



The 1st International Electronic Conference on Games

15–16 October 2025 | Online



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The 1st International Electronic Conference on Games

15–16 October 2025 | Online



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Welcome from the Chair

Dear Colleagues,

We are pleased to announce the **1st International Electronic Conference on Games (IECGA 2025)**, which will occur virtually over two days, from 15 to 16 October 2025.

This conference will focus on the following four sessions:

1. Algorithmic, Computational and Applied Game Theory
2. Behavioral, Experimental, and Cooperative Game Theory and Bargaining
3. Learning, Evolution, Market Design and Auctions
4. Non-Cooperative and General Game Theory

The 1st International Electronic Conference on Games is sponsored by MDPI and the journal *Games* (ISSN 2073-4336, Impact Factor: 0.5). *Games* is a scholarly, peer-reviewed, open access journal of studies on game theory and its applications published bimonthly online by MDPI.

This event will be held online fully, allowing participants from all over the world to participate without concerns on travel and related expenditures. This conference format is particularly appropriate and useful because research concerned with games is progressing rapidly. An electronic conference provides a platform for rapid and direct exchanges about the latest research findings and novel ideas.

Participation, as well as the "attendance" of this online conference, is free. Participants will have the opportunity to examine, explore and critically engage with issues and advances in these areas. We hope to facilitate discussions and exchange within the community.

Accepted abstracts will be published in the *Proceedings* Journal (ISSN: 2504-3900, Impact Factor: 0.5). Outstanding contributions from each session will have the chance to be selected for oral presentations and may be eligible for conference awards.

Moreover, instead of limiting presentations to a live poster session, all IECGA 2025 participants have the opportunity to upload and display their research in the form of a poster at the poster gallery on the conference website. Therefore, all participants with poster submissions at the poster gallery are now eligible for awards! Please click [HERE](#) for more instructions on poster and oral submissions.

We hope the community will share in this enthusiasm and help make the 1st International Electronic Conference on Games, a success!



Prof. Dr. Kjell Hausken
Conference Chair

University of Stavanger, Stavanger,
Norway



games

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Games (ISSN 2073-4336) is an international, peer-reviewed, quick-refereeing open access journal (free for readers), which provides an advanced forum for studies on game theory and its applications. Its aim is to provide an interdisciplinary forum for all sciences using game theoretical tools, models, and methods, including economics, psychology, political science, anthropology, mathematics, computer science, and biology. To guarantee a rapid refereeing and editorial process, *Games* follows standard publication practices in the natural sciences.

Note that *Games* does NOT publish papers on gaming, video games, sports competition, electronic games, serious games, and gamification, except if they have a clear connection to game theory.

Games publishes regular research articles, reviews and short notes. Our aim is to encourage scientists to publish their experimental and theoretical results in as much detail as possible. Therefore, there is no restriction on the maximum length of the papers. For theory papers, full details of proofs must be provided so that results can be checked. For experimental papers, full experimental details must be provided so that the results can be reproduced. Additionally, electronic files or software regarding the full details of the calculations, experimental procedure, etc, can be deposited along with the publication as 'Supplementary Material'.

Impact Factor: 0.5 (2024)

Keynote Speakers



Assoc. Prof. Cheong
Kang Hao

Nanyang Technological University, Singapore

Prof. Kang Hao Cheong is an accomplished academic at Nanyang Technological University (NTU). He holds degrees from the National University of Singapore (NUS) and has rich teaching experience, having received teaching excellence awards. Currently, he serves multiple roles at NTU, contributing to education and research. His research leverages Parrondo games and interdisciplinary methods, exploring complex systems and AI applications in medical, healthcare, and education fields. He also influences academic publishing and is recognized among top scientists, driving advancements in mathematical sciences and beyond.



Prof. Vincent Crawford

University of Oxford, Oxford, UK

University of California, San Diego, CA, USA

Prof. Vincent Crawford is the Drummond Professor of Political Economy Emeritus; an Emeritus Fellow of All Souls College; and Distinguished Professor Emeritus and Research Professor, University of California, San Diego. He holds an A.B. Summa cum Laude from Princeton University and a Ph.D. in Economics from the Massachusetts Institute of Technology. He is a Fellow of the Econometric Society, the Guggenheim Foundation, the American Academy of Arts and Sciences, the British Academy, and Academia Europea; and he has held research grants from the U.S. National Science Foundation and the European Research Council. He has served as co-editor of the American Economic Review and of Games and Economic Behavior, and on the editorial boards of Econometrica, the Journal of Economic Literature, and several other journals. He is currently a co-editor of the Journal of Mechanism and Institution Design. He is known for his work on game-theoretic microeconomic theory, particularly bargaining and arbitration, strategic communication, matching markets, learning, and coordination. His current research is on behavioral and experimental game theory and behavioral economics more generally.



Dr. Jie Zheng

Center for Economic Research, Shandong University, Jinan, China

Jie Zheng is University Distinguished Professor at Shandong University, and he serves as the Director for the Center for Research on Experimental and Theoretical Economics (CREATE). He is recognized as Distinguished Expert of “Taishan Scholar” Project, and has received the “Changjiang Scholar Award” from Ministry of Education of the Chinese Government. Dr. Zheng received his B.A and M.A. in Economics from Tsinghua University, and Ph.D. in Economics from Washington University in St. Louis. He is an Associate Editor for Journal of Economic Behavior and Organization and a co-director of China Behavioral and Experimental Economics Forum. He has guest edited various special issues on games and economic behaviour for several journals. His main research fields are information economics, industrial economics, experimental economics and behavioral economics. He has published over 60 research papers in journals including Nature Communications, American Economic Review (Papers and Proceedings), Games and Economic Behavior, Management Science, Journal of Industrial Economics, Journal of Mathematical Economics, Experimental Economics, Journal of Economic Behavior and Organization, as well as top Chinese journals.

Invited Speakers



Dr. Carlos Gracia-Lázaro

Institute for Biocomputation and Department of Mathematics and
Physics of Complex Systems, Statistics, University of North
University of Zaragoza, Carolina, Greensboro, NC, USA
Zaragoza, Spain



Dr. Igor Erovenko



Dr. Kalliopi Kastampolidou

Department of Informatics,
Ionian University, Corfu, Greece



**Assoc. Prof. Bruno Antonio
Pansera**

University Mediterranea of
Reggio Calabria, Reggio
Calabria, Italy



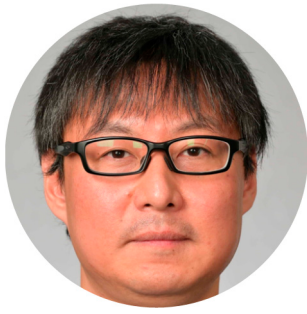
Prof. Indrajit Ray

Cardiff University, Cardiff, United
Kingdom



Prof. Russell Golman

Carnegie Mellon University,
Pittsburgh, PA, USA



Prof. Satoshi Uchida

Research Center for Ethi-Culture
Studies, RINRI Institute, High-
tech Research Center,
Kokushikan University, Tokyo,
Japan



Prof. Thomas Jeitschko

Michigan State University, East
Lansing, MI, USA



**Prof. Dr. Pedro Henrique
Triguís Schimit**

Informatics and Knowledge
Management Graduate
Program, Universidade Nove de
Julho Rua Vergueiro, São Paulo,
Brazil



