Simulation in Social Science:
Using Your Computer as a Tool for Theory Building

Honors 204D

Spring 2019 Syllabus

T & Th 11:30-12:45p; Room 103 Crown Center

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Overview

Computer simulation[1] has been used for decades as a tool to help us understand and predicting the natural world. The use of simulations to generate weather forecasts is a familiar example. Increasingly, scientists are also now using computer simulations to address a wide range of questions about complex human behavior. Why, for example, are many cities around the world racially or ethnically segregated? Does generosity encourage or inhibit cooperation in others? And why do well-informed groups sometimes make ill-advised decisions? Useful insights about questions like these can often be gained with the assistance of computer simulations.

Complex patterns of human behavior typically arise from repeated interaction among people over time, where each individual interaction is affected by the interactions that preceded it, and in turn affects those that follow. Traditional, relatively static theoretical accounts of the behavior of individual persons are ill suited for representing such complexities, simply because they do not afford a ready means of capturing their temporal dynamics. Computer simulation, by contrast, is ideally suited to this purpose.

This course will teach you the "nuts and bolts" of computer simulation as it applies to human social behavior. We will emphasize the use of simulations to (a) express theory about social behavior, and (b) derive predictions about social phenomena—obtained by actually running the simulation—that would be difficult or impossible to derive in any other way.

[1] The terms computer simulation and computer modeling are often used interchangeably. Here I use *computer simulation* when referring to the general scientific approach, and use *computer model*, or simply *model*, when referring to specific instances of this approach.

In this course you will learn how to analyze and validate computer models, and how to create your own models using freely available software (NetLogo). No prior programming experience is required, although some experience of this type may be helpful to a limited degree.

The first half of the semester will be devoted to exercises and assignments designed to help you learn the NetLogo programming language and gain an understanding of how computer simulations operate in general. Then, during the rest of the semester you will work with a partner to develop your own model in a specific topic area that you will select from among a fixed set of available alternatives. As part of this, you will give several brief in-class presentations on your model (e.g., regarding the real-world phenomenon you are simulating how key theoretical constructs are implemented in your model, the results it generates, etc.) and get constructive feedback from the class that will be helpful for further developing your simulation.

By the end of the course you will be able to think critically about simulations designed by others, and you will have developed the skills needed to evaluate the appropriateness of computer simulations as a means of understanding and predicting human social behavior. More specifically, our four most important learning objectives will be:

(a) To gain a basic understanding of computer simulation as a method of scientific inquiry, including the factual knowledge and techniques associated with using the NetLogo programming language, and the principles that pertain to using simulation as a research tool. (E)

(b) To learn how to apply the course material to improve thinking, problem solving, and decision making about a wide rank of topics in the social sciences. (I)

(c) To develop your creative capacity, particularly as it relates to using the building blocks of the NetLogo programming language (i.e., its vocabulary, syntax, and grammar) learned during the first half of the semester to crate novel solutions to programming problems encountered as you develop your own simulation during the second half of the semester (E)

(d) To learn appropriate methods for collecting, analyzing, and interpreting numerical information that constitutes the output by your simulations (E)

Prerequisites

This course is open only to students in the Interdisciplinary Honors Program. Further, you must have already completed HONR 101, HONR D101, HONR 102, and HONR D102. Beyond that, it is strongly recommended (but not officially required) that you have at least some college-level social science background. The course is apt to be of greatest interest and value to students majoring in one of the social sciences, especially anthropology, economics, political science, psychology, or sociology.

Prior experience with computer programming/coding is not a prerequisite. Although a little coding experience may be helpful, most students should be able to learn the necessary programming skills without prior experience. In a few circumstances, prior coding experience can actually be an impediment. The programming language we will use in this course (NetLogo), is a “low-threshold, high ceiling” language, meaning that it is relatively easy to learn (low threshold) but still very powerful (high ceiling).

Students taking this course should have a laptop or desktop computer at their disposal in order to complete homework assignments and projects. Further, you must be willing to install the free NetLogo language and simulation environment on that computer. The homework assignments and projects cannot be completed without having NetLogo installed. NetLogo is available on lab and public computers across campus (e.g., in

the IC), but you are apt to find it frustrating if you have to rely exclusively on those resources in order to do all of your out-of-class work for this course.

However, please note that because all lab computers have NetLogo installed on them, and because it is much easier for me as the instructor when students use those computers rather than their laptops (it's a vision issue), I strongly prefer that you not use your laptop computer during class.

Textbooks & Software

The following two books are required reading for the course. Both should be available in the Loyola University Bookstore, but can also be purchased elsewhere. Specific reading assignments are listed in the table at the end of this syllabus.

