

# Models of Social Dynamics

Soc 273

Simulation research is gradually taking hold within sociology, and with reason: simulations can model processes that are theorized by sociologists – related to emergence, unintended consequences, nonlinearity, and complexity – but that are difficult to study using traditional quantitative methods. At the same time, there is little consensus, least of all within sociology, regarding the epistemological and methodological nature of simulations, which, after all, are a far cry from the sorts of direct empirical research that sociologists rightly value. Thus one of the primary concerns in this class will be to determine what place simulations, along with other forms of mathematical modeling, have in sociological (and more generally, social-scientific) research. Readings will be drawn from a range of social sciences, on topics including disease transmission, network dynamics, organizations, and collective action. Additional readings will be drawn from the natural sciences for whatever guidance these can provide. Major themes to be discussed will include the criteria of internal and external validity, the desirability of model simplicity vs. complexity, the role of parameters, the place of initial conditions, and the potential of simulation research to contribute to prediction, explanation, and theoretical development.

## **Course info**

Semester: Fall 2004

Instructor: David Gibson

Time: Thur., 12-2 p.m.

Location: 601 WJH

Web page: [www.courses.fas.harvard.edu/~soc273/](http://www.courses.fas.harvard.edu/~soc273/)

Office hours: Wed. 1-3 or by appointment, in 564 WJH

## **Texts at Coop**

Joshua Epstein and Robert Axtell, *Growing Artificial Societies* (MIT Press, 1996).

Robert Axelrod, *The Evolution of Cooperation* (Basic, 1985).

Stephen Wolfram, *A New Kind of Science* (Wolfram Media, 2002).

John Gottman et al., *The Mathematics of Marriage* (MIT Press, 2002).

Other readings can be found under “Readings” on the course web site—open “reading links” for links to pdf files. Others are “to be distributed”; the mechanism for this will be explained in class. The books are also on reserve in the WJH library. If you have difficulty accessing the articles (as non-Harvard students might), contact the instructor.

## **Requirements**

Attendance and Participation (20%)

Performance as discussion leader (5%)

End-of-semester presentation (5%)

Final paper (50%)

Memos (20%)

**Attendance and participation:** Students are expected to attend class, and to participate in class discussions. Intelligent participation requires that you keep up with the reading, and that you read one another’s memos (see below).

**Discussion leader:** One student will serve as discussion leader each week. This person will be responsible for starting the discussion with a short (approx. 15-30 minute) presentation of main ideas, findings, and questions raised by these.

**Final paper:** You will write a final paper of approximately 20–25 pages in length, based on your own small-scale simulation (or other sort of computational) project. The simulation need not be sophisticated, and you are free to program it in whatever language or software package you want. An additional Friday meeting will be scheduled during which Cheri Minton and I will talk about simulation basics and language/package options. These are due on January 14<sup>th</sup>.

**Memos:** Each student will submit, by 3:00 p.m. of the day before class, a *one-page* memo reflecting on some aspect of the assigned readings. The memos will be posted onto the class web page (under “Memos”), and you will be expected to read one another’s memos in advance of class. These memos are not to exceed one page, with one-inch margins and 12-point font, though they may be single-spaced. (Longer memos will be submitted to Word’s Autosummarizer for condensing, and thereby rendered both unrecognizable and indecipherable). They should contain your best idea about one or more of the readings, and should be written as clearly as possible. I will grade the memos on a check, check-minus, check-plus basis. Most memos will receive a check, representing an A-/B+ (90%) grade. You only get a check-plus if your idea is so good I wish I’d had it, and is well-written to boot.

*A note on readings:* Simulations are complex, but generally not in the sense of involving complex math. (More mathematical will be some of our non-simulation readings.) If you come across some math that you can decipher, it’s often worth trying to, but if this is a futile (or even especially time-consuming) effort, skip it and keep reading. Our discussions will rarely revolve around such details anyhow.

