Workshop on "Agent-Based Computational Modelling. An Instrument for Analysing Complex Adaptive Systems in Demography, Economics and Environment" at the Vienna Institute of Demography, December 4–6, 2003

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Agent-based models are increasingly used in different fields when studying complex adaptive systems. Micro-level interaction between heterogeneous agents is at the heart of recent advances in modelling within sociology, demography and related disciplines as well as economics, ecology and environmental sciences. Different keywords are used to denote approaches that have a common focus on modelling from the bottom up: social simulation, artificial societies, individual-based modelling in ecology, agent-based computational economics (ACE) and economics with heterogeneous interacting agents, agent-based computational demography (ABCD), to name just some of them. Scientific journals and even societies have flourished accompanying the scientific debate, where the core question usually raised at interdisciplinary workshops, such as the one we organised, is related to agents: should agents be simple or should they be complex? Proponents of the simplicity of agents (the so-called keep-it-simple-and-stupid, or KISS principle, pushed by Robert Axelrod) point out that the most interesting analytical results are obtained when complexity at the macro level is produced by simple micro-level dynamics. In this approach, the analogy is with mathematical models where complex dynamics may arise from simple rules. Proponents of the complexity of agents obtain their arguments especially from the fields of sociology and cognitive psychology, and emphasise, using the words of Conte, the idea that agents should be kept "as simple as suitable". This debate continuously pervaded the workshop held at the Vienna Institute of Demography, which was certainly lively, and also truly interdisciplinary.

The workshop was opened by Wolfgang Lutz and Thomas Fent (who acted as the main local organiser), both of whom welcomed the idea that this fascinating topic was hosted by the VID. Francesco Billari and Alexia Prskawetz kicked off the debate from "a user's perspective", describing their experience in stimulating scholars interested in demography ever since a workshop held at the Max Planck Institute for De-

mographic Research in 2001, which gave rise to the book "Agent-Based Computational Demography". Their call for the development of didactic platforms that are more user-friendly for scholars not specially trained in information sciences provoked an immediate debate, which again recalled the simplicity-versus-complexity discussion.

The first topical session was devoted to "Agent-Based Modelling as an integrative framework for assessing the micro-macro link and the evolution of complex socio-ecological interactions". Contributions in this session started from analytical examples to discuss the logic of AB modelling. Edmund Chattoe, discussing the link between micro-level complex mate-choice processes within social networks and macro-level outcomes focused on the falsification power of the AB approach for the micro-macro link, what he called "falsification by emergence". From a spatial ecology perspective, Ulf Dieckmann discussed the importance of simple micro-level rules connected to macro-level ecological outcomes and presented the idea that different definitions of what is 'micro-level' may be used. Using the fascinating example of vampires, Rosaria Conte presented her view on the necessity of modelling agents as cognitively complex entities. Frank Schweitzer, finally, provoked a large debate by advocating the need to go back to mathematical and statistical modelling as far as this is feasible (starting from simple micro-level rules), in order to be able to give a more complete picture of dynamical systems than it is often possible when using simulation only. Synergetics and models for many-particle systems can be helpful in this endeavour.

The second topical session was devoted to "Agent-based modelling in demography". Human populations are a sort of "natural" field to analyse with agent-based approaches, and as usual mating and migration were the key fields: by focusing on the importance of assortative mating to shape kin constellations, Mike Murphy showed that traditional demographic microsimulation is also akin to agent-based modelling. Patrick Heuveline described a model in development in which detailed demographic and social network dynamics are used to study HIV transmission in sub-Saharan Africa. Wolfgang Loibl presented a detailed model of suburban migration in the Vienna region, where the population-environment interaction is the outcome of micro-level decisions and macro-level economic and policy constraints. Alexia Prskawetz presented the model developed with Francesco Billari and Johannes Fürnkranz on the evolution of age-at-marriage norms over generations. Thomas Fent presented a generalised agent-based model on the evolution of age-at-marriage norms over successive generations with realistic demography. Again, the debate was alive and mostly focused on the agents' simplicity vs. complexity.

The third session focused on "Computational tools and mathematical methods in agent-based modelling research". Presentations here took advantage of the first session and on the debate on specific models that had arisen from the second session to go back to foundational issues. Jim Doran argued for the design of complex agents that mimic real agents as much as necessary; the main argument was that scholars ought to start from complexity and then scale down their models in order to see what

are the necessary elements producing certain dynamics. Close to this argument was also the talk by Bruce Edmonds, who also discussed in detail the relationships between models of the physical space and models of the social space. Andreas Geyer-Schulz presented a model of asymmetric directed communication structures, discussing an approach to model complexity in information science. Jürgen Scheffran, starting from the example of the analysis of emission reduction in environmental sciences, brought the debate on tools and methods to a close by discussing the relationships that exist between complementary approaches such as agent-based modelling, game theory and complexity science.

The focus of the fourth session was "Agent-based modelling in economics". Christophe Deissenberg presented a non-orthodox model of money and exchange in an economy with spatially differentiated agents, where the emergence of money is justified from the bottom up. Alexander Kaufmann presented a model with complex agents, in the spirit of the multi-agent system approach, dealing with the interaction of heterogeneous rationalities and its impact on the innovation output of firms. The following presentation, by Andreas Pyka, showed the importance of agent-based modelling when adopting an evolutionary view on economic processes, with a study of the theory of entrepreneurship.

The fifth and final session was devoted to "Agent-based modelling in environmental studies". Volker Grimm introduced his presentation with reference to models of animal populations and to the currently popular "Finding Nemo" story; in particular, he discussed the role of agent-based models in ecology and natural resource management. Ulf Dieckmann's second talk focused on the role of agent-based models in evolutionary ecology, with a special focus on relationships to evolutionary game theory. Johann Metz, finally, focused his presentation on the "Canonical equation of adaptive dynamics", recalling again the close relationships between the logic of modelling complex adaptive systems using mathematics and using simulation.

The workshop was closed by an open discussion. Actually, during the whole duration of the workshop, including coffee breaks, lunches, dinners and excursions to Vienna's art museums (organised most efficiently also thanks to the great help given by Ani Gragossian, the workshop secretary), scientific debate was alive and open. The workshop contributed to foster communication between scholars of different disciplines and of different epistemologies, a communication that is hard to find in these days of specialisation. The organisers are looking forward to the idea of keeping such a lively debate as visible as possible.