Ecological and Social Agent-based Modeling NR 554 / ANTH 554 Spring 2017

Instructor: Randall Boone, Professor, ESS and Research Scientist, NREL
Natural and Environmental Sciences Building (NESB) – B 234
(970) 491-1806 http://www.randallboone.org
Randall.Boone@ColoState.edu
Office hours: 4-5 pm, WF or appointment

Lecture: TR 9:30-10:20, NESB B224
Lab: R 10:30-12:20, GTL Lab, NR 232

Course Website: Canvas

Course Description: Students will learn the theory and practice of agent-based modeling through lectures and by using and constructing computer simulations. Frequent use of case studies in ecology and social modeling will emphasize points. An agent-based modeling platform will be used in laboratories that is straightforward, so that each student will be able to create models with complexities on-par with their interests and abilities.

Course Objectives: When the course is complete you should be able to demonstrate:

- Your understanding of the purpose of agent-based modeling, its utility, and its history;
- The distinctions between top-down and bottom-up approaches, and emergence;
- A familiarity with the tools used in agent-based modeling;
- An ability to create agent-based models using NetLogo;
- In depth familiarity of how agent-based modeling may be applied to a topic of interest;
- Your understanding of the assessment of agent-based models.

Readings: Railsback, S. and V. Grimm. 2011. Agent-Based and Individual-Based Modeling: A Practical Introduction. Princeton University Press, Princeton, New Jersey.

Additional journal articles will be provided to you as PDFs on Canvas. Most of these readings will be optional.

For required readings, we will often discuss how points they make may apply to your research, work, or interests. We may discuss items in the readings that are confusing or with which we disagree. Students should consider these questions (e.g., three ways in which a paper related to a topic of interest, three things that were confusing about a paper) when reading the papers. *Student readiness will be reflected in the participation portion of the course grading*.

Class schedule (subject to change):

Week 1

Tuesday (Jan 17) – ***Introduction, Overview, Agent-based models, and Why We Model***
No readings

Thursday (Jan 19) – ***Comparing modeling approaches***
Readings
Railsback and Grimm. 2011. Part I.1 (pages 3-12)
Optional Readings
May, R.M. 2004. Uses and abuses of mathematics in biology. Science 303:790-793.
Bonabeau, E. 2002. Agent-based modeling: methods and techniques for simulating human systems. Proceedings of the National Academy of Science 99:7280-7287.

(Lab) **(Jan 19)** ***Comparing modeling approaches***

Week 2

Tuesday (Jan 24) – ***Individual-based modeling***
Readings
Railsback and Grimm. 2011. Part I.4-5 (pages 47-74)
Huston, M., D. DeAngelis, and W. Post. 1988. New computer models unify ecological theory. BioScience 38:682-691.
Optional Readings
Grimm, V. 1999. Ten years of individual-based modelling in ecology: what have we learned and what could we learn in the future? Ecological Modelling 115:129-148.
Boone, R.B., C.M. Johnson, and L.B. Johnson. 2006. Simulating wood frog movement in central Minnesota, USA using a diffusion model. Ecological Modelling 198:255-262.

Thursday (Jan 26) – ***Top-down, bottom-up, and emergence***
Readings
Railsback and Grimm. 2011. Part I.3 (pages 35-46)
Railsback and Grimm. 2011. Part II.8 (pages 101-114)
Optional Readings
Berry, B.J., L.D. Kiel, and E. Elliott. 2002. Adaptive agents, intelligence, and emergent human organization: capturing complexity through agent-based modeling. Proceedings of the National Academy of Science 99:7187-7188.

(Lab) **(Jan 26)** ***NetLogo introduction***
Readings
Railsback and Grimm. 2011. Part I.2 (pages 15-34)
Railsback and Grimm. 2011. Part I.6 (pages 75-94)

Week 3

Tuesday (Jan 31) – ***Agent-based modeling theory and practice***

Readings

Railsback and Grimm. 2011. Part II.9-10 (pages 115-141)

Axtell, R.L., J.M. Epstein, J.S. Dean, G.J. Gumerman, A.C. Swedlund, J. Harburger, S. Chakravarty, R. Hammond, J. Parker, and M. Parker. 2002. Population growth and collapse in a multiagent model of the Kayenta Anasazi in Long House Valley. Proceedings of the National Academy of Science 99:7275-7279.

