Agent Based Modeling
ECO 581

Fall 2013
Tues, Thurs: 3:30 – 4:45pm, 201 Winslow Hall
Tim Waring (timothy.waring@maine.edu)
Office hours Wed noon-1pm 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 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 models. Students will be encouraged to connect their models to research conducted on campus.

Learning Objectives:

I intend to prepare you to:

- Characterize the unique niche of agent-based models as a scientific tool
- Select an ABM-appropriate research question of your choice
- Draft, develop, debug and analyze an ABM addressing your research 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 10p 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 undergraduates 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 Text

1. Railsback, S. F., & Grimm, V. (2011). *Agent-based and individual-based modeling: A practical introduction*. Princeton University Press.

Emergence

2. Epstein, J. M. (1999). Agent-based computational models and generative social science. *Complexity*, 4(5), 41–60.
3. Jad Abumrad & Robert Krulwich, Emergence, WNYC's RadioLab www.radiolab.org/2007/aug/14/

Norms and Rationality

4. Chase, V. M., Hertwig, R., & Gigerenzer, G. (1998). Visions of rationality. *Trends in Cognitive Sciences*, *2*(6), 206–214.
5. Epstein, J. M. (2001). Learning to Be Thoughtless: Social Norms and Individual Computation. *Computational Economics*, *18*(1), 9–24.

Evolution and Cooperation

6. Axelrod, R., & Hamilton, W. D. (1981). The evolution of cooperation. *Science*, 211(4489), 1390.
7. Nowak, M. A. (2006). Five Rules for the Evolution of Cooperation. *Science*, *314*(5805), 1560–1563.

Evolution and Culture

8. Wade, N. 2010. *Human culture, an evolutionary force*. The New York Times. http://www.nytimes.com/2010/03/02/science/02evo.html
9. Ehrlich, P. 2008. *Does human culture evolve via natural selection, as our genes do?* SEED Magazine. http://seedmagazine.com/content/article/cultural_evolution/
10. 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.

Institutions

11. Ostrom, E. (2008). Do institutions for collective action evolve? *Journal of Bioeconomics*, 1–28. doi:10.1007/s10818-013-9154-8

Online Resources (high quality, easy to use resources)

12. *Introduction to Agent-Based Modeling*. An online book by Marco Janssen, Arizona State University. http://www.openabm.org/book/introduction-agent-based-modeling
13. *Games & Gossip*. Open Agent Based Modeling Consortium. Marco Janssen, Arizona State University. http://www.openabm.org/book/1928/games-gossip

14. *Agent-Based Modeling in the Social Sciences*. An online course by Leigh Tesfatsion, Iowa State University. http://www2.econ.iastate.edu/tesfatsi/abmread.htm

Related Books (none of which are as good introductions as Railsback & Grimm)

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

Online Resources

20. Courses
    a. http://www2.econ.iastate.edu/tesfatsi/abmread.htm
    b. http://www.openabm.org/book/introduction-agent-based-modeling
21. Repositories
    a. www.openabm.org

ECO 581 - Notes

- Have students implement some HW in which they construct a simple evolving system
- Create a modeling cookbook
    - Include probability & frequency code
    - Include 0-1 parameters
    - Code in monitors, buttons, etc.
    - Neighbors & imitation
- ZombieLand Model
    - http://www.personal.kent.edu/~mdball/zombies1_4.htm

- Summary Discussion
    - Focus even more on skills, reduce random readings
    - Have NetLogo warmup each day.
    - Model the whole model life-cycle in early exercises (design, build, test, analyze)
    - Teach lists, neighbors, diffuse
    - Teach procedure types – reporting procedures, procedures with parameters
    - Teach multiple ways to code the same task (with lists, with patches, etc)
    - Use a visual aid to explain the flow of control in NetLogo (observer, patches, turtles, etc)
    - Teach a design and implementation process from the beginning, and model it in front of class, writing procedures, commenting them, testing them
    - Add themes – demography, social learning, spatial interactions, evolution, feedbacks, SES systems
    - Teach debugging tricks and code
    - More dynamic environment is SES models
    - Teach "hostile to your hypothesis" early on.
    - Encourage people to make a visual representation (anything, flow diagram, a series of cartoon drawings) as a sort of pre-pseudo code
    - Teach the command center, agent inspectors, etc.