

**Syllabus, “Spatial Agent-based Models of Human-Environment Interactions”**  
**GEOG631/EVPP631/CSS645**  
**Dr. Dawn C. Parker, Spring 2007**  
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**Meeting time and location:** Tuesdays 7:20-10:00 PM, Innovation 320

**Class Web Site:** [http://mason.gmu.edu/~dparker3/spat\\_abm/spat\\_abm](http://mason.gmu.edu/~dparker3/spat_abm/spat_abm)

**Description:** This course will introduce graduate students in the spatial, environmental, and computational social sciences to the use of agent-based techniques as a means of modeling human-environmental interactions. Emphasis will be placed on spatial processes, the use of spatial identifiers to link socioeconomic and biophysical models, and, where possible, links to geographic information and technology. We will cover applications in areas such as agriculture, forestry, biodiversity, water resource management, habitat degradation, and interactions between human populations and non-human species.

The course will combine literature review with some hands-on modeling. When demo versions are available, we will compile and run models as we review articles based on those models. In addition, students will complete a class project where they develop their own models in their areas of interest. Students with no programming background can develop simple models using Netlogo. Students with advanced programming abilities will be encouraged to develop more sophisticated models using packages such as RePast, SWARM, MASON. etc., or may develop their own ABM using the language of their choice.

**Course Themes:** Since application of ABM to research on human-environment interactions is a fairly new area, standard methodology is still in development stages. Therefore, we will focus our discussion on progress to date, and need for further methodological development, in several key areas, including:

- Model ontologies and model communication
- Alternative theoretical models of decision making
- Empirical methods for building agent decision models
- Modeling market interactions
- Modeling institutions
- Modeling cross-scale feedbacks and interactions

- Integration of agent-based modeling and GIS
- Understanding the behavior of complex models
- Model verification and validation (esp. pattern-oriented validation)

**Prerequisites:** Students should have a familiarity with spatial structures and concepts, some background in a social science, and a high level of computing competence. Students should have some familiarity with agent-based modeling and complexity theory, such as would be provided by Introduction to Computational Social Science (CSS 600) or Land-Use Modeling Techniques and Applications (EVPP531/GEOG531). Knowledge of a programming language is helpful but not required. Additional readings will be suggested for students lacking background in any of these areas. Generally, no one student has background in all of these areas. Students are encouraged to make stronger contributions in their areas of expertise, and to learn from the expertise of others in their weaker areas.

### Course requirements:

- **Readings:** Each week students will be required to read 3-4 readings. Some weeks you have a choice—read carefully.
- **Short writing assignments:** Most weeks there will be at least one short writing assignment. Topics will be given out in lecture/via e-mail for the first several weeks. Starting Feb 13, each student will be required to complete a brief written review of one of the weekly readings, based on the SWA questions on the class web site ([http://mason.gmu.edu/~dparker3/spat\\_abm/handouts/SWA\\_instructions.pdf](http://mason.gmu.edu/~dparker3/spat_abm/handouts/SWA_instructions.pdf)) Students will share these reviews with the rest of the class before the class meeting time. These will be due by 9 AM on Monday, using the web-based course management system (<http://www.css.gmu.edu/cms/course/view.php?id=6>). You need to create a logon for yourself on this site.
- **MaSpace postings:** Each student will be required to subscribe to the MaSpace list (<http://csiss.ncgia.ucsb.edu/mailman/listinfo/maspace>) and post one substantive methodological/research oriented to the list. Hint: you may want to post a question that will help you complete a good term project. NOTE! The listserv is down; will let you know when it is back up.
- **Presentations:** Students will each be required to give an in-depth review of 2 articles over the course of the semester, starting Feb. 13. Presentation guidelines are posted on the public website.
- **Term project and presentations:** Each student will complete a term project in their area of interest and will present the results to the class. A 500-1000 word abstract/proposal of your project is due Feb. 27. Please also include (separate to this length requirement) any relevant citations (5-10 citations, probably no more than that). The abstract should tell me:
  - What is the research question that you wish to investigate (as someone else puts it, what is the model "for"; not what is the model "of")?
  - Why is this question interesting and relevant?
  - How will you address the question? (what sort of model, what language, etc.)