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## Schedule

### A. INTRODUCTION

Sept. 23. Introduction to the course

- syllabus
- scheduling of discussion leaders
- point of departure: statistical models
- recurring issues

Sept. 30. An overview and a case-study

Macy, Michael W. and Robert Willer. 2002. "From Factors to Actors: Computational Sociology and Agent-Based Modeling." *Annual Review of Sociology* 28:143-66.

Rauch, Jonathan 2002. "Seeing Around Corners." *The Atlantic Monthly*, April, pp. 35-48.

Joshua Epstein and Robert Axtell, *Growing Artificial Societies*.

Oct. 7. Cooperation

Robert Axelrod, *Evolution of Cooperation*. Chs. 1-3.

Nowak, Martin A. and Karl Sigmund. 1998. "Evolution of Indirect Reciprocity by Image Scoring." *Nature* 393:573-77.

Riolo, Rick L., Michael D. Cohen, and Robert Axelrod. 2001. "Evolution of Cooperation without Reciprocity." *Nature* 414:441-43.

Mark, Noah P. 2002. "Cultural Transmission, Disproportionate Prior Exposure, and the Evolution of Cooperation." *American Sociological Review* 67:323-344.

Oct. 14. Excursus: modeling in the natural sciences

Nov. 4. Stephen Wolfram, *A New Kind of Science*, pp. 23-41, 231-254, 299-301, 363-399, 429-432, 737-753.

Schilling, Govert. "Exploring a Virtual Universe." *Nature* 414:12-14.

Gerstein, Mark, and Michael Levitt. 1998. "Simulating Water and the Molecules of Life." *Scientific American*, November.

Rafkin, Scot C.R., Magdalena R.V. Sta. Maria, and Timothy I. Michaels. 2002. "Simulation of the Atmospheric Thermal Circulation of a Martian Volcano Using a Mesoscale Numerical Model." *Nature* 419:697-99.

Gibbs, W. Wayt. 2001. "Cybernetic Cells." *Scientific American*, August.

Rosenfeld, Jeffrey. 2000. "The Butterfly that Roared." *Scientific American*.

Hoffman, Ross N. 2004. "Controlling Hurricanes." *Scientific American*.

Oct. 21. Network evolution (and a paper on simulation methodology)

Gould, Roger V. 2002. "The Origins of Status Hierarchies: A Formal Theory and Empirical Test." *American Journal of Sociology* 107:1143-78.

Skyrms, Brian, and Robin Pemantle. 2000. "A Dynamic Model of Social Network Formation." *PNAS* 97:9340-46.

Watts, Duncan. 1999. "Networks, Dynamics, and the Small-World Phenomenon." *American Journal of Sociology* 105:493-527.

Axelrod, Robert. 1997. "Advancing the Art of Simulation in the Social Sciences." Pp. 21-40 in *Simulating Social Phenomena*, edited by R. Conte, R. Hegselmann, and P. Terna. Berlin: Springer. (This isn't about network evolution, but about the methodology of simulations.)

Suggested:

Mark, Noah. 1998. "Beyond Individual Differences: Social Differentiation from First Principles." *American Sociological Review* 63:309-30.

**Oct. 21, 2:00-3:30: Programming tutorial with Cheri Minton.**

Oct. 28. Network diffusion and search

Kaplan, E., D. Craft, and L. Wein. 2003. "Emergency Response to a Small Pox Attack: The Case for Mass Vaccination." *PNAS* 99:10935-10940.

Eubank, Stephen, Hasan Guclu, V.S. Anil Kumar, Madhav V. Marathe, Aravind Srinivansan, Zoltan Toroczkai, and Nan Wang. 2004. "Modelling Disease Outbreaks in Realistic Urban Social Networks." *Nature* 429:180-84.

Watts, Duncan J. 2002. "A Simple Model of Global Cascades in Random Networks." *PNAS* 99:5766-71.

David Gibson, "Concurrency and Commitment."

Recommended:

Kleinberg, Jon M. 2000. "Navigation in a Small World." *Nature* 406:845.

Watts, Duncan J., Peter Sheridan Dodds, and Mark Newmann. 2002. "Identity and Search in Social Networks." *Science* 296:1303-05.