Prof. Dr. Sun-Ki Chai

Department of Sociology,
University of Hawaii, Honolulu,
HI, USA

Program at a Glance

	Day 1	Day 2
Morning	Session 3. Learning, Evolution, Market Design and Auctions	Session 4. Non-Cooperative and General Game Theory
Afternoon	Session 2. Behavioral, Experimental, and Cooperative Game Theory and Bargaining	Session 1. Algorithmic, Computational and Applied Game Theory

IECGA 2025 Program

15th October 2025 (Wednesday)

Session 3. Learning, Evolution, Market Design and Auctions

Time: 9:00 (CEST, Basel) | 03:00 (EST, New York) | 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
9:00-9:10	<i>Opening Speech</i> <i>Prof. Dr. Kjell Hausken</i>	
9:10-9:20	<i>Welcome from the session chair</i> <i>Dr. Tatsuya Sasaki</i>	
9:20-9:50	Dr. Pedro Henrique Triguís Schimit Invited Speaker	Vaccination as a Game: Behavioural Dynamics, Network Effects and Policy Levers – A Comprehensive Review
9:50-10:20	Dr. Satoshi Uchida Invited Speaker	The effects of prospect theory on indirect reciprocity: from Image-Scoring to "integrated reciprocity"
10:20-10:50	Dr. Kalliopi Kastampolidou Invited Speaker	Evolutionary Games on Networks and Biological Systems: Recent Insights and Open Challenges
10:50-11:10	Yusuf Hotagua Selected Oral Speaker	Gamified Auction Systems: Enhancing Learning and Evolution in Digital Market Environments
11:10-11:30	Mohammed Salahsour Selected Oral Speaker	Perceptual Rationality
11:30-11:50	Luis R. Izquierdo Selected Oral Speaker	Repeated prisoner's dilemma with errors and option to leave
11:50-12:10	Charles Pebereau Selected Oral Speaker	None of your business! Efficient disclosure policies with heterogeneous audiences
12:10-14:00	BREAK	

Session 2. Behavioral, Experimental, and Cooperative Game Theory and Bargaining

Time: 14:00 (CEST, Basel) | 08:00 (EST, New York) | 20:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
14:00-14:10	<i>Welcome from the session chair</i> <i>Dr. Marco A. Marini</i>	
14:10-14:40	Prof. Vincent Crawford Keynote Speaker	Strategic Thinking: Theory, Evidence, and Applications Strategic thinking
14:40-15:10	Prof. Russell Golman Invited speaker	Strategic sophistication, the ability to reason iteratively about others' mental states and actions
15:10-15:40	Prof. Thomas D. Jeitschko Invited Speaker	Strategy Input Methods and Observed Behaviors: A Systematic Comparison of Manual vs. Automated Mixing in the Lab
15:40-16:10	Prof. Dr. Indrajit Ray Invited Speaker	How do bidders perceive prior probabilities?
16:10-16:30	Jan Rychtar Selected Oral Speaker	The effect of heterogeneity on vaccination decisions
16:30-16:50	Daniel Stephenson Selected Oral Speaker	Heterogeneous vulnerability and vaccination behavior: Evidence from experimental games

16th October 2025 (Thursday)

*Session 4. Non-Cooperative and General Game Theory***Time: 9:00 (CEST, Basel) | 03:00 (EST, New York) | 15:00 (CST Asia, Beijing)**

CEST Time	Speaker	Title
9:00-9:10	<i>Opening Speech Dr. Isamu Okada</i>	
9:10-9:40	Prof. Bruno Pansera Invited Speaker	Recent developments in pursuit-evasion games
9:40-10:10	Dr. Jie Zheng Keynote Speaker	Ranking with Challenge: A Multi-stage Contest Design
10:10-10:40	Prof. Dr. Sun-Ki Chai Invited Speaker	Nested Hierarchies, Span of Control, and Norms of Cooperation"
10:40-11:00	Priyanka Khosla Selected Oral Speaker	Tullock conflict with violence and asymmetric cost structures
11:00-11:20	Mrinmoy Maity Selected Oral Speaker	From Q-Learning to Quantum Models: The Evolution of Game Theory through Artificial Intelligence
11:20-11:40	Alejandro Gutiérrez-Mielgo Selected Oral Speaker	Games with Costly Endogenous Separation
11:40-12:00	Hend Ghazzai Selected Oral Speaker	More recycling to save the planet?
12:00-12:20	Fatma Zohra Daoud Selected Oral Speaker	Analysis on Fractional-order Asymmetric games with varying interaction rates
12:20-14:00	BREAK	

*Session 1. Algorithmic, Computational and Applied Game Theory***Time: 14:00 (CEST, Basel) | 08:00 (EST, New York) | 20:00 (CST Asia, Beijing)**

CEST Time	Speaker	Title
14:00-14:10	<i>Welcome from the session chair Prof. Konstantinos Serfes</i>	
14:10-14:40	Prof. Kang Hao Cheong Keynote Speaker	Winning by Losing: Unraveling the Mysteries of Parrondo's Games
14:40-15:10	Dr. Carlos Gracia Lazaro Invited Speaker	"Evolution of Cooperation: From Theory to Experimentation"
15:10-15:40	Dr. Igor Erovenko Invited Speaker	Data-driven machine learning approaches to modeling pertussis vaccine scare behavior
15:40-16:00	Alexander Rodivilov Selected Oral Speaker	Guaranteed Payoff Equilibrium
16:00-16:20	Evangelia Chalioti & Himnish Hunma Selected Oral Speaker	Mimicking Human Behavior in the Stochastic Prisoner's Dilemma

Session 1. Algorithmic, Computational and Applied Game Theory

sciforum-131009: Epistemic Equilibria at the Edge of Computability: A Multi-objective Game-Theoretic Model for Uncertainty Regulation in Generative Multi-Agent Systems

Alfonso Ernesto de la Fuente Ruiz ^{1,2}

¹ Scale.AI

² Outlier.AI

We propose a formally grounded framework for epistemic regulation, including monitoring and alignment, in multi-agent systems comprised of generative reasoning agents (e.g. Large Reasoning Models) that interact in a shared environment, modeled as a co-adaptive game between reasoning agents and an uncertain, possibly adversarial/non-stationary environment. By including diverse reasoning agents acting as higher-level players which serve as meta-agents or critics, the aim is to collectively probe and expand the limits of a shared-knowledge space. At the core of this setup lies a multi-objective optimization problem: to simultaneously minimize epistemic uncertainty, maximize agreement with a verifiable knowledge base, and avoid collapse into undecidable, divergent, or non-halting inference chains. The AI agents are heterogeneous and specialised by design, interact through strategic critique and synthesis, and converge (under bounded computability constraints) to an epistemic equilibrium, a state of stabilized, self-consistent belief formation. Internally, we model the AI inference loop as a stratified meta-reasoning architecture: queries falling within a formally decidable domain are resolved with provable certainty, while queries outside this domain (e.g., out-of-distribution or ill-posed queries) are flagged and approximated with full epistemic transparency. This design echoes the halting problem and aligns with recent ideas from co-evolutionary cognition and edge-of-chaos dynamics in AI systems. In particular, we analyze the conditions under which hallucinations (overconfident errors) propagate or dissipate in recursive AI agent networks, how strategic heterogeneity suppresses epistemic collapse, and what edge-of-chaos and co-evolutionary dynamics are at play.

