SOE 3: Economic Models and Evolutionary Game Theory I

Time: Monday 11:00–12:30 Location: H 0110

SOE 3.1 Mon 11:00 H 0110

The tragedy of the commons of BitTorrent: a concrete application of agent based models — •Steve Genoud[1], Tamás Vinkó[2], Sergi Lozano[1], and Dirk Helbing[1] — [1]ETHZ, Zürich, Switzerland — [2]TUD, Delft, The Netherlands

Peer to peer (p2p) softwares allows the creation of new cheap, decentralised and scalable means of computing. Any Skype call, for instance, rests on this technology. The BitTorrent protocol is another example of a successful implementation of p2p file-sharing.

The distribution of a load across individual users give p2p systems their strength. But this creates a situation similar to a public goods game. As producer-consumer, users are tempted to consume as much as possible, while producing nothing. Therefore the users behaviors, especially their sharing preferences, are crucial for the system performance. These aspects, especially the dynamic effects of incentives, are currently overlooked in the literature.

We propose an agent based model of BitTorrent as a *techno-social system*. We compose a detailed simulation of the protocol with a decision model of the agents. The resulting model should obey the macro social behavior we observe in real communities. We can use measurements of the performance of actual systems to fix the parameters of the model. Finally, we show how this framework may be used to test new protocols.

SOE 3.2 Mon 11:15 H 0110

Multidimensional multiplicative noise arising in evolutionary dynamics — Arne Traulsen[1], •Jens Christian Claussen[2], and Christoph Hauert[3] — [1]Evolutionary Theory Group, Max-Planck-Institute for Evolutionary Biology, Plön — [2]Institut für Neuro- und Bioinformatik, Univ. Lübeck — [3]Dept. of Mathematics, Univ. of British Columbia, Vancouver

We present a general framework to describe the evolutionary dynamics of an arbitrary number of types in finite populations based on stochastic differential equations. For large, but finite populations this allows to include demographic noise without requiring explicit simulations. Instead, the population size only rescales the amplitude of the noise. Moreover, this framework admits the inclusion of mutations between different types, provided that mutation rates, μ, are not too small compared to the population size N, i.e., limitations occur for $\mu N \ll 1$. We illustrate our approach by a Rock-Scissors-Paper game with mutations, where we demonstrate excellent agreement with simulation based results for sufficiently large populations. In the absence of mutations the excellent agreement extends to small population sizes.

SOE 3.3 Mon 11:30 H 0110

Game theoretic foundations of macroeconomic rational expectation equilibria — •Eckehard Olbrich[1], Nils Bertschinger[1], and David H. Wolpert[2] — [1]MPI MiS, Leipzig, Germany — [2]Santa Fe Institute, NM, USA

We investigate the game-theoretic foundations of rational expectation equilibria in a prototypical macroeconomic model, the famous "coconut" model [1, 2]. In this model agents have to decide whether to make a costly investment in a production facility. Agents only value goods produced by *other* agents, but can trade a good they produce for a good produced by another agent. In this model a market failure equilibrium can arise as a self-fulfilling prophecy, where everyone believes nobody else invests, and therefore nobody makes the investment necessary to have a good to trade. However in other equilibria, the self-fulfilling prophecy leads everyone to invest, and there is no market failure. We show that there are multiple ways to formulate the coconut model as a game, each resulting in different Nash equilibria. We also show that the equilibrium analysis of [2] contains inconsistencies and resolve them. In particular, we establish that the dynamical system analyzed in [2] is only a necessary condition for Nash equilibria, but does not provide a reasonable model for *off*-equilibrium agent behavior. To correct this we introduce learning to the model, and present a modified stability analysis. [1] P. Diamond, *Aggregate demand management in search equilibrium*, J. Pol. Econ. **90**, 881–894. [2] P. Diamond and D. Fudenberg, *Rational expectations business cycles in search equilibrium*, J. Pol. Econ. **97** (1989), 606–619.

SOE 3.4 Mon 11:45 H 0110

Response to social norms enhancement by heterogenous populations — •Claudio J. Tessone[1], Anxo Sánchez[2], and Frank Schweitzer[1] — [1]Chair of Systems Design, ETH Zürich. Kreuzplatz 5, CH-8032 Zürich, Switzerland — [2]Grupo Interdisciplinar de Sistemas Complejos (GISC), Departamento de Matemáticas, Universidad Carlos III, E-28933 Leganés , Spain

We study the appearance of diversity-induced resonance in a purely economic model of cooperating and defecting agents. The contribution of an agent to a public good is seen as a social norm. So, defecting agents face a social pressure, which decreases if free-riding becomes widespread. Diversity, in this model, comes from the different sensitivity of agents towards the social norm, which itself can change over time in a periodic manner. We study the evolution of cooperation in response to the social norm (i) for the replicator dynamics, and (ii) for the logit dynamics, both analytically and by means of computer simulations. Diversity-induced resonance is observed as a peak in the response of the agents to a change in the strength of the social norm, as a function of the diversity in the individuals. We provide an analytical, mean-field approach for the logit dynamics that is in very good agreement with the simulations, making explicit the connection with the physical paradigm of diversity-induced resonance in bistable systems. From a socio-economic perspective, our results show that, counter-intuitively, idiosyncratic diversity in the individual sensitivity to social norms may result in a society that better follows such norms as a whole, even if part of the population is less prone to follow them.

SOE 3.5 Mon 12:00 H 0110

Complex dynamics in game learning — •James Sanders[1], Tobias Galla[1], and J. Doyne Farmer[2] — [1]School of Physics and Astronomy, The University of Manchester, Manchester, UK — [2]Santa Fe Institute, Santa Fe, New Mexico, USA

Game learning processes are of interest in many fields, from the study of financial markets in which traders learn from their past successes and failures, to the design of computer systems that can improve their behaviour based on previous experiences. We study experience-weighted attraction, an empirically-based model of game learning behaviour, focusing in particular on the conditions under which it displays chaotic dynamics. We discuss low-dimensional games as well as those with a large number of strategies, where very high-dimensional chaotic attractors can be seen. This has potential implications for complex systems that can be modelled using experience-weighted attraction, as the presence of this kind of complex dynamics places severe limits on the predictability of a system.

SOE 3.6 Mon 12:15 H 0110

Self-organized cartel dynamics in a modified trust game — •Tiago P. Peixoto and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen, Otto-Hahn-Allee 1, D-28359 Bremen, Germany

We investigate the dynamics of a trust game on a mixed population where individuals are forced to play against a predetermined number of partners, which they are allowed to dynamically choose. Players are also allowed to update their level of trustworthiness, based on payoff. The dynamics undergoes a transition at a specific value of the strategy update rate, above which an emergent cartel organization is observed, where individuals have similar values of below optimal trustworthiness. This dynamics is marked by large fluctuations and a high degree of unpredictability for most of the parameter space, and serve as a plausible qualitative explanation for observed fluctuations in certain commodity prices.