26th ALTENBERG WORKSHOP IN THEORETICAL BIOLOGY

Strategic Interaction in Humans and Other Animals

organized by

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Konrad Lorenz Institute

for Evolution and Cognition Research

Altenberg, Austria

The topic

Game theory has been and continues to be applied successfully by economists, biologists and philosophers to a large number of diverse problems that can all be cast in terms of strategic interactions. These applications have, in turn, affected the development of game theory itself. A notable example of this is the use of game theoretic methods by John Maynard Smith in evolutionary biology, which inspired the field of evolutionary game theory, resulting in new solution concepts and the application of dynamical systems to games. Thus, by being applied to evolutionary biology the foundations and methods of game theory have been reshaped themselves.

More recently, game theory has also been tested in the laboratory with human subjects. There are continuing debates on how experimental findings should be interpreted and whether or to what extent the predictions of traditional game theory fail in the laboratory. There are also many connections between experimental game theory and the methods of evolutionary game theory because of the importance of learning in games that, in the abstract, lead to dynamical models that may often be viewed in terms of individual learning and in terms of population processes.

Aims of the Workshop

The workshop aims at gathering together biologists, economists, mathematicians, and philosophers who share an interest in game theory. Some of the topics that will be explored concern applications of game theory; others will be about its conceptual foundations when viewed in terms of evolutionary or learning processes. We do not aim at surveying the field. Instead, we hope that some particularly significant issues will be presented, illustrating the richness of the applications and foundations of game theory, and its relevance for the social and the life sciences.

Strategic Interaction in Humans and Other Animals

Thu 1 September	Evening	
6.00 pm		Welcome reception and dinner at the KLI

Fri 2 September	Morning	Chair: TBA
9.30 am – 9.45 am		Announcements
9.45 am – 10.45 am	Zollman	Concerns and Alternatives to Costly Signaling in Biology
10.45 am – 11.15 am	Coffee	
11.15 am – 12.15 am	Berger	Learning To Trust
12:15 pm – 2.00 pm	Lunch	at the KLI

Fri 2 September	Afternoon	Chair: TBA
2.00 pm – 3.00 pm	Bergstrom	Evolution of Utility Functions for Socially Connected Individuals
3.00 pm – 3.30 pm	Coffee	
3.30 pm –4.30 pm	Robson	The Evolution of the Theory of Mind
4.30 pm – 5:00 pm	Coffee	
5.00 pm – 6.00 pm	Hammerstein	The Role of Learning and Emotions in Game Theory
6.00 pm	Departure for Dinner	at the restaurant “Waldschenke” in the Vienna Forest

Sat 3 September	Morning	Chair: TBA
9.00 am – 10.00 am	Fernando	Competition and Cooperation between Information Sharing Neural Agents
10.00 am – 11.00 am	Blume	Network Formation in the Presence of Contagious Risk
11.00 am – 11.30 am	Coffee	
11.30 am – 12:30 am	Cressman	Game Experiments on Cooperation through Reward and Punishment
12.30 pm - 2.00 pm	Lunch	at the KLI

Sat 3 September	Afternoon	Chair: TBA
2.00 pm –3.00 pm	Hofbauer	Game Dynamics: Discrete Versus Continuous Time
3:00 pm – 3.30 pm	Coffee	
3.30 pm –4.30 pm	Sandholm	Sampling Best Response Dynamics and Deterministic Equilibrium Selection
4.30 pm – 5:00 pm	Coffee	
5:00 pm – 6.00 pm	Binmore	Sex and Evolutionary Stability
6.00 pm	Departure for Dinner	at the restaurant “Mormat” in Vienna

Sun 4 September	Morning	Chair: TBA
9.30 am – 10.30 am	Hegselmann	The Evolution of Division of Labor and Morality – A Computer Simulation of Hume´s Theory
10.30 am – 11.00 am	Coffee	
11.00 am – 12.00 am	Okasha	Veil of Ignorance Arguments in Philosophy, Economics and Evolutionary Biology: Mendel meets Rawls and Harsanyi
12:00 pm – 2.00 pm	Lunch	at the KLI

Abstracts

KEVIN ZOLLMAN (joint work with SIMON HUTTEGGER)
Carnegie Mellon University

Concerns and Alternatives to Costly Signaling in Biology

Many animals honestly communicate with one another despite partially conflicting interests that encourage dishonesty. Traditionally, it has been argued that honesty is maintained because dishonesty bears a cost (also known as a handicap) that overwhelms the incentive to lie. First suggested by Zahavi in biology and Spence in economics, this explanation has been formalized by a number of scholars in both fields and has become the canonical theory in the evolution of animal communication. In this paper we present a number of problems with this explanation, and we discuss a number of alternative explanations, which we believe are more plausible.