The work is directly applicable to LLM red-teaming, adversarial prompting, RAG pipelines, generative agents in specific technical domains, and self-auditing AI systems. Through its technical contributions, this model serves as a tool for understanding how generative AI systems co-evolve with human epistemic norms, and offers a path towards next-generation autonomous cognitive systems that can safely self-extend their reasoning reach and reliably integrate knowledge.



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sciforum-139579: Evolutionarily Stable Strategy for Continuum Opinion Dynamics with Cost of Changing Beliefs

Louis Shuo Wang¹ and Jiguang Yu²

¹ Department of Mathematics, University of Tennessee, Knoxville, TN 37996, USA

² University College London

In today's polarized societies, individuals' opinions evolve not only through rational deliberation and peer influence, but also as a result of psychological, social, and institutional costs that inhibit belief change. We introduce a novel continuum-trait partial differential equation (PDE) model to describe how opinions evolve across two ideological axes (e.g., economic and social views), capturing both spatial and temporal dynamics in a continuous opinion space.

Our model couples diffusion, drift due to cognitive/social movement costs, and nonlocal peer competition, yielding the evolution equation. We rigorously formulate this system with Neumann boundary conditions and prove well-posedness in the appropriate Sobolev spaces. We show that the system admits a Lyapunov (free-energy) functional, and its minimizers—representing evolutionarily stable opinion states—display spontaneous segregation into polarized clusters.

Our theoretical results demonstrate that the combination of rugged cost landscapes and peer crowding effects leads to persistent opinion fragmentation. This work bridges mathematical biology and social dynamics and offers new tools for analyzing the stability and evolution of ideologically divided societies using continuum PDE methods.



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sciforum-130880: Optimizing Reward Mechanisms for Reinforcement Learning in Mahjong AI: A Hybrid Approach with Prior Knowledge Integration

Jiayang Wang ¹, Yang Xu ² and Chuangji Zeng ²

¹ Jiangxi Agriculture University

² Nanchang University

Mahjong, an imperfect information game with a state space exceeding 10^{48} , poses significant challenges for reinforcement learning (RL) due to its sparse rewards and delayed feedback. Traditional RL approaches relying solely on terminal win/loss signals often suffer from inefficient convergence and suboptimal strategy development. This study proposes a hybrid reward mechanism that integrates prior knowledge and predictive modeling to address these limitations.

The framework combines three components to provide dense, interpretable feedback. First, an instructor model based on a CNN-LSTM architecture is trained on expert gameplay data to generate auxiliary rewards by evaluating the alignment between agent actions and expert-predicted optimal moves. Data augmentation techniques, such as tile suit permutation, are employed to enhance generalization despite the limited training samples. Second, a dual-layer GRU-based global reward predictor captures long-term dependencies in the game, forecasting the winning probabilities and score dynamics to enable intermediate reward signals. Third, the hybrid reward system integrates a base reward structure—assigning +3 for wins, -1 for losses, and 0 for draws—scaled by hand using composition multipliers. Dynamic bonuses are further applied based on the consistency between the predicted and actual outcomes, while step-wise predictive rewards quantify decisions' impacts through the differences in successive value estimations.

Experimental evaluations on 10,000 2v2 Shangrao Mahjong games demonstrated the superior performance of the proposed method. Compared to supervised learning, Proximal Policy Optimization RL (PPO RL), multi-agent RL, and deep RL baselines, the hybrid mechanism achieved the highest average score of 5.68, outperforming the PPO RL baseline score of 5.24. The model reached a win rate of 26.56% with accelerated convergence, achieving a 30% win rate in 15 days versus the 35 days required by deep RL. Its strategic efficacy was validated by its maximum average win score of 15.49. By synthesizing knowledge-driven guidance and model predictive feedback, this approach effectively mitigates reward sparsity while enhancing training stability and the decision-making depth.



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sciforum-135208: A Strategic Analysis of the Rajasthan Gramin Bank Merger through Game Theory

Franshu Mahipal and Anita Rani Kamboj

Department of Mathematics, Tanta University, Sri Ganganagar, Rajasthan 335002, India

The Government of India, through an order released on April 7, 2025, approved the merger of Rajasthan Marudhara Gramin Bank (RMGB) and Baroda Rajasthan Kshetriya Gramin Bank (BRKGB), effective from May 1, 2025, forming the new Rajasthan Gramin Bank under the “One State, One RRB” initiative. Sponsored by the State Bank of India, this strategic consolidation integrated over 1,593 branches across 41 districts, combining a business volume of nearly 1 trillion rupees. This study employs game theory to examine the strategic behavior surrounding the merger, emphasizing regulatory clarity, mutual trust, and the equilibrium outcomes among stakeholders. Drawing parallels from the successful 2017 SBI merger—which led to significant profitability and digital transformation—the Rajasthan Gramin Bank merger aims to replicate these benefits by unifying financial and technological resources. A key objective is to bridge the rural-urban divide and create an inclusive digital banking ecosystem using platforms like SBI’s YONO. Early developments point to strong digital integration and adaptive human resource strategies modeled after SBI’s post-merger reforms, enabling responsive, feedback-driven decision-making. Game-theoretic simulations suggest that cooperative approaches yield the Pareto-optimal outcomes, while risks such as asymmetric asset quality and weak signaling may trigger strategic defection or inefficiencies. This research underscores the vital role of strategic consolidation and game-theoretic frameworks in shaping resilient, inclusive, and efficient rural banking systems, offering valuable insights for policymakers and financial institutions aiming to enhance stability and economic outreach.



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sciforum-131856: Algorithmic collusion under competitive design

Ivan Conjeaud

Paris School of Economics Aix-Marseille School of Economics, Paris, France

In this article, I study a model in which two companies use Q-learning algorithms to repeatedly play a game from a class including first/second price auctions, Bertrand competition and prisoner's dilemma. Previous papers have highlighted the tendency of these algorithms to behave collusively without any instruction to do so (algorithmic collusion), depending on their parameterization. Unlike previous papers in the literature, I assume that the companies are free to select the parameters for their algorithms strategically. Thus, in a first stage, the companies simultaneously select parameters for their algorithms, then in a second stage the algorithms repeatedly play the game (for example an automatized auction for advertisement spots) and the designers collect the limiting payoffs. I show that, under the (mere) assumption that the companies' machines have limited capacities, any Nash equilibrium of the aforementioned (two-stage) game features some algorithmic collusion (Theorem 1). In other terms, letting the margin of competition move to the design of the algorithms is not sufficient to avoid algorithmic collusion. In the second part, I use extensive numerical simulations to study a restriction to this model to a repeated prisoner's dilemma played by ϵ -greedy algorithms. Their results reveal the strategic role of exploration levels and how it hampers collusion in equilibrium.



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sciforum-130626: Control of Incomplete Fractional Punishment in Optional Public Goods Game

Josias Grau, Christian Emilio Schaerer and Rocio Botta

National University of Asuncion

While the free-rider problem has been studied extensively ([Botta 2013, Yamagishi 1986, Botta 2021]), this has also increased the number of theories and questions to be answered around it. One way in which the free-rider problem is modeled is through a Public Goods Game, in which contributions made to a common pool of resources by players are then scaled and distributed equally to all participants.

In this work, we focus on the "optional" variant of the Public Goods Game, where players may opt for a risk-free (yet often lower) reward instead of participating in the game. Building on [Botta 2024] and [Grau 2022], we combine fractional (targeting a subset of free-riders) and incomplete (reducing benefits while imposing fines) punishment via optimal control to enhance cooperation in the entire population. Our mechanism mirrors real-world practices and helps to save the financial amount spent on penalizing just a part of the total number of free riders while still obtaining the desired cooperation.