The final paper should be no more than 30 pages, double-spaced with 1 inch margins, including citations. You may also create a web page with animations, model demo, etc. if you like. One paper from last time the course was taught was published in JASS, so be inspired!

- **Final exam:** There will be a take-home final based on the course readings, modeling concepts, and term project presentations.

Late short writing assignments will not be accepted. You may make up up to two SWAs by doubling up for another week, posting a writing on a seminar or conference paper presentation that you attend, or completing another assignment that we both agree on. If you are not able to present a paper of your choice on the assigned day due to an authentic emergency, you will be asked to present another paper later in the semester instead. Other late work will lose one quarter of a letter grade per day.

**Grading:** Student’s grades will be based on the following:

25%: Article presentations

25%: Short writing assignments, MaSpace postings, and class participation

25%: Term project

25%: Final exam

*Term papers will be evaluated using Turnitin, a plagiarism-detection service. Other written work may be also submittd to turnitin. Please see the writing center resources (<http://writingcenter.gmu.edu/resources/plagiarism.html>) for very helpful guidelines. You will be able to check your own papers before you turn them in to me, so that there are no surprises.*

*Please check before class to ensure that cell phones and pagers are turned off. Note that George Mason is an [honor code](#) university.*

Date	Topic	Readings (Presenter)	Assignment Due
Jan. 23	Conceptual introduction	<p>Bousquet, F., and C. Le Page. 2004. Multi-agent simulations and ecosystem management: a review. <i>Ecological Modelling</i> 76 (3-4): 313-332</p> <p>Janssen, M. A., and E. Ostrom. 2006. GOVERNING SOCIAL-ECOLOGICAL SYSTEMS in K. Judd and L. Tesfatsion, eds. <i>Handbook of Computational Economics II: Agent-Based Computational Economics</i>. Elsevier/North-Holland</p> <p>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. <i>Annals of the Association of American Geographers</i> 93 (2).</p> <p>Grimm, V. Forthcoming. <i>Ecological Models: Individual-based Models</i> in S.-E. Jørgensen, ed.</p>	

