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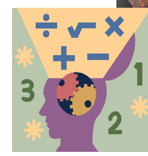
Hydrologic Sciences Graduate Group Presents

Special Colloquium Series, Spring & Fall 2005:

Between Nature and Science:
Advanced Modeling Concepts for Environmental Sciences



James Crutchfield

Computational Science and Engineering Center
and Physics Department
University of California, Davis

Multiagent Dynamical Systems

Thursday June 2nd
4:00-5:00pm
PES 3001
Light refreshments provided

I will show how to model multiagent systems using dynamical systems theory by deriving a class of macroscopic differential equations that describe mutual adaptation in agent collectives, starting from a discrete-time stochastic (microscopic) model. The resulting dynamical systems show that the agents' adaptation is a dynamic balance between optimization of actions that achieve the highest rewards (exploitation) and randomization that chooses locally suboptimal, but novel actions (exploration).
It turns out that, although individual agents interact with their environment and other agents in a purely self-interested way without sharing knowledge and ignorant of a context larger than immediate interaction, a strategic dynamic emerges naturally between agents. Under suitable assumptions, the strategic interactions can be interpreted as a game. Overall, though, the emergent strategies are determined by environment-mediated interactions and agents' local reinforcement schemes and so are not amenable to game-theoretic techniques. Application to several familiar, explicitly game-theoretic interactions shows that the adaptation dynamics exhibits a diversity of collective behaviors, including stable limit cycles, quasiperiodicity, intermittency, and deterministic chaos. The simplicity of the assumptions underlying the macroscopic equations suggests that these behaviors should be expected broadly in multiagent systems.

Jim Crutchfield received his B.A. summa cum laude in Physics and Mathematics from the University of California, Santa Cruz, in 1979 and his Ph.D. in Physics there in 1983. He is currently a Professor of Physics at the University of California, Davis, where he is helping to start up its new Computational Science and Engineering Center. Until recently he was Research Professor at the Santa Fe Institute, where he ran the Dynamics of Learning Group, and Adjunct Professor of Physics in the Physics Department, University of New Mexico, Albuquerque. Before coming to SFI in 1997, he was a Research Physicist in the Physics Department at the University of California, Berkeley, since 1985. He also has been a Visiting Research Professor at the Sloan Center for Theoretical Neurobiology, University of California, San Francisco; a Post-doctoral Fellow of the Miller Institute for Basic Research in Science at UCB; a UCB Physics Department IBM Post-Doctoral Fellow in Condensed Matter Physics; a Distinguished Visiting Research Professor of the Beckman Institute at the University of Illinois, Urbana-Champaign; and a Bernard Osher Fellow at the San Francisco Exploratorium.

Sponsored By: John Muir Institute for the Environment, Computational Science and Engineering Center, Department of Civil and Environmental Engineering, Department of Land, Air, and Water Resources, Department of Chemical Engineering and Materials Science, Soil Sciences, Atmospheric Sciences, and Hydrologic Sciences Graduate Groups, College of Agriculture and Environmental Sciences, U.C. Cooperative Extension