To tune the combined policy, we design an appropriate objective function to solve a problem of optimization with restriction, where the restriction is given by the replicator dynamics problem, including the fractional and incomplete punishment.

The findings provide policymakers with actionable insights; while stronger instantaneous punishments increase cooperation (and reduce the overall costs of punishment in the long term), they imply higher initial investments. Even though high cost can be challenging for managers, especially when free-riders make up a large part of the group, the proposed control mechanism offers a cost-effective alternative by strategically targeting only a fraction of free-riders or adjusting the fines, balancing enforcement costs with long-term cooperative outcomes.



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sciforum-140203: Evolutionary game analysis of the impact of dynamic dual credit policy and carbon tax policy on new energy vehicles

Ying Xie

15805659660

Under the dynamic dual-credit and carbon tax policies, the consumer utility function, the automobile manufacturer profit function and the evolutionary game model between the government and automobile manufacturers are constructed, and dual-credit transaction price are incorporated into the model to analyze the evolutionary stability strategy of automobile manufacturers' production decisions under the dynamic dual-credit policy and carbon tax policy. The results show that: 1) The combination of dynamic dual-credit and static carbon tax policies is optimal, and a moderate increase in the carbon tax rate is helpful to improve the enthusiasm of new energy vehicle manufacturers; 2) When the credit price is around 800 yuan, it can best improve the enthusiasm of new energy vehicle manufacturers. Both too high and too low prices are not conducive to the market role of the dual-credit policy; 3) A higher carbon tax rate is conducive to the rapid development of the new energy vehicle industry in the short term, but it is easy to cause market fluctuations.



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sciforum-142825: Guaranteed Payoff Equilibrium

Endre Csóka ¹, András Pongrácz ¹ and Alexander Rodivilov ²

¹ The Department of Combinatorics and its Applications, Alfréd Rényi Institute of Mathematics, 1053 Budapest, Hungary

² School of Business, Stevens Institute of Technology, Hoboken, NJ 07030, USA

We introduce the Guaranteed Utility Equilibrium (GUE), a strategy profile where each player secures a utility guarantee regardless of the other players' strategies, and the sum of these guarantees equals the highest achievable total utility. GUE possesses several desirable properties that the Dominant Strategy Equilibrium (DSE) lacks, such as collusion-proofness and robustness under repeated play. GUE also ensures that all Bayesian Nash Equilibria are utility-equivalent to the GUE profile. Particularly in dynamic games, GUE arises more frequently than DSE. For instance, a GUE exists in every finite two-player zero-sum game. Furthermore, a stronger version of the core result of the No-Trade Theorem is a direct consequence of the "no-trade" strategy profile constituting a GUE. Perhaps the only significant property of DSE not shared by GUE is that a GUE profile is not necessarily a DSE. For mechanism design, however, this distinction is a crucial advantage, as it allows for GUE-implementation in problems where a DSE-implementation of efficiency is impossible; the mechanism in \cite{CLRT}, for instance, is a GUE-implementation in a problem of this kind. The concept also extends naturally to an approximate version (ϵ -GUE), which is particularly useful in transfer-free mechanism design.



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sciforum-126730: Mimicking Human Behavior in the Stochastic Prisoner's Dilemma

Evangelia Chalioti and Himnish Hunma

Economics Department, Yale University, New Haven, CT, USA

Introduction: This paper studies human behavioral patterns exhibited in the Iterated Stochastic Prisoner's Dilemma and trains algorithms that replicate these patterns. We create a training framework that enables learning algorithms to capture human biases and inconsistencies observed during human play. We find that a Reinforcement Learning algorithm (Q-Learner) can emulate how human agents update their beliefs about the future, akin to pessimism and optimism, once the final form of the game is realized.

Methods: We adopt the stochastic setup introduced by Kloosterman (2020), in which human agents play an infinitely repeated game while facing uncertainty regarding the payoff matrix that is used to calculate the reward in each iteration of the dilemma. The defective probability—the probability that the payoff matrix offering lower returns to cooperation is realized—is allowed to vary. To model learning behavior, we implement a randomized, teacherless training framework applied to a Q-Learning algorithm. This approach does not require pre-existing data. Rather, the Q-Learner learns to play via cues from its environment. It is trained on over 230 Prisoner Dilemma strategies.

Results: We find that at the beginning of the game, the trained Q-Learner exhibits a cooperative majority which persists at most values of the defective probability. Flips from a cooperative to a defective majority tend to persist at higher values of the defective probability, although cooperative majorities remain the prevailing outcome. The range of defective probabilities at which the Q-learner flips to a defective majority aligns with the Grim Trigger probability at which humans exhibit the same switch in behavior in Kloosterman's experiments.

Conclusion: The value of defective probability leads players to make optimistic or pessimistic assumptions about the future, impacting their current behavior. Under high learning rates, the Q-Learner can exhibit the same behavior after following randomized training.



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sciforum-131046: On the 3-interval Ulam-Renyi game with 3 lies

Sergey Bereg

University of Texas at Dallas

We consider a variant of the classical 20 question game with lies (a.k.a. Ulam-Renyi game).

There are two players: Paul (the Questioner) and Carole (the Oracle).

Carole selects a number $x \in U = \{0, 1, \dots, 2^m - 1\}$ without revealing it to Paul.

Paul asks membership questions of the form "Is $x \in S$?" where $S \subseteq U$.

Carole's aim is to maximize the number of questions Paul must ask.

She is allowed to lie up to e times.

Paul wins if, after q questions, exactly one value of x remains possible; otherwise, Carole wins.

It is known [1] that Carole can win whenever $Q_{\min}(2^m, e) \leq q$ where

$Q_{\min}(2^m, e) = \min_{q \sim 2^{q-m}} \sum_{i=0}^e \binom{q}{i}$.

We study the k -interval Ulam-Renyi game where each query set S is the union of at most k intervals.

Recently it was shown [2] that Paul can win the game with $e=3$ lies and $k=4$ intervals using $Q_{\min}(2^m, e)$ questions for sufficiently large m .

In this paper, we show that three intervals suffice for Paul to win when $m = O(1)$.

It remains an open problem whether Paul can win using 3-interval sets for all values of m .

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sciforum-139496: Optimal feedback strategy for Dolichobrachistochrone differential game problem based on dynamic programming approach

Ghanem Aicha ¹, Bouremani Touffik ² and Benterki Djamel ¹

¹ Laboratory of Fundamental and Numerical Mathematics (LMFN), Faculty of Sciences, Ferhat Abbas University Setif 1, Setif, 19000, Algeria.

² Laboratory of Applied Mathematics (LaMA), Faculty of Technology, Ferhat Abbas University Setif 1, Setif, 19000, Algeria.

The aim of this work is to apply the dynamic programming framework developed by S. Mirica in 2004 in order to solve the classical Dolichobrachistochrone differential game, which was originally formulated by R. Isaacs in 1965, in a rigorous manner. A key objective of this study is to identify the optimal feedback strategies for the first time, which is an original contribution that enhances the theoretical landscape of differential games. These strategies offer significant benefits, including the ability to dynamically optimise the system performance, allocate resources more effectively and achieve targets efficiently. Their inherent simplicity also allows for easier implementation and analysis, contributing to reduced computational complexity.