Ulrich Berger

Learning To Trust

In the binary trust-game, trust and trustworthiness are socially optimal but backwards induction prescribes neither to trust nor to honor trust. This is a social dilemma, so why do we often observe both trust and trustworthiness in the real world? In an evolutionary game theory framework with best response dynamics I show that reputation effects can greatly alleviate the dilemma if trustors can obtain costly information on trustees' previous behavior, where the probability of observing behavior is endogenized. There exists an asymptotically stable Nash equilibrium where trustees mix between honoring and abusing trust, and trustors mix between blind trust and pessimistic conditional trust.

TED BERGSTROM
University of California, Santa Barbara

Evolution of Utility Functions for Socially Connected Individuals

Where behavior is determined by genetic copying or by cultural heritage, individuals are often more likely to interact with others of their own type than with a randomly selected member of the population. Humans thrive in an environment where payoffs vary across space and time with bewildering complexity. Individuals routinely find themselves in situations that have not been encountered frequently enough in evolutionary history for natural selection to have chosen a best response. Evolution must take shortcuts such as endowing creatures with preferences over outcomes, notions of causal connection, and the ability to survey available options and choose actions likely to produce desired outcomes. This paper addresses the question: “What kind of preferences can be expected to evolve in an environment where individuals interact with others of similar heritage?”

ARTHUR ROBSON (joint work with NICK KASIMATIS and DANIEL MONTE)
Simon Fraser University

The Evolution of the Theory of Mind

We investigate an evolutionary rationale for the theory of mind (TOM), focusing on the fundamental advantage of an ability to represent an opponent's preferences. We consider a setting of stage games with perfect information, in which the game tree is constant, but outcomes are randomly assigned to terminal nodes in each period. Furthermore, the overall set of outcomes grows with time. Individuals with TOM are able to build a complete picture of an opponent's preferences despite a relatively rapid rate of arrival of new outcomes. Naive players, who must condition their choices on familiarity with the entire game, learn much more slowly and cannot keep up with even moderate arrival rates. In games with many stages, more sophisticated higher order beliefs are obtained for free, since what sophisticated players learn about another player's preferences is common knowledge.

PETER HAMMERSTEIN
Humboldt-Universität zu Berlin

The Role of Learning and Emotions in Game Theory

When economists transferred ideas from evolutionary game theory to their own discipline, *learning* played the role of *selection* in their new framework. The replicator equation can indeed be interpreted as some kind of social learning. This is a mathematical and not an empirical finding, however. Learning in the real world is often not captured by anything like the replicator equation. More generally speaking, learning is not a process that simply mimics evolution on short time scales. Looking at human behavior from this angle, many 'odd phenomena' known from experimental economics can be demystified. In a similar spirit, modern knowledge about emotions also helps us understand why human behavior often violates game-theoretic principles. The mechanisms behind learning and emotions can themselves be conceived as strategic devices shaped by natural selection. Studying these mechanisms from an evolutionary perspective shows that they make us smart despite the fact that they induce violations of axiomatic decision theory.

CHRISANTHA FERNANDO
University of Sussex

Competition and Cooperation between Information Sharing Neural Agents

Four broad classes of search algorithms can be defined. Solitary search in which one candidate solution exists at a time, trivial parallel search which consists of a population of independent solitary candidates, parallel search with competition for search resources, and parallel search with competition and information transfer between candidate solutions. Natural selection is the archetypical example of this last category of search and there is evidence that it is implemented in the brain albeit with limited heredity. Neuronal response functions such as orientation selectivity compete for stimulus resources and replicate between neurons by lateral connections and spike-time dependent plasticity [1]. We propose that replication of higher-order neuronal structures also takes place using similar mechanisms [2]. These and other neuronal replicators constitute a neuro-ecology. We propose general principles that would allow an organism to behave optimally given that agents controlling it can compete and cooperate for its control.

1. Young JM, Waleszczyk WJ, Wang C, Calford MB, Dreher B, et al. (2007) Cortical reorganization consistent with spike timeing but not correlation-dependent plasticity. Nature Neuroscience 10: 887-895
2. Fernando C, Karishma KK, Szathmáry E (2008) Copying and evolution of neuronal topology. PLoS ONE 3: e3775.

LARRY BLUME (joint work with DAVID EASLEY, JOHN KLEINBERG, ROBERT KLEINBERG, and EVA TARDOS)
Cornell University

Network Formation in the Presence of Contagious Risk

In many circumstances, agents face the following tradeoff in forming a network: each agent receives benefits from the direct links it forms to others, but these links expose it to the risk of being hit by a cascading failure that might spread over multi-step paths. This issue is pertinent for financial and epidemiological phenomena, among others.

We formulate a strategic network formation problem, and provide asymptotically tight bounds on the welfare of both optimal and stable networks. Socially optimal networks are, in a precise sense, situated just beyond a phase transition in the behavior of the cascading failures, and that stable graphs lie slightly further beyond this phase transition, at a point where most of the available welfare has been lost. We explore the tradeoffs between clustered and anonymous market structures. We describe how small amounts of "over-linking" in networks with contagious risk have strong welfare consequences.