Boone, R.B. and K.A. Galvin. 2014. Simulation as an approach to social-ecological integration, with an emphasis on agent-based modeling. In: Understanding society and natural resources: forging new strands of integration across the social sciences. Manfredo, M., et al. (eds.). Springer Dordrecgt Heidelberg, New York. Pages 179-202.

Thursday (Feb 2) – ***The many forms of agent-based modeling***

Optional Readings

Goldstone, R.L. and M.A. Janssen. 2005. Computational models of collective behavior. Trends in Cognitive Sciences 9:424-430.

Parker, D.C., S.M. Manson, M.A. Janssen, M. Hoffmann, and P. Deadman. 2003. Multi-agent systems for the simulation of land-use and land-cover change: a review. Annals of the Association of American Geographers 93:314-337.

(Lab) **(Feb 2)** ***Ecological agent-based modeling case studies***

Optional Readings

Reynolds, C.W. 1987. Flocks, herds, and schools: a distributed behavioral model. In: SIGGRAPH'87: Proceedings of the 14th Annual Conference on Computer Graphics and Interactive Techniques. ACM Press, New York. Pages 25-34.

Boone, R.B., S.J. Thirgood, and J.G.C. Hopcraft. 2006. Serengeti wildebeest migratory patterns modeled from rainfall and new vegetation growth. Ecology 87:1987-1994.

Week 4

Tuesday (Feb 7) – ***Game theory and agent-based modeling***

Readings

Railsback and Grimm. 2011. Part II.12-13 (pages 157-182)

Optional Readings

Elliott, E. and L.D. Kiel. 2002. Exploring cooperation and competition using agent-based modeling. 2002. Proceedings of the National Academy of Science 99:7193-7194.

Kraus, S. 1997. Negotiation and cooperation in multi-agent environments. Artificial Intelligence 94:79-97.

Thursday (Feb 9) – *Tools for agent-based modeling*

Readings

Railsback, S.F., S.L. Lytinen, and S.K. Jackson. 2006. Agent-based simulation platforms: review and development recommendations. Simulation 82:609-623.

Optional Readings

Gilbert, N. and S. Bankes. 2002. Platforms and methods for agent-based modeling. Proceedings of the National Academy of Science 99:7197-7198.

(Lab)* (Feb 9) *Social agent-based modeling case studies

Optional Readings

Boone, R.B., K.A. Galvin, S.B. BurnSilver, P.K. Thornton, D.S. Ojima, and J.R. Jawson. 2011. Linking pastoral household decision making to ecosystem services using simulated scenarios. Ecology and Society 16(2):6 [online] URL: http://www.ecologyandsociety.org/vol16/iss2/art6/

Rauch, J. 2002. Seeing around corners. Atlantic Monthly April:35-48.

Week 5

Tuesday (Feb 14) – *Creating agent-based models*

Readings

Railsback and Grimm. 2011. Part II.14-15 (pages 183-206)

Optional Readings

Gilbert, N. and P. Terna. 2000. How to build and use agent-based models in social science. Mind & Society 1:57-72.

Johnston, E., Y. Kim, and M. Ayyanger. 2007. Intended and unintended: the act of building agent-based models as a regular source of knowledge generation. Interdisciplinary Description of Complex Systems 5:81-91.

Thursday (Feb 16) – *Creating agent-based models*

Readings

Railsback and Grimm. 2011. Part III.20 (pages 255-270)

NetLogo 5.0. User Manual. Pages 93-141.

(Lab)* (Feb 16) *NetLogo Programming

Week 6

Tuesday (Feb 21) – *Models of ecological interaction*

Readings

Railsback and Grimm. 2011. Part II.16 (pages 209-224)

Optional Readings

Dumont, B. and D.R.C. Hill. 2001. Multi-agent simulation of group foraging in sheep: effects of spatial memory, conspecific attraction, and plot size. Ecological Modelling 141:201-215.

Bousquet, F., C. Le Page, I. Bakam, and A. Takforyan. 2001. Multiagent simulations of hunting wild meat in a village in eastern Cameroon. Ecological Modelling 138:331-346.

Thursday (Feb 23) – ***Models of social interaction***

Readings

Boone, R.B. and C.K. Lesorogol. 2016. Modelling coupled human-natural systems of pastoralism in East Africa. Pastoralism in the developing world: an exploration of interdisciplinary strategies for sustainable pastoralism (Dong, S., K.-A. S. Kassam, J.F. Tourrand, and R.B. Boone, eds.) Springer, Switzerland, pp. 251-280.

