

**DRAFT:** Syllabus, Spring 2016, for OIDD 325:  
Thinking with Models  
3:00–4:20 M & W, Room: \*\*\*TBA\*\*\*  
Canvas: \*\*\*TBA\*\*\*

Professor Steven O. Kimbrough, Instructor  
Office hours: 565 JMHH, 9:30–11:00 and 1:30–3:00 Wednesdays, and by appointment

October 22, 2016

## 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).
- Other readings and handouts to include:
  1. Bankes (1993)
  2. Bankes et al. (2002)
  3. Weisberg (2013, chapters 1 and 2)
  4. ...

## 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.

## 4 Class Schedule

1. Introduction and overview of the course.  
Reading (before 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), “Why Agent-Based Modeling” and from the *NetLogo User Manual*
  - Learning NetLogo
    - Tutorial #1: Models
3. Simple ABMs: Life.  
Reading (before class): (Wilensky and Rand, 2015, chapter 2, pages 45–68), “Creating Simple Agent-Based Models” and from the *NetLogo User Manual*
  - Learning NetLogo
    - Tutorial #2: Commands

– Tutorial #3: Procedures

4. Simple ABMs: Heros and Cowards.  
Reading (before class): (Wilensky and Rand, 2015, chapter 2, pages 68–87), “Creating Simple Agent-Based Models”.
5. Simple ABMs: Simple Economy.  
Reading (before class): (Wilensky and Rand, 2015, chapter 2, pages 87–99), “Creating Simple Agent-Based Models”.
6. NetLogo as a Conventional Programming Language.  
Reading (before class): The Info tab of the Conventional Programming 1 NetLogo model, found on the Modeling Commons ([modelingcommons.org](http://modelingcommons.org), search “kimbrough”).
7. Exploring and Extending Agent-Based Models, 1.  
Reading (before class): (Wilensky and Rand, 2015, chapter 3, pages 101–128), “Exploring and Extending Agent-Based Models”.
8. Exploring and Extending Agent-Based Models, 2.  
Reading (before class): (Wilensky and Rand, 2015, chapter 3, pages 128–153), “Exploring and Extending Agent-Based Models”.
9. Creating Agent-Based Models, 1.  
Reading (before class): (Wilensky and Rand, 2015, chapter 4, pages 157–189), “Creating Agent-Based Models”.
10. Creating Agent-Based Models, 2.  
Reading (before class): (Wilensky and Rand, 2015, chapter 4, pages 189–197), “Creating Agent-Based Models”.
11. The Components of Agent-Based Modeling, 1.  
Reading (before class): (Wilensky and Rand, 2015, chapter 5, pages 203–234), “Overview” and “Agents.”
12. The Components of Agent-Based Modeling, 2.  
Reading (before class): (Wilensky and Rand, 2015, chapter 5, pages 234–282), “Environments” etc.
13. Analyzing Agent-Based Models, 1.  
Reading (before class): (Wilensky and Rand, 2015, chapter 6, pages 283–291).
14. Analyzing Agent-Based Models, 2.  
Reading (before class): (Wilensky and Rand, 2015, chapter 6, pages 291–310).
15. Verification, Validation, and Replication, 1.  
Reading (before class): (Wilensky and Rand, 2015, chapter 7, pages 311–325).
16. Verification, Validation, and Replication, 2.  
Reading (before class): (Wilensky and Rand, 2015, chapter 7, pages 325–350.).

17. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Survey of some models. Read (before class): Weisberg (2013, chapters 1 and 2).
18. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Constrained optimization models. Reading (before class): (Kimbrough and Lau, 2016, chapter 2), "Constrained Optimization Models: Introduction and Concepts."
19. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Constrained optimization models. Reading (before class): (Kimbrough and Lau, 2016, chapter 3), "Linear Programming."
20. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Constrained optimization models. Reading (before class): (Kimbrough and Lau, 2016, chapter 4), "Simple Knapsack Problems."
21. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Constrained optimization models. Reading (before class): (Kimbrough and Lau, 2016, chapter 5), "Assignment Problems."
22. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Exploratory modeling and solution pluralism. Reading (before class): Bankes (1993), Bankes et al. (2002), (Kimbrough and Lau, 2016, chapter 13), "Identifying and Collecting Decisions of Interest."
23. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Topics: TBA.
24. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Topics: TBA.
25. Topics in modeling (lecture and demonstration, short small group exercises); term project work and assignments.  
Topics: TBA.
26. Student presentations.
27. Student presentations.
28. Last class. Student presentations and wrap-up.

**Small group assignment hand-ins due: 5 p.m. Sunday, May 1, 2016.**

**Small  
group  
hand-ins.**

## 5 Calendar, Spring 2016

Reading days: April 28–9, 2016. Final examinations: May 2–10, 2016.

	0	1	2
0	—	W: 2016-02-17	W: 2016-03-30
1	W: 2016-01-13	M: 2016-02-22	M: 2016-04-04
2	W: 2016-01-20	W: 2016-02-24	W: 2016-04-06
3	M: 2016-01-25	M: 2016-02-29	M: 2016-04-11
4	W: 2016-01-27	W: 2016-03-02	W: 2016-04-13
5	M: 2016-02-01	M: 2016-03-14	M: 2016-04-18
6	W: 2016-02-03	W: 2016-03-16	W: 2016-04-20
7	M: 2016-02-08	M: 2016-03-21	M: 2016-04-25
8	W: 2016-02-10	W: 2016-03-23	W: 2016-04-27
9	M: 2016-02-15	M: 2016-03-28	—

Table 1: Class number :: date correlation, for Monday (M) and Wednesday (W) classes, spring 2016.

## 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.