BP 13: Evolutionary Game Theory (joint session SOE/DY/BP)

Time: Tuesday 12:30–13:15 Location: MA 001

BP 13.1 Tue 12:30 MA 001

Equality-efficiency tradeoff in a dynamical Voluntary Contribution Game with Assortative Matching and heterogeneous agents. — •Stefano Duca — ETH Zurich, Zurich, Switzerland

Many scholars in the socio-economical literature have noted that any system that allows and incentivizes the transfer of wealth between agents exhibits a trade-off between efficiency and equality. Using an agent based model we study the welfare properties over time of Assortative Matching in Voluntary Contribution Games (VCM).

Every round, individuals choose how much to contribute into a group account and are ranked according to it. Based on this ranking, participants are then matched in equal-size groups; members of each group share their group output equally according to a VCM payoff function. Wealth accumulates over time and agents differ in talent and starting wealth.

In this paper, we study several ranking mechanisms based on different dimensions and ask what are the properties of these mechanisms in terms of total production of wealth and its distribution.

We find that, while in general it is impossible to determine a single best ranking system, some perform objectively better than others.

Using a computational approach we determine the mechanism that maximizes the social welfare, chosen from the Pareto frontier, depending on the preferences of a social planner.

BP 13.2 Tue 12:45 MA 001

Exiting the Primordial Soup – Transition from Pre-Darwinian to Darwinian Evolution — Charlotte V. Vogelbusch[1], Steven H Strogatz[2], •Hinrich Arnoldt[1], and Marc Timme[1] — [1]Chair for Network Dynamics, Institute for Theoretical Physics and Center for Advancing Electronics Dresden (cfaed), TU Dresden, Dresden, Germany — [2]Department of Mathematics, Cornell University, Ithaca, NY 14853, USA

Darwin proposed the now-accepted existence of a last universal common ancestor (LUCA) from which all species emerged in an evolutionary process. Life on earth just before LUCA was fundamentally collective - a primordial soup - as ancient life forms shared their genetic material freely through massive horizontal gene transfer (HGT). How to exit this collective state and start Darwinian evolution is far from understood and heavily debated. Here we present a minimal model for this hypothesized "Darwinian transition." The model suggests that HGT-dominated dynamics may have been intermittently interrupted by selection-driven processes during which genotypes became fitter and decreased their inclination toward HGT. Stochastic switching in the population dynamics may have destabilized the HGT-dominated collective state and led to the emergence of vertical descent, the first well-defined species, and thus started Darwinian evolution [1]. Moreover, advanced models with dynamic inclination to HGT competence suggest a viable route from collective pre-Darwinian to vertical Darwinian evolution and hint to a constrained exit window in parameter space. Ref.: [1] Phys. Rev. E 92, 052909 (2015)

BP 13.3 Tue 13:00 MA 001

Analytical approximation of temporal difference multi-agent reinforcement learning — •Wolfram Barfuss[1,2], Jonathan F. Donges[1,3], and Jürgen Kurths[1,2,4] — [1]Potsdam Institute for Climate Impact Research, GER — [2]Humboldt University, Berlin, GER — [3]Stockholm Resilience Centre, Stockholm University, SWE — [4]University of Aberdeen, UK

Reinforcement learning in multi-agent systems has been studied by the fields of economic game theory, artificial intelligence and physics. Especially an economic and physics perspective has lead to analytical approaches of learning dynamics in multi-agent systems. However, these studies put their focus on simple iterated normal form games, such as the iterated Prisoners Dilemma. Environmental dynamics, i.e. changes in the state of the agent's environment affecting the payoffs received by the agents are mostly lacking. In this work we combine the analytical approach from physics with temporal difference learning from the field of artificial intelligence. This form of learning explicitly uses the discounted value of future environmental states to adapt the agent's behavior. We develop a uniform notation for multi-agent environment systems, generalizable to any environment and an arbitrary number of agents. We find four reinforcement learning variants emerging and compare their dynamics. This work is important to advance the understanding of interlinked social and environmental dilemmas, such as climate change, pollution and biosphere degradation.