Modeling Sustainability
ECO 581

Fall 2011
Mondays 3:10pm – 5:40pm , 201 Winslow Hall
Tim Waring (timothy.waring@maine.edu)
Office hours Wed noon-4pm or by appointment
Students are requested to bring laptops to class.

Agent-based models are a bizarre mix of science and art: while often used in scientific discourse, they are complex and challenging to build, test, and articulate. This course uses an intensive workshop format to provide significant experience with building, testing, and articulating agent-based models in order prepare students to use and critique these models in their own work.

This skills-based course in the modeling of social-ecological systems, focuses on providing students all the conceptual and computational tools they need to design, modify, test and build agent-based models of socio-ecological systems. It draws inspiration and theoretical perspectives from research on common pool resource dynamics, human cooperation, evolutionary game theory, and complex adaptive systems. Students will use the free, cross-platform modeling system called NetLogo to explore the dynamics of models, critique these models, modify and extend them. The semester's work will be cumulative, and build toward student-authored socio-ecological systems models. Students will be encouraged to connect their models to either local socio-ecological systems or to socio-ecological research conducted on campus.

Learning Objectives:

I intend to prepare you to:

- Define, explain and defend a socio-ecological reseach question of your choice
- Draft, develop and debug an agent-based model addressing your question
- Explain and critique an agent-based model from the literature (without code)
- Analyze and test an existing agent-based model (with code)
- Read and write NetLogo code
- Analyze and critique classmates models
- Test, analyze and present your own model
- Document your code and your model using a standard documentation system

Assignments

40% **ABM Project**

The course is focused on creating an agent based model relevant to your graduate studies. It will include a paper write up (max 15p single spaced) as well as the model itself. Proposal 5%, Draft model 10%, Draft paper %5, Final model & paper 20%.

20% **Modeling Exercises**

Four cumulative modeling exercises, 5% each, or any combination of 2%-8% that suits you and sums to 20%.

10% **Paper Critique**

Choose, present and critique an agent-based modeling paper from a literature of your choice.

10% **ABM Peer Review**

Analyze and critique a classmates ABM.

10% **Model Analysis**

Choose, test and analyze an agent-based model in written in NetLogo.

10% **Participation**

This will be a very interactive and hands-on class. I request your help to keep it lively and interesting.

Technical Stuff

Models and Papers will be turned in electronically, and directly to my desktop. We will use the free SugarSync service to accomplish this. I will send you a SugarSync invitation, followed by a link to a shared assignments folder that you should sync to your machine. You may get readings this way, too.

Expectations and Guidelines

As graduate students I expect to be able to treat you as intellectual peers, with all of the independence, commitment and responsibility that status entails. Below are some of the things that I try to train undergradutes on. I expect these will not be a problem for you, as a professional-grade student.

Attendance - please plan to attend all classes, on time or early.
Deadlines - please have all assignments completed on the due date.
Participation - read the readings, participate in discussions, kill cell phones, etc.
Originality - please make sure that all submitted work is entirely your own.
Respect - treat fellow students and the teacher with respect.
Support - the University of Maine offers several great support services for students. Among them are the drop-in UMaine Writing Center, the School of Economics Laboratory & Advising Center, 305 Stevens Hall, my own office hours, and the Services for Students with Disabilities Onward Program, 121 East Annex, 581-2319.

Readings

Course Book

1. Miller, J. H., & Page, S. E. (2007). *Complex adaptive systems: An introduction to computational models of social life*. Princeton Univ Press.

Week 3 - ABM Methodology

2. Janssen, M. A, & Ostrom, E. (2006). Empirically based, agent-based models. *Ecology and Society*, 11(2), 37.
3. Janssen, Marco A., Holahan, R., Lee, A., & Ostrom, Elinor. (2010). Lab Experiments for the Study of Social-Ecological Systems. *Science*, 328(5978), 613-617. doi:10.1126/science.1183532

Week 4 - ABM Methodology

4. 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

Week 5 – ABMs and Emergence

5. Epstein, J. M. (1999). Agent-based computational models and generative social science. *Complexity*, 4(5), 41–60.

Week 6 – Complexity Theory

6. Turchin, P., & Gavrilets, S. (2009). Evolution of complex hierarchical societies. *Social History and Evolution*, 8(2), 167–198.
7. Weeks, B., Rodriguez, M. A., & Blakeslee, J. H. (2004). Panarchy: complexity and regime change in human societies. *Proceedings: Santa Fe Institute Complex Systems Summer School*.
8. Cioffi-Revilla, C., Luke, S., Parker, D. C., Rogers, J. D., Fitzhugh, W. W., Honeychurch, W., Frohlich, B., et al. (2007). Agent-based modeling simulation of social adaptation and long-term change in inner Asia. Advancing Social Simulation: *The First World Congress in Social Simulation*, edited by T. Terano and D. Sallach. Tokyo, New York, and Heidelberg: Springer Verlag.
9. Turchin, P. (2011). Toward Cliodynamics–an Analytical, Predictive Science of History. *Cliodynamics*, 2(1).
10. Janssen, M. A. (n.d.). Games & Gossip. Open Agent Based Modeling Consortium. http://www.openabm.org/book/1928/games-gossip (section 1)

Week 7 - Ecological Dynamics

11. Theoretical Ecology – Wikipedia
12. Alvard, M. S. (1993). Testing the "ecologically noble savage" hypothesis: Interspecific prey choice by Piro hunters of Amazonian Peru. *Human Ecology*, 21(4), 355–387.
13. Feeny, D., Berkes, F., McCay, B. J., & Acheson, J. M. (1990). The Tragedy of the Commons: Twenty-two years later. *Human Ecology (Historical Archive)*, 18(1), 1-19.
14. TBA - McGill