Lansing, J.S. and J.N. Kremer. 1993. Emergent properties of Balinese water temple networks: coadaptation on a rugged fitness landscape. American Anthropologist 95:97-114.

Optional Readings

Janssen, M.A. and E. Ostrom. 2006. Emperically based, agent-based models. Ecology and Society 11:37 [online] URL: http://www.ecologyandsociety.org/vol11/iss2/art37/

Lesorogol, C.K. and R.B. Boone. 2016. Which way forward? Using simulation models and ethnography to understand changing livelihoods among Kenyan pastoralists in a "new commons". International Journal of the Commons 10:747-770.

Page, S.E. 1999. Computational models from A to Z. Complexity 5:35-41.

(Lab) **(Feb 23)** ***NetLogo Programming***

Week 7

Tuesday (Feb 28) – ***Class project introduction***

No readings

Thursday (Mar 2) – ***Judging appropriate levels of complexity in modeling***

Readings

Railsback and Grimm. 2011. Part III.17-18 (pages 225-242)

Optional Readings

Epstein, J.M. 1999. Agent-based computational models and generative social science. Complexity 4:41-60.

(Lab) **(Mar 2)** ***NetLogo Programming***

Week 8

Tuesday (Mar 7) – ***Nature inspired simulation***

Readings

Railsback and Grimm. 2011. Part II.11 (pages 143-156)

Optional Readings

Sims, K. 1994. Evolving virtual creatures. In: Computer Graphics, Annual Conference Series (SIGGRAPH '94 Proceedings). Pages 15-22.

Bornhofen, S. and C. Lattaud. 2006. Outlines of artificial life: a brief history of evolutionary individual based models. Lecture Notes in Computer Science 3871:226-237.

Thursday (Mar 9) – *Environments, spatial data, and agent-based modeling*
Optional Readings
Matthews, R.B., N.G. Gilbert, A. Roach, J.G. Polhill, and N.M. Gotts. 2007. Agent-based land-use models: a review of applications. Landscape Ecology 22:1447-1459.
Entwisle, B. 2007. Putting people into place. Demography 44:687-703.

(Lab*)(Mar 9) *NetLogo Programming

(Spring Break)

Week 9

Tuesday (Mar 21) – *Propose individual case studies (one-on-one)*
No readings

Thursday (Mar 23) – *Propose individual case studies (one-on-one)*
No readings

(Lab)* (Mar 23) *Environments and geospatial agent-based modeling, plus Nature inspired modeling

Week 10

Tuesday (Mar 28) – *Propose individual case studies (in class)*
Student suggested readings

Thursday (Mar 30) – *Propose individual case studies (in class)*
Student suggested readings

(Lab)* (Mar 30) *Model Development

Week 11

Tuesday (Apr 4) – *A group case study – Group polarization*
Readings
Moscovici, S. and M. Zavalloni. 1969. The group as a polarizer of attitudes. Journal of Personality and Social Psychology 12:125-135.
Optional Readings
Powe, L.A., Jr. 2003. Disease or Cure? A review of Republic.com, by Cass Sustein. Michigan Law Review 101:1947-1959.

Thursday (Apr 6) – *Merged with lab*

(Lab)* (Apr 6) *Model development

Week 12

Tuesday (Apr 11) – ***Evaluation and Critique of agent-based models***

Readings

Railsback and Grimm. 2011. Part IV.23 (pages 291-308)

Optional_Readings

Wilensky, U. and W. Rand. 2007. Making models match: replicating an agent-based model. Journal of Artificial Societies and Social Simulation 10(4):2 [online] URL: http://jasss.soc.surrey.ac.uk/10/4/2.html

Thursday (Apr 13) – ***Merged with lab***

(Lab) **(Apr 13)** ***Model development***

Week 13

Tuesday (Apr 18) – ***From simulation to theory in and across disciplines***

Readings

Railsback and Grimm. 2011. Part III.19 (pages 243-254)

Optional_Readings

Smith, E.R. and F.R. Conrey. 2007. Agent-based modeling: a new approach for theory building in social psychology. Personality and Social Psychology Review 11:87-104.

Axelrod, R. 2006. Agent-based modeling as a bridge between disciplines. In: Handbook of Computational Economics (Tesfatsion, L. and K.L. Judd, eds.), Vol. 2: Agent-based Computational Economics. North-Holland. Pages 1565-1584.