Railsback, S. F., & Grimm, V. (2012). *Agent-based and individual-based modeling: A practical introduction*. Princeton, NJ: Princeton University Press.

Weisberg, M. (2013). *Simulation and similarity: Using models to understand the world*. NY: Oxford University Press.

It is also necessary that you install the free NetLogo simulation software on your laptop or desktop computer. The homework assignments and projects cannot be completed without having NetLogo installed. NetLogo is also installed on all University lab computers as well as those in the Information Commons, but having it available on your own machine is much more convenient for completing homework assignments. NetLogo can be downloaded from https://ccl.northwestern.edu/netlogo/.

Attendance

You are expected to attend every class meeting. Some material will be presented in class that is NOT in the textbooks, and there will be in-class activities to help you learn NetLogo. The benefits of these activities cannot be gained except by being in class. During the first half of the semester there will also be periodic quizzes to assess your learning. You must be in attendance on the days these quizzes are given to get credit for them.

Major Simulation Project

You will be expected to work with a partner on a major simulation project that is to be completed by the end of the semester. You and your partner will be asked to choose that project from among a set of pre-defined alternatives, but there is plenty of room within each project to creatively shape the final Product. You and your partner will be expected to work together as a team, pool your skills and resources, and develop the most creative—yet still true to theory—computer model that you can. You will pass several graded milestones as you develop your model, including two preliminary in-class team presentations, a final team presentation, and an independent write-up that is to accompany each presentation. The in-class presentations will be made and graded as a team (i.e., both members will receive the same grade), but the accompanying write-ups will be written and graded independently.

Grading

Your course grade will be based on your performance on each of the following:

- Coding Homework Assignments and In-Class Coding Quizzes: 20%
- Two Mid-Project In-Class Presentations: 10% each
  - These presentations are made as a team, and both members received the same grade.
- Two Sets of Formative Peer Evaluations/Feedback (given, not received): 5% each
- Two Individually Written Mid-Project Reports: 10% each
  - Each team member turns in an independently written report.
- Final Team Presentation: 15 %
  - This presentation is made as a team, and both members received the same grade.
- Final Written Report: 15%
  - Each team member turns in an independently written report.

Academic Dishonesty

Plagiarism and other forms of academic dishonesty will not be tolerated. It is often desirable to incorporate the ideas of others in one's written work (e.g. project reports), but when doing so you must cite the source. This is true regardless of who or what that source is (a website, a textbook, a journal article), and it is true regardless of whether or not you directly quote that source—paraphrasing does not absolve you of the obligation to cite. Likewise, if you incorporate someone else's code into a model, again you must cite the source (e.g., in the Info Tab of your NetLogo model). To learn more about plagiarism, the following is a very helpful website: http:\\www.plagiarism.org.

If any plagiarism or other form of academic dishonesty is observed, you will receive no credit for the component of the course on which that infraction occurred, your final course grade will be reduced by one full letter grade, and you will be referred to the College of Arts and Sciences for possible disciplinary action. If a second instance of plagiarism occurs, you will receive a grade of F in the course. Do not plagiarize. The cost is too great.

Students with Disabilities

Students with disabilities who require accommodation for access and participation in this course should contact the instructor as soon as possible after the start of the semester. All such students must be registered with the Student Accessibility Center (SAC). Go to https://www.luc.edu/sac/. SAC is located in Sullivan Center 117; Phone 773-508-3700 (voice), or 773-508-3810 (fax).

LUC Course Drop Policy

Students may drop courses without penalty during the first 8 days of the semester. After that, and until the end of Week 10, dropped courses are assigned a grade of "W." Students may not drop courses after the end of Week 10. University policy requires that students who stop attending a course but have not officially withdrawn receive a grade of "WF," which is a penalty grade and is equivalent to a grade of "F."

Date — Major In-Class Events & Homework Assignments

Week 1

1/15
In Class| - Course Overview
Homework| - Assignment 0: Download NetLogo
- **Work Through**[1] the *Introduction* (both *What is NetLogo?* and *Sample Model: Party*) in the NetLogo User Manual (found by clicking "Help" in NetLogo)
- **Read**[1] R&G, *Ch. 1: Models, Agent-Based Models, & the Modeling Cycle*

1/17
In Class| - **Work Through** *Tutorial #1* in the NetLogo User Manual
Homework| - **Work Through** NetLogo *Tutorials #2* and *#3*
- **Work Through** R&G, *Ch. 2: Getting Started with NetLogo*

[1] Some assignments ask you to "Work Through" a chapter, while others ask you to "Read" a chapter.

