Complex Systems Models in the Social Sciences

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The nonlinear dynamics exhibited by complex social systems pose challenges and create opportunities. In complex social systems, agents adapt to an environment partially constructed by the actions of other adaptive agents. For example, individual and organizations adapt their behavior in light of feedback from other individuals and from aggregate variables produced by the collective actions of individuals. Until the advent of agent-based models, including adaptive behavior in all but the starkest of models had been impossible. Agent-based models (ABM) consist of interacting agents. Each agent’s behavior is governed by a small set of simple rules, which often depend on local information and feedbacks. These local rules produce emergent patterns—equilibria, cycles, long transients, and randomness—and emergent functionalities such as robustness.

These lectures will give an introduction to recent approaches in computer modeling of complex social systems, comparing them to more traditional mathematical (analytical) approaches and to the previous generation of computer
simulations in the social sciences. In addition to describing the methods and techniques of this modeling approach, a number of social science applications will be reviewed and analyzed. This course includes a lab session in which students also will be able to run implementations of several of the models discussed in the lectures and learn to build their own computational models. Students will gain sufficient knowledge and experience to plan and build models for your own research. Various software packages and languages will be highlighted including Netlogo (ABM & Networks), Nova (System Dynamics & ABM), Pajek (Empirical Network Analysis), R (Statistics and Network Analysis) and Python (Object Oriented Programming Language). The lab sessions are being conducted by Daniel Martin Katz (dmartink@umich.edu) and Aaron Bramson (aaronbramson@gmail.com).

There will be regular assignments in the lab, and then two options for final evaluation:

---updating and running an existing computation model, and writing up the results or
---developing an original model and writing a short paper on it

Students may want to purchase ONE of the following books:


**Class Schedule**

**July 16: Complex Systems Modeling and Philosophy of Science (Kollman)**

Introduction.


July 17 Genetic Algorithms, The Evolution of Strategies (Kollman)

*Daedalus* 121: 17-30.  
Chapter 1.  
"Adaptive Parties and Spatial Elections."  

July 18: Models of Preference Aggregation and Sorting (Kollman or Page)

"Political Parties and Electoral Landscapes."  
"Political Institutions and Sorting in a Tiebout Model."  
Elizabeth Bruch and Robert Mare. 2006. “Neighborhood Choice and Neighborhood Change.”  

July 19: Intro to Network Science (Part I) (Katz)

Mark Buchanan, *Nexus: Small Worlds And The Groundbreaking Science Of Networks* (2003) (Can be purchased on Amazon for less than $10)  
Mark Granovetter, *The Strength of Weak Ties*, 78 American Journal of Sociology 1360 (1973)

July 20: Intro to Network Science (Part II) (Katz)

Peter Sheridan Dodds, Roby Muhamad2 & Duncan J. Watts, An Experimental Study of Search in Global Social Networks, 301 Science 827 (2003).

**July 23: Community Detection in Networks (Katz)**


**July 24: Complex Systems in an Applied Domain: Computational Legal Studies (Katz)**


Science of Similarity:


"Netflix Prize" available at http://en.wikipedia.org/wiki/Netflix_Prize

From the AT&T Labs: Winning the Netflix Prize http://www.youtube.com/watch?v=ImpV70uLxyw

The Music Genome Project -- http://en.wikipedia.org/wiki/Music_Genome_Project

Inverse v. Forward Problems:


An Introduction to Inverse Problems www.gps.caltech.edu/classes/ge193/lectures/Lecture1.pdf

<< Please Skim this Presentation (just ignore the formalism) >>

The AI Revolution:


http://www.wired.com/magazine/2010/12/ff_ai_flashtrading/


July 26: Path dependence, lock-in, multiple equilibria (Bramson)


July 27: **Exploitation, exploration, and neutral landscapes (Bramson)**


July 30: **Models of International Relations (Joyce)**


July 31: **Models of International Relations (Joyce)**


August 1: **Models of Civil War (Joyce)**


August 2: **Models of Civil War (Joyce)**


**August 3: Models of Culture (Joyce)**


**August 6: Computation in the Scientific Process (deMarchi)**


**August 7: Applications to Electoral Politics (deMarchi)**


**August 8: Computational Models and Empirics (deMarchi)**


**August 9: Computational Models and Empirics (deMarchi)**

Michael Laver, Scott de Marchi and Hande Mutlu. Negotiation in legislatures over