Thursday (Apr 20) – ***Merged with lab***

(Lab) **(Apr 20)** ***Model development***

Week 14

Tuesday (Apr 25) – ***Scenario analysis and Communicating Results***

Readings

Railsback and Grimm. 2011. Part IV.22 (pages 277-290)

Peck, S.L. 2004. Simulation as experiment: a philosophical reassessment for biological modeling. Trends in Ecology and Evolution 19:530-534.

Schmolke, A., P. Thorbek, D.L. DeAngelis, and V. Grimm. 2010. Ecological models supporting environmental decision making: a strategy for the future. TREE 25:479-486.

Optional_Readings

Galvin, K.A., P.K. Thornton, J.R. de Pinho, J. Sunderland, and R.B. Boone. 2006. Integrated modeling and its potential for resolving conflicts between conservation and people in the rangelands of East Africa. Human Ecology 34:155-183.

Thursday (Apr 27) – ***Merged with lab***
No readings

(Lab) **(Apr 27)** ***Model analysis***

Week 15

Tuesday (May 2) – ***Present individual case studies***
No readings

Thursday (May 4) – ***Present individual case studies***
No readings

(Lab) **(May 4)** ***Present individual case studies***

Week 16

Wednesday (May 10, 5 pm) – ***Final project report and model due***

Attendance Policy and Participation: Students are encouraged to attend lectures regularly. Discussions and demonstrations in lectures will be critical for you to develop a deeper understanding of the utility and practice of agent-based modeling. If you are forced to miss a lecture, the visuals used will be posted afterward informing you of what you have missed. However, those visuals will not include the animations, simulations made, or discussions that were had during lecture.

Special Needs: Any student who needs special accommodations or has special needs are encouraged to speak with me about those needs within the first two weeks of the course.

Academic Responsibility: All work in this course must be completed in accordance with the CSU academic honesty policy (http://catalog.colostate.edu/front/policies.aspx). Plagiarism or failing to meet the academic honesty policy in other ways may result in dismissal from class and will be reported. By participating in this course, you agree to abide by the following honor pledge, "I will not give, receive, or use any unauthorized assistance in this course."

Expectations of Me: I will bring my enthusiasm and experience with agent-based modeling to our meetings, and strive to create an atmosphere of collaborative learning. I will have up-to-date lecture materials, and will use engaging examples in our class. Students have their own experiences and background. I will build off those, encouraging and appreciating an interdisciplinary approach to our work. I will strive to keep all students up-to-date on their class standing. I will be readily available to students, with my office door commonly open, and by appointment if helpful.

Expectations from You: In addition to promptness, participation, attention to CSU student expectations, etc., I expect students to embrace the interdisciplinary nature of the course. People of different backgrounds and experience gain from this course – some are anthropologists, some are ecologists, some are graduate students, some undergraduates, some have programming

experience, and some do not. We are colleagues, sharing in a learning experience and learning from each other.

At the core of this course is a project. We will be making incremental progress toward the completion of your project during this course, and so in general, I will be familiar with its status. However, later in the semester there will be opportunities for you to work in a laboratory setting on your project, and to ask questions of me and your classmates. Your attendance at such sessions is optional. However, if you do not attend these sessions, I will assume that your modeling efforts are going well. If you have any difficulties in the class, *speak with me* or find some other way to let me know, otherwise your difficulties may go unrecognized.

Methods of evaluation:

Class participation: *20%*

Students are expected to raise questions and join in discussions in class and laboratories. Evaluation of students' class participation will be provided at intervals through the course.

Occasional modeling exercises: *20%*

Students will be constructing some models or doing other tasks associated with agent-based modeling. These assignments will be evaluated, and feedback provided so that future modeling efforts may be modified if needed.

Individual project updates: *20%*

An individual project will be central to this course. Students will receive assignments that allow them to make incremental progress toward completion of that project. Comments and evaluation of these updates will allow students to modify plans or procedures as needed.

Final project report and model: *30%*

Students will submit a final report describing their individual project and its results, plus the application used in the research.

Final exam: *10%*

A final exam will assess students' understandings of core concepts and techniques.

Final grades will be assigned using the following CSU grading scheme:

Grade	Score	Course Credit
A	93-100	4.0
A-	90-92	3.7
B+	87-89	3.3
B	83-86	3.0
B-	80-82	2.7
C+	77-79	2.3
C	70-76	2.0
D	60-69	1.0
F	0-59	0