%), plus the course project (30%), and class participation and attendance 20%

4 Other Admin and Relata

- Read: `http://nyti.ms/1VlsuOG`, Jonathan Franzen's review in The New York Times of Sherry Turkle's *Reclaiming Conversation*—no devices to be used in class!
- 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, I want everyone to come see me sometime during the semester.

  Office hours. Lunch. Individually or in small groups.

5 Further Thoughts on Teaching and What's New This Semester

- Keep in mind: *Professor bias*
  - Homework problems
  - Neat, clear solutions
- Instead
  - Deep uncertainty
  - Fraught deliberations

  Useful:
  `https://www.newyorker.com/magazine/2019/01/21/the-art-of-decision-making`
  and `http://www.deepuncertainty.org/`.

6 Class Schedule

1. Introduction and overview of the course.

   Reading (after class): (Wilensky and Rand, 2015, chapter 0), "Why Agent-Based Modeling"

2. Getting started with ABM.

   Readings (before class): (Wilensky and Rand, 2015, chapter 1), "What Is Agent-Based Modeling?"; and from the *NetLogo User Manual*

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

   Recommended: Weisberg (2013, chapters 1 and 2).

3. The Ants Model

   From (Wilensky and Rand, 2015, Chapter 2).

4. Working with patches.

   Readings (before class): (Wilensky and Rand, 2015, Chapter 2, pages 45–68), "Life" and from the *NetLogo User Manual,*

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

   Recommended: Kimbrough and Lau (2016, chapter 1), file Chapter1BAbook.pdf on Canvas.

5. Working with turtles.

   Readings (before class):

(a) Wilensky and Rand (2015, 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

6. Simple economy.

   Readings (before class): (Wilensky and Rand, 2015, 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*.

7. Drift Models

   Guest lecturer: Robin Clark. Instructor handouts.

8. Hilltop Butterfly, 1

   Guest lecturer: Robin Clark. Instructor handouts.

9. Hilltop Butterfly, 2

   Guest lecturer: Robin Clark. Instructor handouts.

10. Conventional Programming, 1: NetLogo.

    Reading (before class): The Info tab of the Conventional Programming 1 NetLogo model, found on the Modeling Commons (`modelingcommons.org`, search "kimbrough"). Posted on Canvas as Conventional Programming 1.nlogo. Also, read the Programming Guide in the NetLogo User Manual (see the Help menu in NetLogo).

    Model of the day: LCOE and the Levelized Lighting Calculator.

11. Conventional Programming, 2: NetLogo, begin Python and R.

    Reading (before class): The Info tab of the Conventional Programming 1 NetLogo model, found on the Modeling Commons (`modelingcommons.org`, search "kimbrough"). Posted on Canvas as Conventional Programming 1.nlogo. Also, read the Programming Guide in the NetLogo User Manual (see the Help menu in NetLogo).

12. Conventional Programming , 3: Python, R, and the NetLogo APIs

    Instructor handout.

13. Exploring and Extending Agent-Based Models, 1: Fire and DLA models.

    Reading (before class): (Wilensky and Rand, 2015, 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: Pluchino et al. (2014), "Agent-Based Simulation of Pedestrian Behaviour in Closed Spaces: A Museum Case Study."

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

    Reading (before class): (Wilensky and Rand, 2015, chapter 3, pages 128–153), "Exploring and Extending Agent-Based Models", the Segregation model.

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

    Reading (before class): (Wilensky and Rand, 2015, chapter 3, pages 128–153), "Exploring and Extending Agent-Based Models", the El Farol msodel.

******* Spring Break March 7–15, 2020 (after class 15) *******

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16. Creating Agent-Based Models, 1.

    Reading (before class): (Wilensky and Rand, 2015, chapter 4, pages 157–189), "Creating Agent-Based Models".

    Wolf Sheep predation.

17. Creating Agent-Based Models, 2.

    Reading (before class): (Wilensky and Rand, 2015, chapter 4, pages 189–197), "Creating Agent-Based Models".

18. The Components of Agent-Based Modeling, 1.

    Reading (before class): (Wilensky and Rand, 2015, chapter 5, pages 203–234), "Overview" and "Agents."

19. The Components of Agent-Based Modeling, 2.

    Reading (before class): (Wilensky and Rand, 2015, chapter 5, pages 234–282), "Environments" etc.

20. The Components of Agent-Based Modeling, 3: Social Network Models.

    Modeling social networks with links in NetLogo.

    Reading (before class): (Wilensky and Rand, 2015, Chapter 5)

21. Exam, April 2, 2020 **Exam, April 2**

22. Honeybee Democracy Model

    Guest lecturer: Robin Clark. Instructor Handout.

23. Evolution of Vowels and Cultural Evolution

    Guest lecturer: Robin Clark. Instructor Handout.

24. Analyzing Agent-Based Models.

    Reading (before class): (Wilensky and Rand, 2015, chapter 6).

25. Post-Solution Analysis

    Read before class: (Kimbrough and Lau, 2016, Chapter 1), on Study.Net.

    Instructor handout.

26. Huff and GDP Models.

    Instructor handout.

27. Student presentations

28. Student presentations

Course project hand-ins due: 4 May, 2020, 5:00 p.m.

Course project hand-ins.

7 Course project

Students should for project teams of 2–3 people (4 with permission of instructor) for undertaking the course project. After spring break, 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 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.

References

Kimbrough, S. O. and Lau, H. C. (2016). *Business Analytics for Decision Making*. CRC Press, Boca Ratan, FL.

Pluchino, A., Garofalo, C., Inturri, G., Rapisarda, A., and Ignaccolo, M. (2014). Agent-based simulation of pedestrian behaviour in closed spaces: A museum case study. *Journal of Artificial Societies and Social Simulation*, 17(1):16. `http://jasss.soc.surrey.ac.uk/17/1/16.html`.

Weisberg, M. (2013). *Simulation and Similarity: Using Models to Understand the World*. Oxford University Press, Oxford, UK.

Wilensky, U. and Rand, W. (2015). *An Introduction to Agent-Based Modeling*. The MIT Press, Cambridge, MA.