SYLLABUS

Course: SOC902 Modeling and Simulation of Social Systems (Fall 2016)

Instructor: Bilal Khan
Office: Benton Hall 317
Office Hours: Mondays 12:00-1:00 p.m.
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Class Hours: **Monday 2:30-4:30 p.m**
Class Location: The first 30 minutes (2:00-2:30) will be in **Old Father** 738 (Soc Computer Lab)
The rest of the class (2:30-4:30) will be in **Old Father 707** (Soc Seminar Room)

FALL 2016 FIRST CLASS EXCEPTION due to many students being at ASA
The FIRST class will be held ON **Wednesday, August 24, 11:00-1:30 p.m**
The FIRST class will be held IN **Old Father 738** (Soc Computer Lab)

Class mailing list address: soc902-fall2016@googlegroups.com
Class mailing list archive: https://groups.google.com/forum/#!forum/soc902-fall2016

DESCRIPTION: In this course we will learn how artificial societies can be specified (agent-based modeling) and then made to exist and evolve in time (computer simulation). The techniques of modeling and simulation provide a systematic way to state and test hypotheses about the microscopic mechanisms (e.g. individual behaviors) that might plausibly be responsible for the emergence of observed macroscopic systemic social patterns. We'll come to understand (i) when agent-based models are most fruitfully applied (ii) how to construct a conceptual agent-based model and then formalize it, (iii) how to implement the formalized model as custom computer software in Netlogo, and (iv) how to use the Netlogo programs to carry out simulation experiments that will produce scientifically defensible assertions. To achieve all this, we will begin with a few "toy examples", but soon shift to considering a series of research papers in sociology (and the social sciences more broadly) in which agent-based modeling and simulation has played a central role. For each of these papers, we will dissect the nature of the question, the agent-based model, the simulation, the experiments, and the conclusions -- whenever possible, we will attempt to re-create the results ourselves using hands-on (computer) laboratory experiments. In the course of one semester, we will gain an appreciation for the importance of agent-based simulation in sociology research, and begin to become empowered to create our own models and apply simulation techniques towards sociological research questions of interest to us.

RATIONALE: Many forms of macrostructural sociological patterns are readily observed: disease epidemics, traffic congestion flows, voting behaviors, migration patterns, wealth and age distributions, racial segregation patterns, price equilibria in markets, cultural patterns, the structure and distribution of organizations, spatial settlement patterns, etc. All these observed patterns warrant explanation. A generative perspective on the social sciences seeks such explanations by asking: "How might the local interactions of

individuals spontaneously generate these observed patterns?" One way to answer such a question is to "experiment" with artificial societies on a computer. Each experiment situates an initial artificial population of autonomous heterogeneous agents in a relevant spatial environment, and then allows these agents to "live"--interacting both with each other and with their environment according to simple hypothesized rules. The computer thus serves as a Petri dish containing an evolving artificial society, and using which we assess the extent to which the hypothesized rules appear to "generate" macroscopic sociological regularities of interest. If the hypothesized rules are plausible (consistent with what we know of human individuals) and the regularities that emerge are plausible (consistent with what we observe of human societies), then the rules can be taken as a generative explanation of the systemic social pattern.

TEXT:

Required: Railsback, Steven F., and Volker Grimm. Agent-based and individual- based modeling: a practical introduction. Princeton University Press, 2011.
Available from Amazon.

Optional: O'Sullivan, David, and George LW Perry. Spatial simulation: exploring pattern and process. John Wiley & Sons, 2013.

PREREQUISITES: Although programming plays a significant part in specifying the rules by which individuals in the society act, the course does not assume that you already know how to write computer programs. NetLogo will be one of the skills you will acquire in the course. Basic statistics will play a part in testing the agreement between observed real-world structures and the macro-structures generated in the simulation experiments.

EQUIPMENT & SOFTWARE:

Required: Access to a computer running Windows, MacOS, or Linux on which to run Netlogo. The installer for Netlogo 5.3.1 is available for Mac, Windows, and Linux for free download by right clicking and "Save As" here.

READINGS: (these papers can be downloaded as a single zipped directory of PDF files, by right clicking and "Save As" here). Papers are grouped into three categories:

- Modeling and Simulation Basics (B*),
- Instructor-presented Modeling Case Studies (M*), and
- Student-presented case studies (X*).

