

Course Title

Agent-based Models with NetLogo: An Introduction.

Instructor

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Course Rationale

What do moving to a wealthy neighborhood, choosing to enter a given restaurant after glancing at clients already sitting there, voting for a given political candidate after long discussions with colleagues and friends, joining a social protest all have in common? All these decisions tend to be embedded in complex interdependence structures whose macroscopic consequences are non-linear and difficult to predict.

Aggregate and ecological empirical data are often available and appropriate to describe the synchronic and diachronic macro-level patterns generated by these interdependent conditional decisions but they are insufficient to discover the complex micro- and network-level dynamic behind individuals' decisions. As Thomas Schelling remarked, "the simple mathematics of ratios and mixtures tells us something about what outcomes are logically possible, but tells us little about the behaviour that leads to, or that leads away from, particular outcomes" (Schelling, 1971, « Dynamic Models of Segregation », JMS,1, p. 147).

Over the last decade, sociology discovered the flexibility of agent-based computational modeling for designing, formalizing, and studying *in silico* set of hypotheses on complex bundles of structure-action loops. These models are powerful but they are difficult to construct. They require to master complex programming languages that are still less frequently taught in undergraduate and graduate programs than statistical software.

Course Style

The course is an intensive applications-oriented introduction to NetLogo (release 5.0), a flexible programming suite to design, simulate, and study agent-based models. A hands-on approach will be used throughout the course wherein the instructor will explain each programming building blocks and then the participants will immediately see their computational translation by means of code examples. Lectures will be of increasing complexity and follow a Lego-approach in that simple elements are progressively embedded in more and more complex programming structures.

Course Description

The first session introduces the basic concepts behind agent-based modeling such as "class" and "objects", presents NetLogo architecture, and explains examples illustrating NetLogo main data structures, variable declaration/initialization, procedure writing as well as main NetLogo control structures. The second section moves on to the object-oriented side of NetLogo and present examples illustrating how to create NetLogo objects (patches, turtles, and links) and how to invoke them by using "agentsets". Especial attention is devoted to how to program spatial and relational neighborhoods. The third and fourth sessions provide examples of how to assembly the programming structures presented in the two first lectures by means of a step-by-step implementation of "famous" sociological theoretical models. The two last sessions also introduce NetLogo built-in facilities to study the model's behaviour and to draw inferences from it.

Course Goals

The main goals of the course are to make participants autonomous in programming and studying their first, sociologically meaningful agent-based model, and, on the other hand, to provide them with the capacity to navigate NetLogo features that cannot be presented during the class.

Requirements

Familiarity with programming languages like Java, C++, Python or R makes the class easier but it is not required.

Software (to be installed on attendees' laptop)

NetLogo 5.0 (or higher), freely downloadable at
(<http://ccl.northwestern.edu/netlogo/download.shtml>)

"R", freely downloadable at (<http://www.r-project.org/>)

Course Resources (provided by the instructor at the end of the course)

All NetLogo codes commented line by line

Slides covering all the topics discussed during the class

Readings

/ On NetLogo /

Tisue, S. and Wilensky U. (2004), "NetLogo: Design and implementation of a multi-agent modeling environment" (<http://ccl.northwestern.edu/papers/>).

Wilensky U. (1999), *NetLogo*, Evanston, IL, Center for Connected Learning and Computer-Based Modeling, Northwestern University (<http://ccl.northwestern.edu/netlogo>) ("programming" section).

Luis Izquierdo, *NetLogo 5.0 Quick Guide*, (<http://ccl.northwestern.edu/netlogo/resources.shtml>)

Railsback S. F. and Grimm V. (2011), *Agent-based and Individual-Based Modeling: A Practical Introduction*, Princeton, Princeton University Press (namely chs. 1, 2, 4, 6, 8, 9, 13, 14, 15, 20, 22 and 23).

/ On NetLogo and Other Agent-Based Modeling environments /

Lyntinen, S. L. and Railsback S. F. (2012), "The Evolution of Agent-based Simulation Platforms: A Review of NetLogo 5.0 and ReLogo" (http://www.swarm.org/index.php/Software_Reviews)

Nikolai C. and Madey G. (2009), "Tools of the Trade: A Survey of Various Agent Based Modeling Platforms", *Journal of Artificial Societies and Social Simulation*, 12(2)2.

/On Agent-Based Modeling from a computer science perspective/

Wooldridge M. (2009). *An Introduction to MultiAgent Systems*, John Wiley and Sons, Ltd.

Helbing, D. (2012). Agent-based Modeling, in Helbing, D. Social Self-Organization. Agent-based Simulations and Experiments to Study Emergent Social Behavior, Springer-Verlag Berlin Heidelberg (ch. 2).

/On Agent-based Modeling and Complex Systems/

Epstein J. (2006), *Generative Social Science: Studies in Agent-Based Computational Modeling*, Princeton, Princeton University Press.

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

/On Agent-based Modeling and Social Mechanisms /

Hedström, P., Ylikoski, P. (2010), "Causal Mechanisms in the Social Sciences", *Annual Review of Sociology*, 36, pp. 49-67.

Manzo, G. (2010), "Analytical Sociology and Its Criticisms", *European Journal of Sociology*, 51, 1, pp. 129-170.

Manzo, G. (2007), "Variables, mechanisms, and simulations: can the three methods be synthesized? A critical analysis of the literature", *Revue Française de Sociologie - An Annual English Selection* -, 48, Supplement, pp. 35-71.