SOE 9: Evolutionary Game Theory (joint session SOE / BP / DY)

Time: Tuesday 11:00–12:15 Location: GÖR 226

SOE 9.1 Tue 11:00 GÖR 226

Assortative matching with inequality in voluntary contribution games — •Stefano Duca, Dirk Helbing, and Heinrich H. Nax — D-GESS, ETH Zurich, Switzerland

Voluntary contribution games are a classic social dilemma in which the individually dominant strategies result in a poor performance of the population. The negative zero-contribution predictions from social dilemma situations give way to more positive (near-)efficient ones when assortativity, instead of random mixing, governs the matching process in the population. Under assortative matching, agents contribute more than what would otherwise be strategically rational in order to be matched with others doing likewise. An open question has been the robustness of such predictions in terms of provisioning of the public good when heterogeneity in budgets amongst individuals is allowed. Here, we show analytically that the consequences of permitting heterogeneity depend crucially on the exact nature of the underlying public-good provision efficacy, but generally are rather devastating. Using computational methods, we quantify the loss resulting from heterogeneity vis-a-vis the homogeneous case as a function of (i) the public-good provision efficacy and (ii) the population inequality.

SOE 9.2 Tue 11:15 GÖR 226

Anomalous Long-Term Behavior in Evolutionary Dynamics from Ergodicity Breaking — •Jan Nagler[1] and Frank Stollmeier[2] — [1]ETH Zurich — [2]MPI DS, Network Dynamics, Göttingen

Fluctuating environments determine life, ranging from the early stages of molecular evolution to the emergence and maintenance of cooperation in our society. Predicting the long-term evolution of species and strategies in uncertain environments is a long-standing challenge in evolutionary dynamics. For evolutionary games where the payoff a player receives is dependent on the fluctuating environmental state, we predict the dynamics in the long-term, i. e. the game's stationary states. For deterministically and stochastically varying payoff structures we find anomalous, sometimes counterintuitive, long-term behaviors which are markedly different from traditional games defined by constant payoffs. Intricately, the anomalous stationary states are sensitive to the covariance of the payoffs. In contrast to evolutionarily stable states of games with constant payoffs, where coexisting species necessarily receive equal payoffs, anomalous stable states can be unfair, meaning that, on average, two coexisting species may receive different payoffs. Moreover, environmental noise can induce transitions between different games. We introduce a classification for evolutionary games with payoff stochasticity, which contains the traditional games for vanishing payoff variance. Our framework, developed here analytically, robustly predicts the long-term evolution of species and strategies in fluctuating environments.

SOE 9.3 Tue 11:30 GÖR 226

Extinction properties in the coexistence two-species population induced by demographic fluctuation — •Hye Jin Park and Arne Traulsen — Department of Evolutionary Theory, Max Planck Institute for Evolutionary Biology, Plön, Germany

Two-species system can be described by the reaction rules which occur according to given rates. Due to this stochasticity a population size fluctuates, and the system is out of the deterministic system. Even thought the system has a stable fixed point in the deterministic case, it can be in an another state for the stochastic model. Since the population is never recovered once it goes to extinct, all populations go to extinct eventually unless the population size goes to infinity. Here, we investigate extinction properties of two-species system and examine which one is preferred to extinct first when two species can coexist for a long time. In this paper, we find the most probable trajectory to extinction in the species-abundances space using WKB (Wentzel-Kramers-Brillouin) method and show that the one of the species is preferred to extinct first as carrying capacity increases. In addition, we find that the mean time to extinction increases as a power law for small carrying capacity while exponentially increases for larger carrying capacity than certain value.

SOE 9.4 Tue 11:45 GÖR 226

Family-friendly zero-sum games — •Philipp M. Geiger, Johannes Knebel, Markus F. Weber, and Erwin Frey — Ludwigs-Maximilians-Universität, München, Deutschland

Here we study how network topology determines the long-time coexistence in the antisymmetric Lotka-Volterra equation (ALVE). The ALVE is the replicator equation of zero-sum games, in which interactions are defined by an antisymmetric matrix such that the gain of one strategy equals the loss of a dominated one. The interactions are represented by a weighted network: nodes correspond to strategies, the topology of directed links indicate their dominance relations, and the weights of links define their interaction strengths. Although one generically observes extinction of some nodes, there are network topologies in which all nodes coexist irrespective of the chosen weights. For example, in the rock-paper-scissors game, the network topology is a directed cycle of three nodes. This topology ensures coexistence of all nodes irrespective of the chosen weights.

In our work, we systematically construct nontrivial coexistence networks of the ALVE by mapping its long-time dynamics to an algebraic problem that we analyze by using concepts from graph theory. In particular, we characterize the kernel of an antisymmetric matrix in terms of Pfaffians and their relation to near-perfect matchings. We understand these coexistence networks as "family-friendly zero-sum games" in which all strategies coexist due to network topology.

SOE 9.5 Tue 12:00 GÖR 226

The role of spatio-temporal resource variability for information sharing and competition. — •Pawel Romanczuk[1,2,6], Matthieu Barbier[3], James Watson[4,5], and Simon A. Levin[6] — [1]Institut of Theoretical Biology, Dept. of Biology, Humboldt Universität zu Berlin, Germany — [2]Bernstein Center for Computational Neuroscience Berlin, Germany — [3]Centre for Biodiversity Theory and Modelling, CNRS, France — [4]The Global Economic Dynamics and the Biosphere programme, Swedish Royal Academy of Sciences, Stockholm Sweden — [5]College of Earth, Ocean and Atmospheric Sciences, Oregon State University, Oregon, USA — [6]Dept. of Ecology and Evolutionary Biology, Princeton University, Princeton, USA

Understanding and predicting how spatial and temporal variability of a resource affects the social behavior of interacting agents ("harvesters") is a fundamental problem in many social-ecological systems. Here we propose a simple, yet generic, lattice-based evolutionary model, to investigate the dependence of evolutionary stable social strategies on the spatial distribution and the effective life-time of the resource landscape. In particular, we identify distinct parameter region which favor different behavioral strategies: territoriality, individualism and information sharing. Finally, we discuss briefly the results of an agent-based model in continuous time and space together with a simplified analytical description, which fully align with our lattice-model results.