Modeling and Simulation Basics (B*)

B1) Epstein, Joshua M. "Why model?" Journal of Artificial Societies and Social Simulation 11.4 (2008): 12. http://jasss.soc.surrey.ac.uk/11/4/12.html [PDF]

B2) Nowak, A., Rychwalska, A., & Borkowski, W. "Why Simulate? To Develop a Mental Model". Journal of Artificial Societies and Social Simulation, 16(3), (2011): 12. http://jasss.soc.surrey.ac.uk/16/3/12.html [PDF]

B3) Macy, Michael W., and R Willer. "From factors to actors: Computational sociology and agent-based modeling." Annual review of sociology (2002): 143-166. [PDF]

B4) Grimm, Volker, et al. "A standard protocol for describing individual-based and agent-based models." Ecological modelling 198.1 (2006): 115-126. [PDF]

B5) Grimm, Volker, et al. "The ODD protocol: a review and first update." Ecological modelling 221.23 (2010): 2760-2768. [PDF]

B6) Grimm, Volker, Revilla, E., Berger, U., Jeltsch, F., Mooij, W. M., Railsback, Steven F., Thulke, H.-H., et al. (2005). "Pattern-Oriented Modeling of Agent-Based Complex Systems: Lessons from Ecology". Science, 310(5750), 987-991. doi:10.1126/science.1116681 [PDF]

B7) Kornhauser, D., Wilensky, U. & Rand, W. 2009. "Design guidelines for agent based model visualization". Journal of Artificial Societies and Social Simulation, 12, 1. http://jasss.soc.surrey.ac.uk/12/2/1.html [PDF]

B8) Ormerod, Paul, and Bridget Rosewell. "Validation and verification of agent- based models in the social sciences." Epistemological aspects of computer simulation in the social sciences. Springer Berlin Heidelberg, 2009. 130-140. [PDF]

B9) Galán, José Manuel, et al. "Errors and artifacts in agent-based modelling." Journal of Artificial Societies and Social Simulation 12.1 (2009): 1. [PDF]

B10) Sargent, Robert G. "Verification and validation of simulation models." Proceedings of the 37th conference on Winter simulation. Winter simulation conference, 2005. [PDF]

Instructor-presented Modeling Case Studies (M*)

M1) Schelling, Thomas C. "Dynamic Models of Segregation." Journal of Mathematical Sociology 1:143-186 (1971) Micromotives and macrobehavior. WW Norton & Company, 2006. [PDF]--[MODEL]

M2) Axelrod, R. (1992) "The dissemination of culture – A model with local convergence and global polarization". Journal of Conflict Resolution 41(2):203-226. [PDF]--[MODEL]

M3) Hegselmann, Rainer, and Ulrich Krause. "Opinion dynamics and bounded confidence models, analysis, and simulation." Journal of Artificial Societies and Social Simulation 5.3 (2002). [PDF]--[MODEL]

M4) Axtell R L, Epstein J M, et al. (2002). Population Growth and Collapse in a Multi-Agent Model of the Kayenta Anasazi in Long House Valley. Proceedings of the National Academy of Sciences 99(3): 7275-7279. [PDF and http://jasss.soc.surrey.ac.uk/12/4/13.html PDF]--[MODEL]

Student-presented case studies (X*)

X1) Bruch, E., and Robert D. Mare. "Neighborhood choice and neighborhood change." American Journal of sociology 112.3 (2006): 667-709. [PDF]

X2) Van de Rijt, Arnout, David Siegel, and Michael Macy. "Neighborhood Chance and Neighborhood Change: A Comment on Bruch and Mare." American Journal of Sociology 114.4 (2009): 1166-1180. [PDF]

X3) Strang, David, and Michael W. Macy. "In search of excellence: fads, success stories, and adaptive emulation." American journal of sociology 107.1 (2001): 147-182. [PDF]

X4) DellaPosta, Daniel, Yongren Shi, and Michael Macy. "Why Do Liberals Drink Lattes?" American Journal of Sociology 120.5 (2015): 1473-1511. [PDF]

X5) Macy, Michael W. 1991. Chains of Cooperation: Threshold Effects in Collective Action. American Sociological Review 55:730-747. [PDF]

X6) Chwe, Michael Suk-Young. "Structure and strategy in collective action." American Journal of Sociology 105.1 (1999): 128-156. [PDF]

X7) Epstein, J. M. (2002). Modeling civil violence: An agent-based computational approach. Proceedings of the National Academy of Sciences of the United States of America, 99 (Suppl 3), 7243-7250. [PDF]

