Syllabus
Modeling and Simulation of Social and Organizational Behavior

Course Number: S604
Time: Wednesday 1:00-3:45
Place: SLIS, LI001
Instructor: Hamid R. Ekbia, hekbia@indiana.edu
Office Hours: W/R 4:00-5:30, or by appointment

Description
Scientists, professionals, and policy-makers increasingly deal with complex systems and phenomena — that is, with large aggregates of heterogeneous, partly structured, and interactive (human or nonhuman) components. Examples include the spread of viruses, neural activity, and fire in the wild, the diffusion of fashions, innovations, or ideas in culture, and residential segregation, evolution of cooperation, or violence and uprising in society. Modeling and simulation present effective techniques for understanding and analyzing such systems and phenomena. This course provides an introduction to a subset of these techniques generally known as Agent-Based Modeling and Simulation (ABMS). ABMS is a framework that allows experimentation with simulated complex systems. It conceives a complex system as a group of agents that interact and adapt to changing environments. Starting with a description or theory of individual agents, it seeks to formulate rules of behavior that can then be used to study the behavior of the system as a whole — that is, of how it would evolve over time. By generating unexpected patterns of behavior that might emerge from interactions among simple agents, ABMS provides insights into both individual agent and overall system behaviors.

The course will interleave theoretical discussions with hands-on lab sessions in order to give students both the conceptual tools and technical skills required to understand and model complex systems. The class readings and lectures will draw on literature from cognitive and social sciences, and the labs will be devoted to learning computational tools and techniques for ABMS. Prior knowledge of programming will be helpful, but it is *not* expected or required. The course will include two small projects and one final project. These can be either individually written essays or computer models done in teams of two. Every student will also lead one class discussion during the semester.

For more detail, please go to: http://www.slis.indiana.edu/faculty/hekbia/S604

Text

Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An introduction to Computational Models of Social Life, Princeton University Press.

In addition, every week there are required readings that all participants are expected to have read before class meeting. There are also additional optional readings available for those who want to go deeper into a topic. Both groups of readings will be made available electronically.

Schedule

Week 1: Introduction
In this introductory session, we explore the philosophical shifts in the foundations of science in recent years.

Reading
Required:
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 1 (Introduction).

Glennan, S. (2000). A Model of Models. Philosophy of Science Archives. Retrieved on August 31, 2008 from: http://philsci-archive.pitt.edu/archive/00001134/00/Models1.4.pdf

Harré, R. (1988). The Philosophies of Science: An Introductory Survey. Oxford: Oxford University Press. pp. 168-183 (Chapter 6).

Optional:
Aris, R. (1979). Mathematical Modeling Techniques. San Francisco: Pitman Advanced Publishing Program. pp. 1-38 (Chapters 1 & 2)

Harré, R. (1988). Cognitive Science: A Philosophical Introduction. London: Sage, pp. 42-56.

Lab Session
The GEOMAC project
http://www.nytimes.com/2007/12/15/us/15fire.html?_r=1
http://www.geomac.gov/

Week 2: What is Complexity?
The concept of "complexity" has turned into a kind of buzzword in recent years, with multiple meanings and interpretations. In this session, we examine some of these meanings.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 2 (Complexity in Social Worlds).

Law, J. and Mol, A. (2002). Complexities: Social Studies of Knowledge Practices. Duke University Press. Chapters 1 and 2 (pp. 1-52).

Optional:
Resnick, M. (1999). Turtles, Termites, and Traffic Jams: Explorations in Massively Parallel Microworlds. MIT Press. (pp. 49–68)

Granovetter, Mark (1978), **"Threshold Models of Collective Behavior"**, *American*

Journal of Sociology, Vol. 83: 6, pp. 1420-1442 (available from JSTOR

Lab Session
We introduce the conceptual basics of ABMS using NetLogo as the modeling environment, and study the Standing Ovation Problem:

Miller, John, and Scott E. Page (2004), The Standing Ovation Problem, *Complexity*, Vol. 9, No. 5, May/June, pp. 8-1.

NetLogo Tutorial. http://ccl.northwestern.edu/netlogo/

Assignment
Email me the date on which you want to lead class discussion.

Week 3: Models and Simulations
We discuss models, simulations, their similarities and differences, as well as their role as analytic tools for understanding complex systems and behaviors

- What are models?
- What are simulations?
- Models and simulations as analytic tools

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 3 (Modeling).

Cummins, Robert E. (2000). "How does it work" versus "what are the laws?": Two conceptions of psychological explanation. In F. Keil & Robert A. Wilson (eds.), Explanation and Cognition, 117-145. MIT Press.

Di Paolo, E. A., Noble, J. & Bullock, S. (2000). Simulation models as opaque thought experiments. Artificial Life VII: The Seventh International Conference on the Simulation and Synthesis of Living Systems, Reed College, Portland, Oregon, USA, 1-6 August.

Lab Session
We will examine Epstein's model of civil violence as an example.

Epstein, J. (2002). Modeling Civil Violence: An Agent-based Computational Approach. PNAS, 99(3)7243–7250.

Week 4: Emergence: Social and Psychological
Many social behaviors can be understood as emerging from interactions among individuals engaged in simple behaviors: residential segregation, cooperation, wars, social influence, urban growth, etc. In recent years, agent-based models of many of these phenomena have been developed by social scientists. This week we study one of these models.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 4 (Emergence).

Sawyer, K. (2005). Social Emergence: Societies as Complex Systems. Cambridge University Press. Chapters 3-5 (pp. 27-99).

Lab Session
We will examine a few NetLogo models in different domains to get a better handle on the concept of emergence in various areas.