Our method is based on a refined version of Cauchy's method of characteristics, adapted to stratified Hamilton–Jacobi equations. This technique enables the characterisation of a broad class of the optimal trajectories and helps to define the domain of existence of the value function. To demonstrate the effectiveness of the proposed feedback strategies, we apply the well-known Verification Theorem for locally Lipschitz value functions as a sufficient condition for optimality.



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sciforum-131043: Strategic Evolution in a Dual-Game Framework: An Agent-Based Model of Inequality and Cooperation

Edgardo Bucciarelli ¹ and Aurora Ascatigno ²

¹ Dept. DiSEGS, University of Chieti-Pescara, Italy

² School of Advanced Studies, University of Chieti-Pescara, Italy

Introduction

This study uses agent-based modeling to explore the effects of learning mechanisms and population scaling on inequality and cooperation within a framework combining the Ultimatum Game (UG) with the Public Goods Game (PGG). Initially, agents participate in UG sessions, where their accumulated payoffs determine their initial endowments for subsequent PGG sessions. Agent behavior—reflecting traits like fairness, selfishness, and cooperativeness—is based on experimental data from a lab-in-the-field study integrating both games. This research aims to understand how different learning dynamics and structural conditions affect strategy evolution and outcome distribution.

Methods

We conducted several agent-based simulations to replicate a real-world experimental design. In the first four simulations, 182 agents played 30 rounds of the UG followed by 30 rounds of the PGG, starting with fixed strategies and a marginal per capita return (MPCR) of 0.3. We later introduced a higher MPCR, medium-level learning, and imitative learning. A final simulation expanded the imitative learning model to 500 agents over 100 rounds. The results showed that increasing the MPCR and implementing learning mechanisms enhanced cooperation and reduced inequality in the PGG. Imitative learning notably yielded the most significant improvements.

Results

The larger final simulation, with extended interactions, resulted in the highest PGG payoffs and the lowest inequality levels. While payoffs from the UG remained stable, inequality decreased as learning fostered fairer strategies. Inferential tests highlighted significant differences in decision-making across simulations, underscoring the role of behavioral adaptation.

Conclusions

By integrating the UG with the PGG, this study clarifies how initial bargaining influences subsequent cooperation. Overall, learning mechanisms, especially imitation, and prolonged interactions promote successful strategies, encouraging fairness and enhancing cooperative outcomes.



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sciforum-131054: Turning Bribes into Lemons: an optimal mechanism

Andrew Clausen ¹ and Christopher Stapenhurst ²

¹ The University of Edinburgh

² Budapest University of Technology and Economics

Corruption requires a coalition to form and reach an agreement. Is there a cheap way to stop any agreement from being reached? We find an optimal mechanism that resembles Poker. The players' hands are synthetic asymmetric information, and they create a lemons problem in the market for bribes. Our Poker mechanism is robust: it thwarts bribes regardless of the negotiation procedure, including alternating offers bargaining, Dutch auctions, arbitration, and so on. Our mechanism's cost is inversely proportional to the number of players. So when we embed our mechanism in regulatory approval and regulatory compliance settings, we find that it is optimal to hire competing auditors to each case. In compliance cases, there is a trade-off between rewarding the agent for honesty and punishing the agent for non-compliance. This trade-off is resolved by rigging the Poker hand distribution against the agent. Our results are also pertinent to robust mechanism design and worst-case information structures.



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Session 2. Behavioral, Experimental, and Cooperative Game Theory and Bargaining

sciforum-139610: A game model for primitive economic exchange

Vikrant Kala and Anirban Ghatak

Indian Institute of Management, Kozhikode, India

This paper presents a game theoretic model of primitive economic exchange, designed to capture strategic human behavior in pre-monetary societies. The model draws on insights from evolutionary theory, anthropology, and psychology to represent fundamental behavioral dimensions such as ethicality, selfishness, and forgiveness. It provides a framework to analyze how cooperation and reciprocity, considered to be core components of economic exchange, may have evolved and stabilized in small populations.

Understanding human behavior in such environments requires a synthesis of both the sciences and the social sciences. While disciplines like history, anthropology, and psychology offer detailed empirical accounts of human behavior, fields such as evolutionary biology and ecology provide insight into the origins of and adaptive logic behind such behaviors. This model integrates these perspectives to investigate how individuals might behave under conditions where reputation management, fairness, and social exchange are necessary for survival.

The game is structured around three core behavioral axes: Ethical vs. Unethical, Selfish vs. Unselfish, and Agreeable vs. Non-Agreeable. Payoff analysis suggests that a strategy profile characterized by ethicality, selfishness, and Non-Agreeableness emerges as evolutionarily stable. This outcome highlights the importance of maintaining a reciprocal balance, meeting one's own needs, and selectively discriminating against exploiters in environments where repeat interactions are likely. In contrast, unethical or unfair strategies are only advantageous in isolated, one-shot exchanges, consistent with the literature on evolutionary games, human behavioral ecology, and anthropology.

This interdisciplinary approach offers three key contributions:

It is synthesized from underutilized but complementary theories across multiple disciplines. It models human-specific behaviors with a theoretical grounding in established fields. It produces results consistent with those of earlier game models, despite a more complex starting foundation.

Overall, the paper tries to demonstrate how evolutionarily consistent strategies for primitive exchange can be better understood through a unified model of decision-making grounded in both the natural and social sciences.



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sciforum-124148: Allais–Ellsberg Convergent Markov–Network Game

Adil Ahmad Mughal

Department of Economics, Forman Christian College University, Lahore, Pakistan

Behavioral deviations from subjective expected utility theory, most famously captured by the Allais paradox (Allais, 1953) and the Ellsberg paradox (Ellsberg, 1961), have inspired extensive theoretical and experimental research into risk and ambiguity preferences. While the existing studies (e.g., Gilboa and Schmeidler, 1989; Machina, 2009) analyze these paradoxes independently, little work explores how such heterogeneously biased agents interact in networked strategic environments. Our paper fills this gap by modeling a convergent Markov–network game between Allais-type and Ellsberg-type players, each endowed with fully enriched loss matrices that reflect their distinct probabilistic and ambiguity attitudes.

We define convergent priors as those inducing a spectral radius of 1 in iterated enriched matrices, ensuring iterative convergence under a matrix-based update rule. Players minimize their losses under these priors in each iteration, converging to an equilibrium where no further updates are feasible. We analyze this convergence under three learning regimes—homophily, heterophily, and type-neutral randomness—each defined via distinct neighborhood learning dynamics. To validate the equilibrium, we construct a risk-neutral measure by transforming losses into payoffs and derive a riskless rate of return representing players' subjective indifference to risk. This applies risk-neutral pricing logic to behavioral matrices, which is novel.

This framework unifies paradox-type decision makers within a networked Markovian environment (stochastic adjacency matrix), extending models of dynamic learning (e.g., Bala and Goyal, 1998; Golub, 2012; Gale and Kariv, 2003) and providing a novel equilibrium characterization for heterogeneous, ambiguity-averse agents in structured interactions.