X8) Fonoberova, Maria, et al. "Nonlinear dynamics of crime and violence in urban settings." Journal of Artificial Societies and Social Simulation 15.1 (2012): 2. [http://jasss.soc.surrey.ac.uk/15/1/2.html] [PDF]

X9A) Silverman, Eric, et al. "When demography met social simulation: a tale of two modelling approaches." Journal of Artificial Societies and Social Simulation16.4 (2013): 9. [http://jasss.soc.surrey.ac.uk/16/4/9.html] [PDF]

X9B) Billari, Francesco C., et al. "The "Wedding-Ring": An agent-based marriage model based on social interaction." Demographic Research 17.3 (2008): 59-82. [PDF]

X10) Grow, André, and Jan Van Bavel. "Assortative mating and the reversal of gender inequality in education in Europe: An agent-based model." PloS One10.6 (2015): e0127806. [PDF]

X11) Aktipis, C. Athena, Lee Cronk, and Rolando de Aguiar. "Risk-pooling and herd survival: an agent-based model of a Maasai gift-giving system." Human Ecology 39.2 (2011): 131-140. [PDF]

X12) Takahashi, Nobuyuki. "The emergence of generalized exchange." American Journal of Sociology (2000): 1105-1134. [PDF]

CLASS SCHEDULE: The following table is a tentative plan for the course lectures:

Lec	Date	Discuss	Part 1	Part 2	Reading Prior
1	Aug 22		Motivations (1)	Netlogo (2)	
2	Aug 29		ODD (3)	1st ABM (4)	B1, B2, B3
	Sept 5	No class			
3	Sept 12		Observations (5)	Testing (6,7)	B4, B5, B6
4	Sept 19		Emergence (7,8)	Experiments (9)	B7
5	Sept 26		Sensing (10)	Segregation (M1)	M1
6	Oct 3		Adaptation (11,12)	Diffusion (M2)	M2
7	Oct 10		Interaction (13)	Percolation (M3)	M3
	Oct 17	No class			
8	Oct 24		Calibration (20)	Coupling (M4)	M4
9	Oct 31		Sensitivity (23)	Validation	B8; B9; B10
10	Nov 7		X1	X2	X1;X2
11	Nov 14		X3	X4	X3;X4
12	Nov 21		X5	X6	X5;X6
13	Nov 28		X7	X8	X7;X8
14	Dec 5		X9	X10	X9;X10
			Modeling Basics		
			Simulation Science		
			Agent behaviors	(micro)	
			System dynamics	(macro)	
			Case studies		

Parenthetical numbers in the table above indicate chapter numbers in the course textbook (Grimm & Railsback's Agent-based and individual-based modeling).

COURSE LEARNING OBJECTIVES: The larger objective is to gain an appreciation for the importance of agent-based simulation in contemporary sociology research, and to begin to be empowered to create our own models, implement them in Netlogo, and use simulation experiments to advance sociological research. Specifically, you will come to know

(i) When agent-based models are most fruitfully applied,
(ii) How to construct a conceptual agent-based model and then formalize it,
(iii) How to implement the formalized model as custom computer software in Netlogo,
(iv) How to use the Netlogo programs to carry out simulation experiments that will produce scientifically defensible assertions, and
(v) A broad range of applications of ABM in contemporary sociology research.

These overall objectives are achieved through the accumulation of objectives for each of the course's lectures; these, in turn, are listed below.

LECTURE LEARNING OBJECTIVES:

	Learning Objective
1	To understand: What are models; What is modeling; Why build models; What are agent-based models (ABMs); How are ABMs different from other modeling approaches; When should you use ABMs; the iterative modeling cycle; To become familiar with: Netlogo user interface; NetLogo's basic agent types: observer, patches, turtles, and links; Netlogo code elements: procedures, reporters, etc; To build your first basic Netlogo ABM;
2	To understand: The Overview, Design, Details (ODD) modeling process; using ODD to design a simple ABM system; To become familiar with: Translating the ODD description of the ABM system into NetLogo code;
3	To understand: The difference between a simulation and an experiment; The importance of software testing and model verification; To become familiar with: Conducting simulation experiments in Netlogo based ABM systems; the process of outputting time series and population level data from Netlogo ABMs;
4	To understand: The concept of emergence; what makes some ABMs exhibit more emergence than others; the process of designing experimental measures and simulation experiments; To become familiar with: BehaviorSpace as a means for conducting systematic experiments in Netlogo; building time series plots and histograms outputs in Netlogo; visualizing dynamic simulations using visual elements in Netlogo; the process of importing Netlogo output data into other software packages for analysis;
5	To understand: The implications of sensing capabilities for agents; To become familiar with: The Netlogo implementation of sensing capabilities for agents; To grasp the scientific methodology underlying a significant modeling/simulation paper addressing research questions on segregation;
6	To understand: The implications of adaptation capabilities for agents; To become familiar with: The Netlogo implementation of adaptation capabilities for agents; To grasp the scientific methodology underlying a significant modeling/simulation paper addressing research questions on culture dissemination;
7	To understand: The implications of interaction capabilities for agents; To become familiar with: The Netlogo implementation of interaction capabilities for agents; To grasp the scientific methodology underlying a significant modeling/simulation paper addressing research questions on social opinion dynamics;
8	To understand: The concept of calibration of ABM systems and its impact on the interpretation of experimental results; To become familiar with: The techniques for calibration supported within Netlogo;

