

Sant'Anna School of Advanced Studies
Pisa, Italy

“Agent-Based Computational Economics”

Prof. Giorgio Fagiolo
2012-2013

Overview

This course is intended to serve as a broad introduction to the huge literature using agent-based computational approaches to the study of economic dynamics.

In the last 20 years a growing number of economists have become increasingly dissatisfied with the mainstream (neoclassical) approach to the analysis of micro-to-macro phenomena. Insights coming from many disciplines (physics, computer science, sociology, biology, cognitive psychology, etc.), as well as numerous contributions from experimental and empirical economics, started to question the validity of the building blocks underlying standard micro-founded macroeconomic models (rationality, equilibrium, interactions, etc.) and triggered a deep reconsideration of the epistemological foundations of the discipline and of the effectiveness of its methodological tools. This has generated a plethora of heterogeneous research programs trying to propose scientific paradigms (evolutionary, post-Keynesian, post-Walrasian, etc.), which configure themselves as complementary or alternative to the “mainstream” one. The common idea underlying all these approaches is that economies can be considered as complex evolving systems and, therefore, should be studied using the appropriate (mostly computational) tools. Mainstream economists, on the contrary, think that ingredients such as bounded rationality, out-of-equilibrium dynamics, non-trivial interactions, heterogeneity, are not essential and can be neglected on a first approximation. Agent-based computational economics (ACE) is the label given to the “meta” research paradigm based on the underlying assumption that complexity features matter in studying micro-to-macro phenomena. In other words, ACE is the computational study of economic dynamics, where the computational aspect signals that analytically-solvable models should be in general complemented and sometimes substituted by computational techniques to analyze economic phenomena. Agent-based models (ABMs) are the most important tool used in ACE. ABMs are algorithmic representations of markets, industries, and economies, and their dynamics. They are based on a bottom-up perspective, where aggregate regularities are generated from the dynamic interaction of heterogeneous, boundedly-rational, adaptive micro agents.

The course is meant to provide a very general overview of the many facets of ACE. It is organized in three parts. The first one (“Why?”) will discuss the roots of the critiques to the mainstream paradigm from a methodological, empirical and experimental perspective. We shall briefly review the building blocks of mainstream models (rationality, equilibrium, interactions, etc.) and shortly present some of the evidence coming from cognitive psychology and experimental economics, network theory and empirical studies, supporting the idea that bounded rationality, non-trivial interactions, non-equilibrium dynamics, heterogeneity, etc. are irreducible features of modern economies.

In the second part (“What?”) we shall discuss what ACE is and what are its main tools of analysis. We will define an ABM and present many examples of classes of ABMs, from the simplest (cellular automata, evolutionary games) to the most complicated ones (micro-founded macro models).

The third part (“How?”) aims at understanding how ABMs can be designed, implemented and statistically analyzed. We shall briefly present the basics of programming, by both discussing the pros and cons of using simulation platforms (Matlab, NetLogo, Swarm, LSD, etc.) vs. computer languages (Java, C++, etc.) and providing some simple “hands-on” applications to cellular automata. Finally, we will see how the outputs of ABMs simulation should be treated from a statistical point of view (e.g., Montecarlo techniques) and we will discuss two hot topics in ABM research: empirical validation and policy analysis.

Reading List

- The reference repository for almost all topics discussed during the course is <http://www.econ.iastate.edu/tesfatsi/ace.htm> maintained by Leigh Tesfatsion.
- A book containing perspectives on the material presented during the course is: Tesfatsion and Judd (Eds), Handbook of Computational Economics, Agent-Based Computational Economics, Volume 2, North-Holland, 2006
- Given its extremely broad perspective and time constraints, the treatment of all the topics in class will be fairly generic. However, a list of specific suggested readings is available for all the main topics discussed.
- Other suggested books on ACE and related subjects:
 - Miller and Page, Complex Adaptive Systems, Princeton University Press, 2007
 - Colander (Ed), Post-Walrasian Macroeconomics, Cambridge University Press, 2006
 - Batten, Discovering artificial economics, Westview Press, 2000
 - Wooldridge, An introduction to multiagent systems, Wiley, 2002
 - Gilbert and Troitzsch, Simulation for the Social Scientist, Open University Press, 2005
 - Flake, The computational beauty of nature, 1998, MIT press
 - Dopfer (Ed), The evolutionary foundations of economics, 2005, Cambridge University Press.

Syllabus

Part I. Why?

- Why Agent-Based Computational Economics (ACE) and Agent-Based Models (ABMs)?
- Empirical and theoretical underpinnings

Part II. What?

- The structure of ABMs
- Flexibility of ABMs
- Examples

Part III: How?

- Designing and implementing ABMS
- Statistical analysis of ABMs
- Applications

Part IV: Selected Topics in ACE

- Empirical validation
- Macroeconomic policy
- Object-oriented programming