Keywords: convergent priors; Markov–network game, Allais-type; Ellsberg-type



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sciforum-138956: Disclosure Policies of Nonprofit Organizations Competing for Donations

Nicole Rauch and Michael Kopel

Social and Economic Sciences (SOWI), Department for Organization and Institutional Economics University: University of Graz, Graz, 8010, Austria

This paper analyzes the strategic role of the voluntary disclosure of private information about costs or willingness to donate in the context of fundraising competition between two nonprofit organizations. We examine how the incentives to disclose change when nonprofit organizations compete for donations instead of profits and how these decisions are shaped by whether donors perceive the organizations' projects as complements or substitutes. We analyze how disclosure decisions depend on the relative usefulness of the private information for the disclosing nonprofit organization (NPO) compared to its competitor. In settings where projects are viewed as weak substitutes or complements, NPOs always disclose their private cost information. They only disclose their willingness to donate information when it is symmetrically useful, enabling coordination and therefore softening the fundraising war. In contrast, when projects are perceived as strong substitutes, disclosure occurs when the information is asymmetrically useful for an organization. We illustrate how our results relate to earlier findings in the literature. Our research bridges the gap between strategic disclosure decisions of nonprofits in donative markets and for-profits in product markets.



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sciforum-123614: Heterogeneous vulnerability and vaccination behavior: Evidence from experimental games

Daniel Stephenson, Oleg Korenok and Jan Rychtar

Department of Economics, School of Business, Richmond, VA 23230, USA

Understanding the impact of population heterogeneity on the spread of vaccine-preventable diseases is crucial for containment and control. Here, we develop an experimental game model to examine how risks from disease and vaccination shape vaccination decisions in a population with heterogeneous vulnerability. We provide a full theoretical analysis of the game including a formula for Nash equilibrium. We hypothesize that overall vaccination rates will be higher for highly transmissible diseases and amongst the most vulnerable individuals. We then perform a series of experiments to confirm that our theoretical predictions and hypotheses agree with experimental results. Our results show that participants vaccinate strategically inline with Nash equilibrium. Specifically, vaccination rates were higher among more vulnerable individuals than among those less vulnerable. Additionally, we observed minimax behavior in a subset of individuals who consistently chose the secure option (vaccination) regardless of others' actions. These findings underscore the epidemiological interdependence of vaccination decisions and the need for public health approaches that recognize the different risks and costs faced by vulnerable groups.



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sciforum-131042: Mistakes versus Preferences in Economic Games

Elif Tosun and Daniel Navarro-Martinez

Pompeu Fabra University

In this paper, we study the extent to which observed deviations from normative principles of behavior in economic games are due to mistakes that people would like to correct. To this end, we conduct two separate experiments: one in the context of prisoner's dilemma games and one in the context of public goods games. In both experiments, our participants evaluate two rules to make decisions that could be followed in such games. Rule 1 implies always implementing dominant strategies if there are any, which is arguably the strongest principle of rational behavior in game theory. Rule 2 involves implementing certain strategies that are superior in terms of payoffs for both players, allowing for more efficient outcomes. This rule can be intuitively appealing, but it does not correspond to any fundamental normative principles of game theory and can lead to violations of dominance. In this setting, participants do three things: 1) they decide whether they want to implement each rule to make decisions for them, 2) they play games with various payoffs, and 3) they are presented with all the inconsistencies between their rule preferences and their decisions in the games and are asked to reconsider them. Changes in game decisions that are made to align with Rule 1 (the normative rule) are considered indicative of mistakes. Decisions that still deviate from dominance after reconsideration are considered to be deviations due to preferences. In prisoner's dilemma games, 31% of the initial choices violate dominance, and mistakes account for 21% of these deviations. In public goods games, 77% of the initial choices violate dominance, and mistakes account for 4% of them. While a small proportion of deviations from normative behavior can be explained by mistakes, the majority cannot, suggesting that systematic behavioral principles primarily drive deviations from the normative standard.



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sciforum-130268: Modeling Denialism as an Epistemic Game: Trust, Misinformation, and Strategic Ignorance

Laida Arbizu Aguirre

Department of Philosophy, University of the Basque Country (UPV/EHU)

Denialism—the consistent dismissal of solid evidence or widespread agreement—represents a substantial obstacle to public discussions, scientific advancement, and shared decision-making. Although frequently viewed as an issue of misinformation or irrational behavior, this paper contends that denialism can be more effectively examined using the framework of epistemic game theory. Within this framework, the decisions of agents rely not solely on their own preferences but importantly on their perceptions of others' knowledge, rationality, and probable behaviors. Denialists, specialists, and broader society engage in a complicated strategic landscape influenced by belief systems, information imbalances, and the presence or absence of a shared understanding. Denialism arises and persists not only due to ignorance but also as a logical reaction to perceived doubts regarding the reliability of information sources, the dependability of experts, and the convictions of others. Modeling these interactions as epistemic games allows for a formal analysis of how disruptions in common knowledge and changes in belief systems sustain denialist tactics, despite substantial evidence. This method highlights the philosophical aspects of denialism—posing inquiries regarding rationality, trust, and the essence of public reasoning—and indicates that successful interventions should address not only gaps in information but also the profound epistemic factors that influence collective belief construction and opposition to evidence.



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sciforum-105747: Negotiating Forest Rights Debates: A Game Theoretic Analysis of Stakeholder Behavior in the Western Himalayas

Aanchal Seth

aanchal seth research scholar punjab university chandigarh India

This study employs Cooperative, Behavioral, and Experimental game theory to examine how forest rights are negotiated among tribal communities, government agencies, and civil society organizations in the western Himalayas. It explores how claims over access, governance, and benefit-sharing regarding forest resources are asserted, contested, and mediated in a complex socio-political environment.

Cooperative game theory is used to model alliance-building and bargaining dynamics, shedding light on how stakeholders form coalitions and negotiate distributive outcomes. Behavioral game theory provides insight into how cognitive biases, cultural values, and perceptions of legitimacy influence real-world decision-making. Experimental game theory is applied to simulate institutional scenarios, testing how variations in governance structures and policy design shape patterns of cooperation or conflict.

This research adopts a mixed-methods approach. Qualitative data from in-depth interviews and focus group discussions captures stakeholder motivations, strategic reasoning, and the cultural framing of forest rights. Quantitative data from structured surveys and field-based experiments enables the modeling of negotiation outcomes and the empirical testing of policy interventions.

The findings underscore the importance of integrating traditional knowledge systems with modern development policies. This study emphasizes the need for sustainable and inclusive strategies that protect both the environment and local livelihoods. By offering a nuanced understanding of how strategic interactions shape the outcomes of forest rights debates, this research provides a framework that can be adapted to similar environmental and developmental challenges in other regions.



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sciforum-120370: Partially Observable Stochastic Game for Psychosis Prevention

Evangelos D Spyrou ^{1,2}, Vassilios Kappatos ² and Chrysostomos Stylios ³

¹ Department of Informatics and Telecommunications, University of Ioannina

² Hellenic Institute of Transport, Centre for Research and Technology Hellas

³ Industrial Systems Institute, Athena Research Centre

Background: Psychosis is a severe mental health condition requiring continuous monitoring and timely interventions. Traditional approaches often fail to adapt to real-time fluctuations in a patient's mental state, limiting their effectiveness. This study introduces a Partially Observable Stochastic Game (POSG) framework to model interactions among key stakeholders, including patients, caregivers, healthcare professionals, and external observers. By incorporating multi-agent decision-making and belief-driven strategies, the model aims to improve psychosis prevention and patient stability. **Methods:** The proposed POSG model represents the patient's mental state as healthy, at risk, or psychotic. Stakeholders select actions such as therapy, medication, or passive monitoring based on noisy observations. Bayesian inference updates belief states, ensuring informed decision-making. A reward system quantifies intervention effectiveness, while a Nash equilibrium ensures optimal strategic interactions. Reinforcement learning (RL) refines policies over time, enabling adaptive decision-making. The model integrates dynamic feedback loops, allowing stakeholders to adjust strategies based on observed patient responses, fostering personalized and effective interventions. **Results:** Simulation results indicate that multi-agent interactions and belief-based strategies enhance patient stability. By dynamically refining strategies, stakeholders reduce unnecessary interventions while improving recovery outcomes. The model demonstrates that coordinated decision-making among multiple stakeholders leads to more stable and predictable intervention success. **Conclusions:** The POSG framework offers a structured and adaptive approach to psychosis prevention, optimizing intervention effectiveness through multi-agent coordination. The results suggest that AI-driven mental health monitoring can pave the way for more personalized and proactive interventions, reducing the burden of psychosis on individuals and healthcare systems. This study highlights the potential of game-theoretic models in mental health applications, contributing to the development of data-driven intervention techniques.