Week 8 – Rationality and Human Behavior

15. Rational Choice Theory http://en.wikipedia.org/wiki/Rational_choice_theory
16. Chase, V. M., Hertwig, R., & Gigerenzer, Gerd. (1998). Visions of rationality. Trends in Cognitive Sciences, 2(6), 206-214. doi:16/S1364-6613(98)01179-6
17. Simon, H. A. (1987). Bounded rationality. The New Palgrave: utility and probability.
18. Simon, Herbert A. (1986). Rationality in Psychology and Economics. The Journal of Business, 59(4), S209-S224.
19. Goldstein, D. G., & Gigerenzer, G. (2002). Models of ecological rationality: The recognition heuristic. Psychological review, 109(1), 75.

Week 9 – Evolution and Human Behavior

20. Veblen, T. (1898). Why is Economics not an Evolutionary Science? *The Quarterly Journal of Economics*, 12(4), 373-397.
21. Waring, T. M. (2010). New evolutionary foundations: Theoretical requirements for a science of sustainability. *Ecological Economics*, 69, 718-730.
22. Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science*, 211(4489), 1390.
23. Axelrod, Robert, & Dion, D. (1988). The Further Evolution of Cooperation. *Science*, 242(4884), 1385 -1390.

Week 10 – Evolution, Cooperation and Culture

24. Boyd, R., & Richerson, P. J. (2009). Culture and the evolution of human cooperation. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1533), 3281 - 3288. doi:10.1098/rstb.2009.0134
25. Mesoudi, A., Whiten, A., & Laland, K. N. (2004). Perspective: is human cultural evolution Darwinian? Evidence reviewed from the perspective of the Origin of Species. *Evolution*, 58(1), 1-11. doi:10.1111/j.0014-3820.2004.tb01568.x

Week 11 –Cooperation and Evolutionary Transitions

26. Maynard Smith, J., & Szathmáry, E. (1995). The major transitions in evolution. Nature, 19.
27. Szathmáry, E., & Smith, M. (n.d.). The major evolutionary transitions. *Nature*, 374, 227–232.
28. Nowak, M. A. (2006). Five Rules for the Evolution of Cooperation. *Science*, 314(5805), 1560-1563. doi:10.1126/science.1133755

Week 12 – Coupled Natural-Human Systems and ABM

29. Agarwal, B. (2001). Gender inequality, cooperation and environmental sustainability. Workshop on Inequality, Collective Action and Environmental Sustainability (pp. 21–23).
30. Parker, D. C., Manson, S. M., Janssen, M. A, Hoffmann, M. J., & Deadman, P. (2003). Multi-Agent Systems for the Simulation of Land-Use and Land-Cover Change: A Review. *Annals of the Association of American Geographers*, 93(2), 314–337.
31. An, L. (2011). Modeling human decisions in coupled human and natural systems: Review of agent-based models. Review of agent-based models, 1, 2.
32. Monticino, M., Acevedo, M., Callicott, B., Cogdill, T., & Lindquist, C. (2007). Coupled human and natural systems: A multi-agent-based approach. *Environmental Modelling & Software*, 22(5), 656–663.

Week 13 - Model Analysis Methods

33. Grimm, Volker, Berger, U., DeAngelis, D. L., Polhill, J. G., Giske, J., & Railsback, Steven F. (2010). The ODD protocol: A review and first update. *Ecological Modelling*, 221(23), 2760-2768. doi:16/j.ecolmodel.2010.08.019
34. Ormerod, P., & Rosewell, B. (2009). Validation and Verification of Agent-Based Models in the Social Sciences. In F. Squazzoni (Ed.), Epistemological Aspects of Computer Simulation in the Social Sciences (Vol. 5466, pp. 130-140). Berlin, Heidelberg: Springer Berlin Heidelberg. Retrieved from http://www.springerlink.com.prxy4.ursus.maine.edu/content/ej20038353164m43/
35. Galán, J., & al, et. (2009). Errors and Artefacts in Agent-Based Modelling. *Journal of Artificial Societies and Social Simulation*, 12(11). Retrieved from http://jasss.soc.surrey.ac.uk/12/1/1.html
36. Sargent, R. G. (2000). Verification, validation and accreditation of simulation models. Simulation Conference Proceedings, 2000. Winter (Vol. 1, pp. 50-59 vol.1). *Presented at the Simulation Conference Proceedings*, 2000. Winter. doi:10.1109/WSC.2000.899697

Related Books

37. Gilbert, G. N., & Troitzsch, K. G. (2005). Simulation for the social scientist. Open Univ Pr.
38. Epstein, J. M. (2006). Generative social science: Studies in agent-based computational modeling. Princeton Univ Pr.
39. Epstein, J. M., & Axtell, R. (1996). Growing artificial societies: social science from the bottom up. The MIT Press.
40. Miller, J. H., & Page, S. E. (2007). Complex adaptive systems: An introduction to computational models of social life. Princeton Univ Pr.
41. Grimm, V., & Railsback, S. F. (2005). Individual-based modeling and ecology. Princeton Univ Pr.

Some Motivation for Modeling Coupled Systems

42. Vitousek, P. M. (1997). Human Domination of Earth's Ecosystems. *Science*, 277(5325), 494-499. doi:10.1126/science.277.5325.494
43. Palumbi, S. R. (2001). Humans as the World's Greatest Evolutionary Force. *Science*, 293(5536), 1786-1790. doi:10.1126/science.293.5536.1786