	To grasp the scientific methodology underlying a significant modeling/simulation paper addressing research questions on coupled social/environmental systems;
9	To understand: The importance of sensitivity, uncertainty, and robustness analysis within ABM systems; To become familiar with: The techniques for sensitivity, uncertainty, and robustness analysis supported within Netlogo;
10	To grasp the scientific methodology underlying a significant sociology paper using ABM models to understand segregation; To become familiar with: Presenting ABM-based sociology research;
11	To grasp the scientific methodology underlying a significant sociology paper using ABM models to understand behavioral adaptation; To become familiar with: Presenting ABM-based sociology research;
12	To grasp the scientific methodology underlying a significant sociology paper using ABM models to understand collective action; To become familiar with: Presenting ABM-based sociology research;
13	To grasp the scientific methodology underlying a significant sociology paper using ABM models to understand social unrest and crime; To become familiar with: Presenting ABM-based sociology research;
14	To grasp the scientific methodology underlying a significant sociology paper using ABM models to understand demographics or demography; To become familiar with: Presenting ABM-based sociology research.

PLAGIARISM. The UNL plagiarism policy is specified here. **The following two addenda apply:**

- The use of any code in whole or in part, must be cited and documented as an electronic resource. Failure to do so constitutes plagiarism in this class, and will be treated as a violation of academic integrity.
- Discussions both in person and over electronic media that are instrumental to the development of your ideas must be acknowledged in a cover letter prefixing your assignment submission. A series of statements to the effect of:

  "My understanding of X in this submission is indebted to discussions with Y", will suffice.

GRADING CRITERIA: Throughout the semester there will be short exercises assigned. The purpose of these is to help you to prepare for your final project (see below items 1-5). You are strongly encouraged to work on them, and to collaborate amongst yourselves to make sure you understand and feel comfortable with the material. The exercises will not be graded. Solutions will be provided, and the exercises will serve as the basis of discussion (item 6 below) at the beginning of each class. Assessment in this course is based on the items listed in the table below:

	Description	%	Due
1	Each student will select and be assigned a major contemporary research paper from (X1-X12) at the beginning of the course. The student will be required to read this paper and extract from it the pertinent ABM-related elements: the problem, the approach, the model (to be described in ODD format), the simulation experiments, the results, the conclusion.	-	
2	A Powerpoint-based lecture presentation (25%) with the help of a discussant (10%) on the ABM-related elements. Each student will serve as the discussant for another student's presentation.	35	Assigned Lecture
3A	A Netlogo-based re-implementation of the paper's model and verification of its simulation experiments (or a simplification/subset thereof) - OR 3B	-	
3B	A literature review of subsequent ABM-based research that builds on (cites) and extends the results in the paper – OR 3A.	-	
4	A report describing the ABM-related elements (from 1) AND EITHER the Netlogo implementation (from 3A) OR the literature review (from 3B).	30	12/12/16
5	Revised final PowerPoint slides, informed by the report (from 4).	25	12/12/16
6	In-class participation in discussions over the semester.	10	Ongoing

MAKE-UP POLICY AND EXTENSIONS. There is no make-up policy or extension possible for the above 6 items.

TARDINESS AND ATTENDANCE. To the extent that this impacts your participation level in class discussions (item 6 above), tardiness and absence is to be avoided. Also, it may become difficult to complete the final project in a satisfactory manner if you miss classes, and it will not be feasible for me to reiterate material that was missed due to an absence. If you are late, please minimize the disruption caused by your late arrival.