#### Nov. 4. Organizations

Sah, Raaj Kurnar and Joseph E. Stiglitz. 1986. "The Architecture of Economic Systems: Hierarchies and Polyarchies." *The American Economic Review* 76:716-27.

Carley, Kathleen. 2002. "Computational Organization Science: A New Frontier." *PNAS* 99:7257-7262.

Cohen, Michael D., James G. March, and Johan P. Olsen. 1972. "A Garbage Can Model of Organizational Choice." *Administrative Science Quarterly* 17:1-25.

Bruderer, Erhard and Jitendra V. 1996. "Organization Evolution, Learning, and Selection: A Genetic-Algorithm-Based Model." *Academy of Management Journal* 39:1322-49.

Levinthal, Daniel A. 1997. "Adaptation on Rugged Landscapes." *Management Science* 43:934-59.

Dodds, Peter Sheridan, Duncan J. Watts, and Charles F. Sabel. "Information Exchange and the Robustness of Organizational Networks." *PNAS* 100:12516-12521.

#### Nov. 11. Veterans' Day – read Gottman

#### Nov. 18. Excursus: non-linear modeling

John Gottman et al., *The Mathematics of Marriage*, chs. 1-10. Coop and on reserve. Link to errata is on the Readings page.

#### Nov. 25<sup>th</sup>. Thanksgiving – work on your final projects!

#### Dec. 2. Social movements and collective action

Oliver, Pamela, Gerald Marwell, and Ruy Teixeira. 1985. "A Theory of the Critical Mass. I. Interdependence, Group Heterogeneity, and the Production of Collective Goods." *American Journal of Sociology* 91:522-56.

Oliver, Pamela E. and Gerald Marwell. 1988. "The Paradox of Group Size in Collective Action: A Theory of the Critical Mass. II." *American Sociological Review* 53:1-8.

Marwell, Gerald, Pamela E. Oliver, and Ralph Prahl. 1988. "Social Networks and Collective Action: A Theory of the Critical Mass. III." *American Journal of Sociology* 94:502-34.

Nestle, Frank O., Hannes Speidel, and Markus O. Speidel. 2002. "Mexican Waves in an Excitable Medium." *Nature* 419:131-2.

Saloma, Caesar, Gay Jane Perez, Giovanni Tapang, May Lim, and Cynthia Palmes-Saloma. 2003. "Self-Organized Queuing and Scale-Free Behavior in Real Escape Panic." *PNAS* 100:11947-11952.

#### Recommended:

Kim, Hyojoung, and Peter Bearman. 1997. "The Structure and Dynamics of Movement Participation." *American Sociological Review* 62:70-93.

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Heckathorn, Douglas D. 1996. "The Dynamics and Dilemmas of Collective Action." *American Sociological Review* 61:250-77.

Dec 9. Macro-evolution/devolution

Nowak, Martin A., Joshua B. Plotkin, and Vincent A. Jansen. 2000. "The Evolution of Syntactic Communication." *Nature* 404:495-8.

Cederman, Lars-Erik. 2002. "Endogenizing Geopolitical Boundaries with Agent-Based Modeling." *PNAS* 99:7296-7303.

Kliver, Jurgen and Jorn Schmidt. 2003. "Historical Evolution and Mathematical Models: A Sociocultural Algorithm." *Journal of Mathematical Sociology* 27:53-83.

Orbell, John, Langche Zeng, and Matthew Mulford. 1996. "Individual Experience and the Fragmentation of Societies." *American Sociological Review* 61:1018-32.

Hein, Jotun. 2004. "Pedigrees for all Humanity." *Nature* 431:518-19.

Rohde, Douglas L.T., Steve Olson, and Joseph T. Chang. 2004. "Modeling the Recent Common Ancestry of All Living Humans." *Nature* 431.

Dec. 16. Student presentations

Dec. 17. **(Friday—to be scheduled)** Student presentations, cont.

Final paper due on Jan. 14<sup>th</sup>.