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sciforum-142994: Player profiles in the gamification of engineering education: statistical analysis

Pablo Fernández-Arias, Diego Vergara, Antonio del Bosque and Álvaro Antón-Sancho

Technology, Instruction and Design in Engineering and Education Research Group (TiDEE.rg), Catholic University of Ávila, C/Canteros, s/n, 05005 Ávila, Spain

The incorporation of digital learning environments in higher education has driven the development of innovative methodological strategies, such as gamification, aimed at computer-assisted learning. The effectiveness of gamification is conditioned by the adaptation of the methodology to the player's profile, for which Bartle's taxonomy of player types distinguishes four profiles: Explorer, Killer, Socializer, and Achiever. This quantitative study analyzes both the distribution of player profiles among engineering faculty and their perceptions regarding the most suitable profile for learning. Additionally, sociological and academic factors influencing the selection of these profiles are examined. The sample size is 532 engineering professors, and a descriptive and inferential analysis was conducted on the answers of those who participated in a training course on gamification in digital environments and answered a questionnaire developed by the authors. The principal findings indicate that most professors identify with the Explorer profile, which is also considered the most suitable for learning, although a discrepancy is observed between one's own profile and the preference for the most effective profile. Furthermore, the predominant profile among professors differs from the one most attributed to students in the literature, which is the Achiever. Significant differences were also identified according to gender, age, teaching experience, and university tenure. Based on these results, it is recommended that universities strengthen faculty training in the design of personalized game-based learning environments, considering the detected sociological and academic differences.



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sciforum-131036: Putting negotiation in context: The US vs. Japan

Elif Tosun ¹, Daniel Navarro-Martinez ¹ and Shohei Yamamoto ²

¹ Pompeu Fabra University

² Rikkyo University

We study the extent to which cultural differences in bargaining behavior are context-dependent. In an online experiment, we examine bargaining behavior in the US and Japan using the ultimatum game, questionnaire items, and multiple contextualized scenarios. Our participants were presented with two general questions about negotiation behavior, one about the tendency to negotiate and another about the level of aggressiveness in negotiations. They also played the ultimatum game, making two decisions, one as the proposer and one as the responder. Finally, they responded to questions about 13 different real-life negotiation scenarios, indicating whether they would try to negotiate or not, and in 7 scenarios stating what their proposal to the other party would be. The participants also indicated how frequent each of the negotiation scenarios was in their environment. We found significant cross-country differences in willingness to negotiate in 6 out of the 13 scenarios. In half of these cases, the Americans were more willing to negotiate; in the other half, the Japanese were more willing. We also found significant differences in the level of the proposals to the other party in two out of seven scenarios. Similarly, in one of these cases, the proposals of the Americans were higher, while in the other the Japanese proposed higher amounts. Our analyses show that the differences in negotiation behavior can be partly explained by how frequent the negotiation scenarios are in the participants' environment. Across the two countries, the questionnaire measure of the general tendency to negotiate highly correlated with the willingness to negotiate in the real-life scenarios. Moreover, our measure of the level of aggressiveness in negotiations significantly correlated with the level of the proposals made in the scenarios. On the contrary, we did not find significant correlations between the ultimatum game behaviors and the responses to the scenarios.



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sciforum-130944: Relaxing Participation Constraints in Cooperative Game Approach to Village–Company Agreements

Mekdad Slime

Laboratory of Mathematical, Statistics and Application, Faculty of Sciences, Mohammed V University in Rabat, Morocco.

This study builds upon a cooperative game framework based on the Cartesian product of two sets, as introduced by M. Slime et al., by proposing a more flexible participation model. In one of their previous studies published in 2024, the authors assumed that all players must participate simultaneously in both games. Here, we relax this constraint by allowing each player to independently decide whether to participate in one, both, or neither of the games. This generalization better reflects real-world situations in multi-agent systems, such as service provision agreements involving agents with differing preferences or capabilities.

We redefine coalition structures and the associated payoff functions within this extended framework and investigate how classical solution concepts—specifically the core and the Shapley value—can be adapted to this setting. While the relaxation introduces additional complexity to the analysis, it enables a richer and more inclusive model of partial cooperation. An illustrative example is provided, and conditions are identified under which desirable properties are achieved.



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sciforum-128971: Research and application of incomplete information game opponent modeling based on deep learning and game tree

Jiayang Wang ¹, Zhipeng Hu ² and Jiahao Wang ²

¹ Jiangxi Agriculture University

² School of Software, Jiangxi Agricultural University, Nanchang 330045, China

Game theory is widely present in various fields of life and can be divided into complete and incomplete information games. Incomplete information games are difficult to solve due to information uncertainty. Although artificial intelligence has made remarkable achievements in the field of complete information games, its progress in incomplete information games remains limited. Mahjong, as a typical incomplete information game, has interested many researchers; however, current Mahjong AI still faces numerous challenges and struggles to effectively handle information uncertainty and complex decision-making problems.

This paper proposes a novel neural network, MJ-Net, which integrates ResNet-CBAM, LSTM, and attention mechanisms to construct an opponent model for Mahjong games. Based on MJ-Net, a residual tile prediction model (for the available tiles in the current field) and a fan-type prediction model (for the possible information on the opponent's hand) are developed. By perceiving changes in the game state and sequences of opponent actions, these models dynamically reassess tile-drawing probabilities and opponents' potential hand information to optimize expected decision values.

Additionally, leveraging domain knowledge and opponent modeling, a defense model is constructed to capture opponents' strategic information, enabling the prediction of their possible actions and fan types. This allows for dynamic adjustment of strategies to reduce risks and increase returns. Finally, a hybrid decision-making framework is established by integrating the game tree with the opponent model and the defense model derived from it. This composite framework optimizes the game tree's search strategy, path evaluation, and pruning, thereby improving the overall decision quality and achieving a balance between offense and defense.

Experimental results demonstrate that MJ-Net performs effectively in hidden information prediction, significantly improving the accuracy of residual tile and fan-type predictions. The decision-making system built upon MJ-Net enhances winning rates and strengthens defensive capabilities in Mahjong games, achieving a balance between defense and offense.



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sciforum-129011: Search While You Bargain: Tightness-Dependent Surplus Shares in Labour Markets

Tuna Dökmeci

Department of Economics, European University Institute

Introduction: Canonical search-and-matching models determine wages by imposing fixed Nash weights that are interpreted as bargaining power and treated as exogenous. I propose a tractable model in which workers and firms may keep prospecting for alternative matches while they negotiate. The key mechanism is straightforward: a party exits the current match only if its previous offer was rejected and it subsequently meets a new potential partner. I impose this rule in a benchmark set-up and later endogenise it in the full model. This feature, first imposed and later endogenised, generates surplus shares that move with market tightness and, to my knowledge, is the first bargaining model in matching markets that does so.