Week 5: Computing and Computational Models
Computing, as both a model and a metaphor, offers new ways of doing science. This is going to be the topic of our discussion in this session.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 5.

Weisfeld, M. (2000). The Object-Oriented Thought Process, Indianapolis: Indiana, SAMS Publishing (Division of Macmillan).

Lab Session
A demo from Craig Reynolds boids website

Assignment
Project 1 due

Week 6: Agent-Based Modeling
In this session, we delve into ABM and the thinking behind it in more detail.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 6 (Why Agent-Based Objects?).

Axelrod, R. (2005). Agent-based Modeling as a Bridge between Disciplines. In K. L. Judd and L. Tesfatsion (Eds.), *Handbook of Computational Economics, Vol. 2: Agent-Based Computational Economics,* Handbooks in Economics Series, Amsterdam: North-Holland.
http://www-personal.umich.edu/~axe/

Macy, M.W. and R. Willer (2001). From Factors to Actors: Computational Sociology and Agent-Based Modeling. *Annual Review of Sociology*, Vol. 28, pp. 143-166. (Available from JSTOR)

Lab Session
We will walk through an exercise of developing an agent-based model on the basis of the following guide:

Axelrod, R. and Tesfatsion, L. (2005). A Guide for Newcomers to Agent-based Modeling in the Social Sciences. In K. L. Judd and L. Tesfatsion (Eds.), *Handbook of Computational Economics, Vol. 2: Agent-Based Computational Economics,* Handbooks in Economics Series, Amsterdam: North-Holland.
http://www-personal.umich.edu/~axe/

Week 7: A Modeling Framework
We discuss Miller and Page's proposed framework, and compare it with other perspectives on ABM that are motivated by other intellectual and disciplinary questions.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 7.

Gilbert, N. and Terna, P. (1999). How to build and use agent-based models in social science

Macal, C. M. and North, M.J. (2006). Tutorial On Agent-Based Modeling And Simulation Part 2: How To Model With Agents. *Proceedings of the 2006 Winter Simulation Conference L. F. Perrone, F. P. Wieland, J. Liu, B. G. Lawson, D. M. Nicol, and R. M. Fujimoto, eds.*

Brown, D.G. 2006. Agent-based models. In H. Geist, Ed. *The Earth's Changing Land: An Encyclopedia of Land-Use and Land-Cover Change.* Westport CT: Greenwood Publishing Group, pp.
7-13.

Lab Session
We will walk through a specific model using various frameworks.

Week 8: Cellular Automata
The theory of CA has been influential in different areas. Miller and Page examine this theory from the perspective of both physical and social sciences.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 8.

Lab Session
We examine a GIS model of urban development.

Week 9: Segregation
The topic of this session is Schelling's influential model of segregation, which predates many of the more recent discussions on emergence and social dymanics.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 9.

Schelling, T. C. (1978), Micromotives and Macrobehavior, Norton, New York, NY, pp. 137-157.

Schelling, T. C. (1969). Models of Segregation. The American Economic Review. 59 (2): 488-493.

Optional:
Schelling, T. C. (1971). Dynamic Models of Segregation. Journal of Mathematical Sociology. 1: 143-186.

Pancs, R. and Vriend, N. J. (2007). Schelling's Spatial Proximity Model of Segregation Revisited. Journal of Public Economics. 91: 1-24
http://webspace.qmul.ac.uk/nvriend/pub/pubec.pdf

Sander, R., Schreiber, D. and Doherty, J. (2000). A Computational Model of Housing Segregation. Accessed from: http://www.law.ucla.edu/sander/H_Seg/WPSA_Sander.pdf

Lab Session
We will examine Chris Cook's segregation model:
http://www.econ.iastate.edu/tesfatsi/demos/schelling/schellhp.htm

Denis Phan's Segregation Model: http://digemer.enst-bretagne.fr/~phan/complexe/schelling.html

Assignment
Project 2 due

Week 10: Game Theory and the Evolution of Cooperation
We scratch the surface of game theory, and then examine Axelrod's tournament as a fascinating example.

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 10.

Axelrod, Robert (1984), The Evolution of Cooperation **(Chapters 1,2,9).** Basic Books Inc., New York, NY.

Axelrod, Robert (1986), **"An Evolutionary Approach to Norms"**, *American Political Science Review*, Vol. 80, pp. 1095-1111 (available from JSTOR)

Lab Session
Axelrod's tournament OR Toronto's interactive tutorial

Week 11: No class
This is your chance to think about your final projects

Week 12: Organizational Dynamics

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 11.

Lab Session
Project ideas will be discussed by students.

Week 13: Thanksgiving Recess

Week 14: Wrapping Things Up

Reading
Miller, J.H. and Page, S.E. (2007). Complex Adaptive Systems: An Introduction to Computational Models of Social Life. Chapter 12 and Epilogue.

Lab session
Student projects

Week 15: Student Project Presentations

Grading
Individual students will write papers or teams of two students will develop an ABM model in a domain of their choice. Each individual or team will present their paper/model to the seminar at the end of the semester.

Grades will be based on:

1. Leading class discussion	20%
2. Projects	30%
3. Term project	50%

Resources
Wonderful web resources are available these days on ABM — papers, tutorials, tools, languages, models (with code and documentation). The following are links to a subset of these resources.

1. Robert Axelrod's homepage: http://www-personal.umich.edu/~axe/
2. Axelrod and Tesfatsion: On-Line Guide for Newcomers to Agent-Based Modeling in the Social Sciences:
   http://www.econ.iastate.edu/tesfatsi/abmread.htm