- **Work Through** implies that you should actually try in NetLogo almost everything that is described in the chapter. Thus, you should plan to read these chapters while you are sitting with your computer turned on and NetLogo running, so that you can try to implement what is described in the chapter as you go. This will require more time and effort, but you will learn and remember the material much better—and will be a more successful modeler—if you actually try these things out for yourself and explore how they work.
- **Read** implies that while there is much to be learned in the chapter, it is mostly conceptual in mature, and there is less work to do directly in NetLogo as you read. These chapters can generally be understood even if you are not sitting in front of your computer with NetLogo running.

Week 2

1/22
In Class| - Catch-Up Day
Homework| - **Read** R&G, *Ch. 3: Describing and Formulating ABMs: The ODD Protocol*

1/24
Homework| - **Work Through** R&G, *Ch. 4: Implementing a First Agent-Based Model*

Week 3

1/29
In Class| - Quiz 1
Homework| - **Work Through** R&G, *Ch. 5: From Animations to Science*

1/31
In Class| - Quiz 2
Homework| - **Read** R&G, *Ch. 6: Testing Your Program*
- **Read** Weisberg, *Ch. 1: Introduction*
Ch. 2: Three Kinds of Models

Week 4

2/5
In Class| - Quiz 3
Homework| - Coding Assignment 1: Creating Life with Code
- **Read** R&G, *Ch. 7: Introduction to Part II*
- Review potential modeling projects

2/7
In Class| - Quiz 4
Homework| - Coding Assignment 2: Defining Bias
- **Work Through** R&G, *Ch. 8: Emergence*

Week 5

2/12
In Class| - Quiz 5
Homework| - Coding Assignment 3: Checkmate
- **Read** R&G, *Ch. 9: Observation*

2/14
Homework| - Coding Assignment 4: BehaviorSpace + Excel
- **Work Through** R&G, *Ch. 10: Sensing*
- **Read** Weisberg, *Ch. 3: The Anatomy of Models*

Week 6

2/19
In Class| - Catch-Up Day

2/21
In Class| - Begin preparing your February 28th presentation
Homework| - Coding Assignment 5: Plotting
- **Work Through** R&G, *Ch. 11: Adaptive Behavior and Objectives*
- **Read** Weisberg, *Ch. 5: Target-Directed Modeling*

Week 7

2/26
In Class| - Continue preparing your February 28th presentation

2/28
In Class| - Presentation describing the real-world phenomenon you will model (Focus on the phenomenon and theory that explains it, **not** NetLogo)
Homework| - Assignment 6: Project Planning
- **Read** R&G, *Ch. 12: Prediction*
- **Read** Weisberg, *Ch. 6: Idealization*

Spring Break

Week 8

3/12	In Class|	- Work on your model
3/14	Due|	- Write-up covering material in February 28th presentation
	In Class|	- Work on Your Model
	Homework|	- **Read** R&G, *Ch. 13: Interaction*
		- **Read** Weisberg, *Ch. 7: Modeling Without a Specific Target*

Week 9

3/19	In Class|	- Work on your model
3/21	In Class|	- Work on your model
	Homework|	- **Read** R&G, *Ch. 14: Scheduling*
		- **Read** Weisberg, *Ch. 9: Robustness Analysis and Idealization*
		Ch. 10: Conclusion: The Practice of Modeling

Week 10

3/26	In Class|	- Work on your model
3/28	In Class|	- Work on your model
		- Start preparing your April 4th in-class presentation
	Homework|	- **Read** R&G, *Ch. 15: Stochasticity*

Week 11

4/2	In Class|	- Work on your model
		- Continue preparing your April 4th in-class presentation
4/4	In Class|	- In-class presentation describing the basics of your model (what features of the real world will be modeled, how specific variables will be operationalized, how it will work)
	Homework|	- **Read** R&G, *Ch. 16: Collectives*

Week 12

4/9	In Class|	- Work on your model
4/11	Due|	- Write-up covering material in April 4th presentation
	In Class|	- Work on your model
	Homework|	- **Read** R&G, *Ch. 17: Introduction to Part III*
		- **Read** R&G, *Ch. 18: Patterns for Model Structures*

Week 13

4/16	In Class|	- Work on your model: Focus on generating quantifiable results
4/18	In Class|	- Work on your model: Focus on generating quantifiable results
	Homework|	- **Read** R&G, *Ch. 19: Theory Development*

Week 14

4/23	In Class|	- Work on your model: Focus on generating quantifiable results - Start preparing your final in-class presentation
	Homework|	- **Read** R&G, *Ch. 20: Parameterization and Calibration*
4/25	In Class|	- Work on your model: Focus on generating quantifiable results - Continue preparing your final in-class presentation

Finals Week

4/30 (9-11a)	In Class|	- Final presentation of the phenomenon, model, and final results that you obtained
	Due|	- Final write-up describing the phenomenon, model, and results