

*VUB AI-Lab / ULB IRIDIA, Winter 2011*  
*Master's Course Series*

**Complex Systems Made Simple:  
A Hands-On Exploration of Agent-Based Modeling**

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This course will explore canonical examples of complex systems through agent-based modeling and numerical simulation. Complex systems are characterized by a large number of elements interacting locally and combining their individual behaviors to produce an emergent behavior at a macroscopic scale. It is often difficult or impossible to infer this emergence from analytical terms, whereas computational models are sometimes able to reproduce it and even make valid predictions. Self-organized, decentralized and adaptive systems, whether physical, biological or human-made, are pervasive in the environment. Striking similarities in the observation of various complex phenomena also created a fruitful exchange of ideas and techniques among disciplines, such as the ecological perspective on economics, or the behavior of ant colonies exported to optimization problems, etc. Using a simulation platform (for example NetLogo), we will review and become familiarized with some of the most popular case studies of complex systems across a variety of topics: cellular automata, pattern formation, swarm intelligence, complex networks, spatial communities, morphogenesis. We also briefly remark on the key concepts unifying these fields, such as: emergence, self-organization, decentralization, “between simple and disordered”, “more is different”, positive feedback, etc.