Syllabus, Spring 2019, for OIDD 325:
Thinking with Models
3:00–4:20 T & R, Room: JMHH G55 [sic]
Canvas:
https://canvas.upenn.edu/courses/1436031

Professor Steven O. Kimbrough, Instructor
Office hours: 565 JMHH, 9:00–10:30 Tuesdays and Thursdays, and by appointment

November 29, 2019

Provisional syllabus, subject to changes, but due dates are set.

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 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 to include:
  1. Bankes (1993)
  2. Bankes et al. (2002)
  3. Weisberg (2013, chapters 1 and 2)
  4. Kimbrough and Lau (2016, chapters 1 and 16)
  5. ...

3 Grades

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. Grades will be based on in-class performance, short assignments, 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 exercises (40%), plus the term project (40%), and class participation and (most days) a paragraph on the readings turned in before class (20%). All of this with Canvas.

4 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.

   Reading (before class): (Wilensky and Rand, 2015, chapter 1), "What Is Agent-Based Modeling", Weisberg (2013, chapters 1 and 2), and from the *NetLogo User Manual*

   - Learning NetLogo

- Tutorial #1: Models

3. Working with patches.

   Readings (before class): Kimbrough and Lau (2016, chapter 1), File Chapter1BAbook.pdf on Canvas, (Wilensky and Rand, 2015, Chapter 2, pages 45–68), "Life" and from the *NetLogo User Manual*, "Learning NetLogo: Tutorial #1: Models."

4. Working with turtles.

   (a) Wilensky and Rand (2015, Chapter 2, pages 68–87)

   (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

5. Simple economy.

   Readings (before class): (Wilensky and Rand, 2015, Chapter 2, pages 87–99).

6. NetLogo as a Conventional Programming Language, 1.

   Reading (before class): The Info tab of the Conventional Programming 1 NetLogo model, found on the Modeling Commons (`modelingcommons.org`, search "kimbrough").

7. 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.

8. Exploring and Extending Agent-Based Models, 2: Segregation and El Farol models.

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

9. El Farol

10. Creating Agent-Based Models, 1.

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

11. Creating Agent-Based Models, 2.

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

12. Conventional Programming in NetLogo, 2.

13. Comparing Models.

******* Spring Break March 2–10, 2019 *******

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

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

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

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

16. Analyzing Agent-Based Models.

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

17. Nominal Groups.

18. Systems analysis and design, 1.

    Assigned preparation for the class: Get an initial idea for a project, either in groups or by yourself. Have this idea in mind when you come to class.

19. Systems analysis and design, 2.

    Reading ahead of class: Chapter II of *Growing Artificial Societies*. File *GAS-CHAP2.PDF*, posted on Canvas.

    Assigned preparation for the class: Get an initial idea for a project, either in groups or by yourself. Have this idea in mind when you come to class.

20. Discussion of project ideas.

21. File I/O

    Reading (before class): In the *NetLogo User Manual*, "CSV" in the "Extensions" section.

22. Analyzing Agent-Based Models, 2: Model Outcome Analysis.

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

23. Multiattribute Decision (MAD) Models.

    Read before class: (Kimbrough and Lau, 2016, Chapter 16), on Study.Net.

24. Briefings and Project Work.

    In this class and the two that follow we will have short briefings related to agent-based modeling, with short exercises. The balance of the class will be given over to doing project work by the groups and to gentle consulting and advising services by the instructors. This is a good opportunity to raise technical questions, which the instructors can help with.

    - Use of links in NetLogo modeling.
    - Describing procedures.
      Reading: "Flowchart" `https://en.m.wikipedia.org/wiki/Flowchart` and "Pseudocode" `https://en.wikipedia.org/wiki/Pseudocode`.
    - Verification, Validation, and Replication, 1.
      Reading: (Wilensky and Rand, 2015, chapter 7, pages 311–325).
    - Verification, Validation, and Replication, 2.
      Reading: (Wilensky and Rand, 2015, chapter 7, pages 325–350.).
    - Arrays and tables.
      Reading: In the *NetLogo User Manual,* "Arrays & Tables" in the "Extensions" section.
    - Matrices
      Reading (before class): In the *NetLogo User Manual,* "Matrices" in the "Extensions" section.

25. Briefings and Project Work.

26. Briefings and Project Work.

27. Student presentations.

28. Last class. Student presentations and wrap-up.

Small group assignment hand-ins due: Tuesday, 7 May, 2019, 11:59 p.m.

Small group hand-ins.

References

Bankes, S. (1993). Exploratory modeling for policy analysis. *Operations Research*, 41(3):435–449.

Bankes, S., Lempert, R., and Popper, S. (2002). Making computational social science effective. *Social Science Computer Review*, 20(4):377–388.

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

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.