		Encyclopedia of Ecology. Elsevier.	
Jan. 30	Intro continued: complexity in human-environment systems, pattern-oriented validation, Logo models	<p>Parker, D. C., T. Berger, and S. M. Manson. 2002. Meeting the Challenge of Complexity: Proceedings of the Special Workshop on Agent-Based Models of Land-Use/Land-Cover Change. Santa Barbara: CIPEC/CSISS Publication CCR-3. <a href="http://www.csiss.org/maslucc/ABM-LUCC.htm">http://www.csiss.org/maslucc/ABM-LUCC.htm</a> (Parts 1, 2, 3.1, 4)</p> <p>Grimm, V., E. Revilla, U. Berger, F. Jeltsch, W. M. Mooij, S. F. Railsback, H.-H. Thulke, J. Weiner, T. Wiegand, and D. L. DeAngelis. 2005. Pattern-Oriented Modeling of Agent-Based Complex Systems: Lessons from Ecology. <i>Science</i> 310: 987-991</p> <p>Manson, S. 2001. Simplifying complexity: A review of complexity theory. <i>Geoforum</i> 32 (3): 405-414 (optional)</p>	Writing assignment 1: topic suitable for ABM
Feb. 6	ABM/GIS integration. Model communication /ontologies. Strategies for parameterizing agent decision models.	<p>Gimblett, H. R. 2002. Integrating Geographic Information Systems and Agent-Based Technologies for Modeling and Simulating Social and Ecological Phenomena. Pages 1-20 in H. R. Gimblett, ed. Integrating Geographic Information Systems and Agent-Based Modeling Techniques for Simulating Social and Ecological Processes. Oxford University Press, Oxford, U.K.</p> <p>Parker, D. C. 2005. Integration of Geographic Information Systems and Agent-Based Models of Land Use: Challenges and Prospects in D. J. Maguire, M. F. Goodchild, and M. Batty, eds. GIS, Spatial Analysis and Modeling. ESRI Press, Redlands, CA</p> <p>Parker, D., D. Brown, J. G. Polhill, S. M. Manson, and P. Deadman. Forthcoming. Illustrating a new 'conceptual design pattern' for agent-based models and land use via five case studies: the MR POTATOHEAD framework in A. L. Paredes and C. H. Iglesias, eds. Agent-based Modelling in Natural Resource Management. Pearson Education</p> <p>Polhill, J. G., D. Parker, D. Brown, and V. Grimm. In review. Using the ODD protocol for comparing three agent-based social simulation models of land use change. Submitted for Model to Model 2007. (Optional)</p> <p>Robinson, D. T., D. G. Brown, D. C. Parker, P. Schreinemachers, M. A. Janssen, M. Huigen, H. Wittmer, N. Gotts, P. Promburom, E. Irwin, T. Berger, F. Gatzweiler, and C. Barnaud. Accepted pending revisions. Comparison of empirical methods for building agent-based models in land use science. <i>Journal of Land-Use Science</i></p>	Writing assignment 2: Logo "segregation" and "cooperation" models. List of 4 article presentation choices due.

Feb. 13	Agrarian societies	<p>Deadman, P., D. Robinson, E. Moran, and E. Brondizio. In Press. Effects of Colonist Household Structure on Land-Use Change in the Amazon Rainforest: An Agent-Based Simulation Approach. <i>Environment and Planning B</i></p> <p>Kohler, T. A., J. Kresl, C. V. West, E. Carr, and R. H. Wilshusen. 2000. Be there then: A modeling approach to settlement determinants and spatial efficiency among late ancestral pueblo populations of the Mesa Verde region, U.S. Southwest. Pages 145-178 in T. A. Kohler and G. J. Gumerman, eds. <i>Dynamics in Human and Primate Societies</i>. Oxford University Press, New York and Oxford</p> <p>Happe, K., K. Kellermann, and A. Balmann. 2006. Agent-based Analysis of Agricultural Policies: an Illustration of the Agricultural Policy Simulator AgriPoliS, its Adaptation and Behavior. <i>Ecology and Society</i> 11 (1): 49. <a href="http://www.ecologyandsociety.org/vol11/iss1/art49">http://www.ecologyandsociety.org/vol11/iss1/art49</a>.</p>	2 writing assignments: expanding MP framework; Read 2 of 3 and standard SWA on one article.
Feb. 20	Water resource management. Guest speaker: Beudry Kok, MIT	<p>Becu, N., P. Perez, B. Walker, O. Barreteau, and C. Le Page. 2003. Agent-based simulation of a small catchment water management in northern Thailand: Description of the catchscape model. <i>Ecological Modelling</i> 170: 319-331</p> <p>Feuillette, S., F. Bousquet, and P. Le Goulven. 2003. Sinuse: A multi-agent model to negotiate water demand management on a free access water table. <i>Environmental Modelling and Software</i> 18: 413-427.</p> <p>Lansing, J. S., and J. N. Kremer. 1993. Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape. Pages 201-224 in C. G. Langton, ed. <i>Artificial Life III</i>. Addison-Wesley, Reading, MA.</p>	Read 2 of 3. SWA on 1 of 3 articles
Feb. 27	Pedestrian models	<p>Batty, M. 2003. Agent-Based Pedestrian Modelling in P. A. Longley and M. Batty, eds. <i>Advanced Spatial Analysis</i>. ESRI Press, Redlands. (Required, not for student presentation)</p> <p>Batty, M., J. Desyllas, and E. Duxbury. 2003. Safety in numbers? Modelling crowds and designing control for the Notting Hill carnival. <i>Urban Studies</i> 40 (8): 1573-1590</p> <p>Gimblett, H. R., M. T. Richards, and R. M. Itami. 2002. Simulating Wildland Recreation Use and Conflicting Spatial Interactions using Rule-Driven Intelligent Agents in H. R. Gimblett, ed. <i>Integrating Geographic Information Systems and Agent-Based Modeling Techniques for Simulating Social and</i></p>	<p>Term paper topic and short abstract (500 words) due.</p> <p>Read Batty plus at least 1 other. Short writing assignment on Batty et al. Gimblett et al., or Itami.</p>

