AGSOE 11: Economic Models and Evolutionary Game Theory III

Time: Wednesday 10:15–12:45 Location: BAR 205

AGSOE 11.1 Wed 10:15 BAR 205

The Unexpected Birth of Cooperation in the Prisoner's Dilemma with Migration — •Dirk Helbing and Wenjian Yu — ETH Zurich, Universitätstr. 41, 8092 Zürich, Switzerland

The prisoner's dilemma models situations where it is risky to cooperate and tempting to defect (i.e. to free-ride or cheat). For this reason, it is often used to study conditions for the cooperation among selfish individuals. In the evolutionary prisoner's dilemma, the finally resulting fraction of cooperators is predicted to be zero. But what happens, if we consider effects of migration? The integration of game theoretical models and models of individual motion has recently led to agent-based models, which can describe various stylized facts in social, economic, and biological systems (such as agglomeration, segregation, turn-taking, class and niche formation). But how does migration influence the level of cooperation? We find that it can change the outcome dramatically! Directed (in contrast to random, diffusive) migration can support the formation of clusters and promote a higher level of cooperation, where conventional spatial games predict a decreasing level. We also study whether this finding is robust to varying parameters and noise. This reveals a new mechanism, how cooperators manage to resist attempts of defectors to invade cooperative clusters under various conditions. In a noisy world, success-driven migration can reach a majority of cooperators even when we assume no cooperators in the beginning and selfish behavior most of the time. This unexpected discovery shows that mobility could have been very crucial for the spontaneous birth of cooperation and (pro)social behavior.

AGSOE 11.2 Wed 10:45 BAR 205

Learning, migration and evolutionary games: a new paradigm in the study of cooperation — •Carlos P. Roca[1,2] and Dirk Helbing[1] — [1]Chair of Sociology, in particular of Modeling and Simulation, ETH Zurich, Swizterland — [2]GISC, Department of Mathematics, Universidad Carlos III de Madrid, Spain

The problem of the emergence and stability of cooperative behavior has attracted a great deal of attention during last decades, being one of the most prominent open questions in a variety of disciplines [1]. Evolutionary game theory has become one of the most fruitful frameworks to address this issue, by proposing stylized models based on social dilemmas and evolutionary dynamics [2]. Only very recently the importance of migration, understood as individuals' mobility, has started to be considered in depth [3]. On the other hand, whereas most studies introduce an evolutionary dynamics based on some sort of imitation, in this work we provide individuals with basic learning capabilities. We have found that the combined effect of learning and migration has a strong influence on cooperation, which nature stands in stark contrast to that of models based on other kind of dynamics. Our work suggests that the existence of particular cognitive abilities, as well as the possibility of mobility, may have been of crucial importance in the flourishing of cooperation.

[1] Pennisi E., Science 309, 2005.

[2] Maynard Smith J., Evolution and the Theory of Games, Cambridge University Press, 1982.

[3] Helbing D., Yu W., Adv. Complex Systems 11, 2008

AGSOE 11.3 Wed 11:15 BAR 205

Evolutionary dynamics in structured populations — •Corina Tarnita[1], Tibor Antal[1], Hisashi Ohtsuki[2], and Martin Nowak[1] — [1]Department of Mathematics and Program for Evolutionary Dynamics, Harvard University, Cambridge MA 02138, USA — [2]Department of Value and Decision Science, Tokyo Institute of Technology, Tokyo, 152-8552, Japan

Evolutionary dynamics are strongly affected by population structure. The outcome of an evolutionary process in a well-mixed population can be very different from that in a structured population. There have been many attempts to study the effect of population structure on evolutionary dynamics. These approaches include spatial models in ecology, spatial games and games on graphs. In most of these models, the underlying spatial structure or social network is given and does not change during the evolutionary process. Here I present a completely analytical theory for a class of models that use dynamical graphs. The interaction graph changes as a consequence of evolutionary updating. I obtain exact results for any evolutionary game including the evolution of cooperation. I present precise conditions for cooperators to be selected over defectors. Finally, I use the same mathematical tools to derive a general condition for strategy selection that holds for a large variety of structured population.

AGSOE 11.4 Wed 11:45 BAR 205

Efficiency based strategy spreading in the prisoner's dilemma game — •Sebastian Weber and Markus Porto — Institut für Festkörperphysik, Technische Universität Darmstadt, Germany

In contrast to well-mixed populations, discrete interaction patterns have been shown to support cooperation in the prisoner's dilemma game, and a scale-free network topology may even lead to a dominance of cooperation over defection. The majority of studies assumes a strategy adoption scheme based on accumulated payoffs. The use of accumulated payoffs, however, is incompatible with the integral property of the underlying replicator dynamics to be invariant under a positive affine transformation of the payoff function. We show that using instead the payoff per interaction to determine the strategy spread, which has been suggested recently and recovers the required invariance, results in fundamentally different dynamical behavior [1]. Most notably, in such an efficiency based scenario the advantage of a scale-free network topology vanishes almost completely. We present a detailed explanation of the fundamentally altered dynamical behavior.

[1] S. Weber, and M. Porto, submitted

AGSOE 11.5 Wed 12:15 BAR 205

Measuring the evolution of socio-economical structure in an online game — •Michael Szell[1] and Stefan Thurner[1,2] — [1]Complex Systems Research Group; HNO; Medical University of Vienna; Währinger Gürtel 18-20; A-1090; Austria — [2]Santa Fe Institute; 1399 Hyde Park Road; Santa Fe; NM 87501; USA

The analysis of high-frequency log files of a massive multiplayer online game currently played by thousands of users allows to assess socio-economical dynamics over the past three years. We are able to relate social and economic behaviour of the players to a series of stylized facts known to exist in the real world. In particular, we analyze the evolution of underlying growing social networks such as constituted by friends and/or foes, private message communication networks, and measure their characteristic properties. Our data confirm the recently observed phenomena of shrinking diameters and growing average degrees. Clustering coefficients of friend-networks decay in time, while those of foes grow. Further, we study the evolution dynamics of social clusters (alliances in the game). We compare our findings with literature on real world data. With this setup we try to establish a "laboratory" for economical behaviour.