ROSS CRESSMAN
Wilfried Laurier University

Game Experiments on Cooperation through Reward and Punishment

Results are reported from two different experiments that test the effects of punishment and/or reward on the cooperative behavior of players in repeated Prisoner's Dilemma (PD) and Public Goods (PGG) games. In the two-player PD experiment, each player has the third option of punishing his opponent at a cost to himself (i.e., the player chooses between cooperation (C), defection (D) and costly punishment (P)) in each round based on payoffs observed and strategies used in previous rounds. In the four-player PGG experiment, an outside agency rewards, punishes, or rewards and punishes players between rounds based on their contributions to the public good. Subjects for both game experiments were university students in Beijing.

For our PD experiment, costly punishment does not increase the average level of cooperation compared to the control experiment where this option is not available, in contrast with several similar experiments conducted in western societies. Our PGG experiment shows that our combined reward and punishment institutional incentive scheme is the most effective in increasing contributions, followed by punishment on its own and that reward on its own has little effect on contributions. These results are discussed in relation to cultural differences in attitudes to a player's reputation and to other PGG experiments based on peer incentive schemes. They are also discussed in relation to the Nash equilibrium structure of the corresponding single-stage games.

JOSEF HOFBAUER
University of Vienna

Game Dynamics: Discrete Versus Continuous Time

Evolutionary game dynamics are usually studied in continuous time. These differential equations are often derived as limits of related models in discrete time. If the step size in these difference equations is small one expects similar behavior as in the differential equation. I present some general results in this direction. However, the fine structure can differ considerably, as is illustrated by a number of examples.

BILL SANDHOLM (joint work with DAISUKE OYAMA and OLIVIER TERCIEUX)
University of Wisconsin

Sampling Best Response Dynamics and Deterministic Equilibrium Selection

We consider a model of evolution in games in which a revising agent observes the actions of a randomly-sized random sample of opponents and then chooses a best response to the distribution of actions in the sample. We call the resulting deterministic evolutionary dynamics sampling best response dynamics. We provide conditions on the distribution of sample sizes under which an iterated p-dominant equilibrium is almost globally asymptotically stable under these dynamics. Since our selection results are for deterministic dynamics, any selected equilibrium is reached quickly; in particular, the long waiting times associated with equilibrium selection in stochastic stability models are absent.

KEN BINMORE (joint work with LARRY SAMUELSON)
University of Bristol

Sex and Evolutionary Stability

We study evolutionary games in which the rest points of the evolutionary dynamic cluster in connected components, focusing on what we call the Resource Game as a canonical example. The long-term outcome in such games can depend critically on second-order forces that were excluded from the evolutionary dynamics because they are typically insignificant compared with selection pressures. We show that the influence of second-order forces on long-term outcomes can depend on whether the reproduction underlying the evolutionary dynamics is sexual or asexual. An implication is that care is needed in adopting the convenience of an asexual model when examining the behavior of a sexual population in games with nontrivial components of rest points.

RAINER HEGSELMANN
University of Bayreuth

The Evolution of Division of Labor and Morality – A Computer Simulation of Hume´s Theory

Hume's moral and political theory is about the problems, helpful inventions, and driving mechanisms of the evolution of societal forms from small to large groups. Hume's theory is rich and informal and although over 250 years old, it is still a modern theory. HUME1.0 is a computer model that reconstructs this theory and that gives detail and precision to the complex and dynamic interplay of trust and trustworthiness, the division of labor, and material wealth. The chapter describes the components of HUME1.0, solutions of design problems, some initial results, and further research perspectives.

SAMIR OKASHA
University of Bristol

Veil of Ignorance Arguments in Philosophy, Economics, and Evolutionary Biology: Mendel meets Rawls and Harsanyi

John Harsanyi and John Rawls both used the veil-of-ignorance thought experiment to study the problem of choosing between alternative social arrangements. With his `impartial observer theorem', Harsanyi tried to show that the veil-of-ignorance argument leads inevitably to utilitarianism, an argument criticised by Sen, Weymark, and others. A quite different use of the veil-of-ignorance concept is found in evolutionary biology. In the cell-division process called meiosis, in which sexually reproducing organisms produce gametes, the chromosome number is halved; when meiosis is fair, each gene has only a fifty percent chance of making it into any gamete. This creates a Mendelian veil-of-ignorance, which has the effect of aligning the interests of all the genes in an organism. I argue that Harsanyi's version of the veil-of-ignorance argument can shed light on Mendelian genetics. There turns out to be an intriguing biological analogue of the impartial observer theorem that is immune from the Sen/Weymark objections to Harsanyi's original.