		<p>Ecological Processes. Oxford University Press, Oxford, UK</p> <p>Itami, R. 2002. Mobile agents with spatial intelligence. Pages 191-210 in H. R. Gimblett, ed. Integrating Geographic Information Systems and Agent-Based Modeling Techniques for Understanding Social and Ecological Processes. Oxford University Press</p>	
Mar. 6	Urban/rural interactions:	<p>Brown, D. G., S. E. Page, R. Riolo, M. Zellner, and R. W. In Press. Path dependence and the validation of agent-based spatial models of land use. International Journal of Geographic Information Systems.  <a href="http://www.pscs.umich.edu/research/projects/sluce/publications/ijgis-sluce-final.pdf">http://www.pscs.umich.edu/research/projects/sluce/publications/ijgis-sluce-final.pdf</a>.</p> <p>Caruso, G., M. Rounsevell, and G. Cojocar. forthcoming. Exploring a spatio-dynamic neighbourhood-based model of residential behaviour in the Brussels periurban area. International Journal of Geographical Information Science</p> <p>Parker, D. C., and V. Meretsky. 2004. Measuring Pattern Outcomes in an Agent-Based Model of Edge-Effect Externalities Using Spatial Metrics. Agriculture, Ecosystems and Environment 101: 233-250. (not for student presentation)</p> <p>Torrens, P. M. Forthcoming (2006). A Geographic Automata Model of Residential Mobility. Environment and Planning B</p>	Read 2 of 4; SWA on 1 of 4.
Mar. 20	Individual-based models	<p>Grimm, V., and S. F. Railsback. 2006. Chapter 1: Introduction in V. Grimm and S. F. Railsback, eds. Individual-based Modeling and Ecology. Princeton University Press, Princeton, NJ. (Required; not for student presentation.)</p> <p>Hogeweg, P., and B. Hesper. 1983. The ontogeny of the interaction structure in bumble bee colonies: A MIRROR model. Behavioural Ecology and Sociobiology 12 (271 - 283)</p> <p>Bennett, D. A., and W. Tang. 2006. Modelling adaptive, spatially aware, and mobile agents: Elk migration in Yellowstone. International Journal of Geographic Information Systems 20 (9): 1039-1066</p> <p>Mooij, W. M., R. E. Bennetts, W. M. Kitchens, and D. L. DeAngelis. 2002. Exploring the effect of drought extent and interval on the Florida snail kite: interplay between spatial and temporal scales. Ecological Modelling 149: 25-39</p>	Read Grimm and Railsback plus at least 1 other; SWA on Hogeweg, Bennett, or Mooij

Mar. 27	Human/non-human interactions	<p>Dreyfus-Leon, M., and P. Kleibe. 2001. A spatial individual behaviour-based model approach of the yellowfin tuna fishery in the eastern Pacific Ocean. <i>Ecological Modelling</i> 146 (1-3): 47-56.</p> <p>Harper, S. J., J. D. Westervelt, and A.-M. Trame. 2002. Management application of an agent-based model : control of cowbirds at the landscape scale in H. R. Gimblett, ed. <i>Integrating Geographic Information Systems and Agent-Based Modeling Techniques for Understanding Social and Ecological Processes</i>. Oxford University Press.</p> <p>Mathevet, R., F. Bousquet, C. Le Page, and M. Antona. 2003. Agent-based simulations of interactions between duck population, farming decisions and leasing of hunting rights in the Camargue (southern France). <i>Ecological Modelling</i> 165: 107-126.</p> <p>An, L., M. Linderman, J. Qi, A. Shortridge, and J. Liu. 2005. Exploring Complexity in a Human–Environment System: An Agent-Based Spatial Model for Multidisciplinary and Multiscale Integration. <i>Annals of the Association of American Geographers</i> 95 (1): 54-79. doi:10.1111/j.1467-8306.2005.00450.x.</p>	Read 2 of 4. SWA on any one of the four.
April 3	Participatory approaches	<p>Bousquet, F., F. O. Barreteau, P. d'Aquino, M. Etienne, S. Boissau, S. Auber, C. L. Page, D. Babin, and J. C. Castella. 2003. Multi-agent systems and role games: An approach for ecosystem co-management in M. A. Janssen, ed. <i>Multi-Agent Approaches for Ecosystem Management</i> (Required, not for student presentation)</p> <p>Castella, J. C., T. N. Trung, and S. Boissau. 2005. Participatory simulation of land-use changes in the northern mountains of Vietnam: the combined use of an agent-based model, a role-playing game, and a geographic information system. <i>Ecology and Society</i> 10 (1). <a href="http://www.ecologyandsociety.org/vol10/iss1/art27/">http://www.ecologyandsociety.org/vol10/iss1/art27/</a></p> <p>Duijn, M., L. H. Immers, F. A. Waaldijk, and H. J. Stoelhorst. 2003. Gaming Approach Route 26: a combination of computer simulation, design tools and social interaction. <i>Journal of Artificial Societies and Social Simulation</i> 6 (3). <a href="http://jasss.soc.surrey.ac.uk/6/3/7.html">http://jasss.soc.surrey.ac.uk/6/3/7.html</a>.</p> <p>Etienne, M., Le Page, C. and Cohen, M. 2003. A step-by-step approach to building land management scenarios based on multiple viewpoints on multi-agent system simulations. <i>Journal of Artificial Societies and Social Simulation</i> 6 (2).</p>	Read Bousquet et al. plus at least 1 other. SWA on Castella, Duijn, or Etienne.

		<a href="http://jasss.soc.surrey.ac.uk/6/2/2.html">http://jasss.soc.surrey.ac.uk/6/2/2.html</a> .	
Apr. 10	FEARLUS, ELMM, and GRID modeling (if available)	Gotts, N. M., J. G. Polhill, and A. N. R. Law. 2003. Aspiration levels in a land use simulation. <i>Cybernetics and Systems</i> 34: 663-683  Polhill, J. G., D. Parker, and N. M. Gotts. Forthcoming. Effects of land markets on competition between innovators and imitators in land use: results from FEARLUS-ELMM in C. Hernandez, K. Troitzsch, and B. Edmonds, eds. <i>Social Simulation Technologies: Advances and New Discoveries</i>	Assignment TBA
Apr. 17	Epidemiology. Dr. Parker out of town	Bian, L. 2004. A conceptual framework for an individual-based spatially explicit epidemiological model. <i>Environment and Planning B</i> 31: 381-395.  Dunham, J. B. 2006. An Agent-Based Spatially Explicit Epidemiological Model in MASON. <i>Journal of Artificial Societies and Social Simulation</i> 9 (1). <a href="http://jasss.soc.surrey.ac.uk/9/1/3.html">http://jasss.soc.surrey.ac.uk/9/1/3.html</a> .	SWA on either, more TBA
Apr. 24	Student projects		Term papers due 9 AM April 23
May 1	Student projects		
May 8	No class meeting		Final exam due