Methods: The model embeds Rubinstein bargaining in a matching market with tightness θ , defined as the ratio of vacancies over unemployed. Workers find jobs at rate $p(\theta)$ (strictly increasing), while firms fill vacancies at rate $q(\theta)$ (strictly decreasing). In the benchmark variant the firm proposes first and a proposer does not search within the same period; these restrictions deliver closed-form solutions that make the mechanism transparent. All assumptions are relaxed in the full game.

Results: The ratio of worker surplus over firm surplus is given by

$$\beta(\theta) = (1 - q(\theta)) / (2 - q(\theta))$$

so the worker's surplus share grows monotonically in θ . Intuitively, a tighter market raises the probability the worker can answer with a counter-offer before being deserted, increasing the bargaining power. When move order and exit decisions are endogenised, a unique subgame-perfect equilibrium survives and the positive sign of $\partial\beta/\partial\theta > 0$ persists under reasonable parameter values.

Conclusions: By linking surplus division directly to market tightness, the protocol results in a tractable, game-theoretic foundation for variable and asymmetric bargaining power inside matching markets and opens new ground for analysing wage dynamics and other two-sided negotiations.



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sciforum-131086: Sex Differences in Cooperation and Costly Punishment under High Emotional Stress: An Experimental Study

Victoria V. Rostovtseva ¹, Anna A. Mezentseva ², Emil R. Imameev ^{2,3} and Yaroslav O. Sizov ²

¹ Center of Anthropoloeology, Institute of Ethnology and Anthropology RAS, Moscow 119334, Russia

² Center of Cross-Cultural Psychology and Human Ethology, Institute of Ethnology and Anthropology RAS, Moscow 119334, Russia

³ Faculty of Biology, Lomonosov Moscow State University, Moscow 119234, Russia

Introduction: Prosocial behavior, a cornerstone of human nature, has been extensively studied for over a century due to its key role in our species's evolution. Emotions are central to fostering cooperation and regulating prosocial actions. This study investigates the emotional component of economic behavior and sex differences in decision-making under high emotional stress.

Methods: We conducted an experiment in Moscow (N=172) using four economic games with real monetary payoffs: a Trust Game (TG), Prosocial Punishment Game (PPG), Prisoner's Dilemma (PD), Ultimatum Game (UG). One-shot decisions were made sequentially in each game. The participants interacted face-to-face with an interaction partner ("actor") of the same sex across all four games. The actors made decisions according to an identical scheme, independent of the participants' decisions. Specifically, in the initial TG, all the participants who trusted their partner ("actor") lost all their funds due to their partner's selfish decision.

Results: Most participants hesitated to impose a costly punishment for selfish behavior. However, 34.4% were willing to apply a costly punishment and confront an unfair partner directly, whereas 16.6% employed an extremely punishing strategy, spending all their available funds to completely eliminate the selfish partner's capital. Women were more likely to employ prosocial punishment than men. In the PD, 66.3% of women defected, given earlier unfair behavior by their partner, while 53.1% of men still cooperated. Women who had used extreme prosocial punishment in the PPG were more prone to offering equal splits in the UG, a behavioral pattern not observed in men. All the effects discussed were statistically significant.

Conclusions: Our study indicates that modern Moscow youth exhibit sex-specific responses to the emotional aspects of economic interactions, in particular, when confronting selfish or unfair behavior. Women exhibited heightened sensitivity to the negative emotions elicited by unfair actions. Women also demonstrated a potential connection between emotions triggered by selfish behavior and an individual's sense of fairness.



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sciforum-130340: Stochastic punishment by authorized third parties in a public goods game: the role of reputation-based migration

Geyang Chen

Department of Sociology, Jeonbuk National University;(post code : 54896) 567 Baekje-daero, Deokjin-gu, Jeonju-si, Jeollabuk-do, Republic of Korea

This paper examines how delegating a third-party punishment can sustain cooperation in large-scale, mobile societies facing public goods dilemmas. Specifically, we explore how the effectiveness of delegated punishment changes in more realistic scenarios (e.g., free-riders are not equally likely to be punished)—when the sanctions are neither certain nor immediate. Additionally, we examine whether informal sanctions, such as reputation-based "voting with one's feet", can complement or substitute formal punishment mechanisms in promoting and maintaining cooperation, especially in the presence of mutant defectors.

We propose an agent-based model of authorized third-party punishment that is non-deterministic and non-immediate in unstructured populations (e.g., during the Great Migration). Three types of players—unconditional cooperators, unconditional defectors, and conditional cooperators—are matched in a one-shot public goods game, after which point their contributions are mapped onto reputation scores that accumulate continuously up to a fixed upper bound. The reputation scores guide players' movements and determine the intensity of the punishment they receive. Agents update their strategies via payoff-based imitation to capture social learning dynamics. We assess the cooperation across scenarios defined by three factors—punishment type (none/deterministic/stochastic), migration rule (random vs. voting with one's feet), and mutation status (presence vs. absence).

The experimental results demonstrate that reputation-based "voting with one's feet" migration significantly enhances the cooperators' spatial clustering and survival probability. This spatial clustering reduces the enforcement burden on third-party punishers, making it easier to sustain cooperation than under a random migration scenario. However, in the absence of any punishment, cooperation collapses rapidly regardless of migration mode. Without mutation, deterministic punishment maintains higher average contributions under both random and reputation-based migration. But under the reputation-based "voting with one's feet" scenario, once mutation is introduced, deterministic punishment exhibits a lower tolerance for internal variations within the core cluster than that under stochastic punishment, causing the cooperation to collapse to a low level.



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sciforum-139825: Strategic Behavior and Cooperative Reasoning in Team-Based Math Competitions: An Experimental Approach to Game Theory in Education

Alfonso Filippone ^{1,2}, Umberto Barbieri ¹, Maria Ermelinda De Carlo ¹ and Raffaele Di Fuccio ¹

¹ Department of Educational and Sport Science, Pegaso University, Italy

² Department of Humanities. Arts, Cultural Heritage, Education, University of Foggia, Italy

This exploratory study aims at investigating the decision-making processes, strategic behaviors, and cooperation dynamics that emerge among lower secondary school students engaged in a team-based math competition. The study takes place within a simulated setting of the "Kangourou della Matematica" contest, allowing systematic observation of how students manage problem-solving, assume roles, make decisions under pressure, and interact within cooperative learning environments.

The sample consists of 20 school teams (80 students; average age: 12). The methodology includes a strategic reasoning test, a risk propensity scale, and a short-form personality questionnaire (Big Five) administered in the pre-competition phase. During the contest, an observational grid is completed by teachers or researchers. After the activity, each group fills in a self-assessment form, and each student responds to a questionnaire on their perceived role and the strategies used during the competition.

Data analysis combines quantitative and qualitative approaches: descriptive statistics, principal component analysis (PCA), cluster analysis, and thematic coding of open responses. Preliminary results reveal distinct strategic and behavioural profiles. The comparison between theoretical models and observed behaviours highlights both alignments and discrepancies, emphasizing the influence of relational dynamics, emotional factors, and time pressure in shaping students' strategic decisions.

This study proposes an integrated and replicable framework for observing and analyzing peer-based strategic interactions in educational contexts. It offers valuable insights for designing didactic interventions that foster intentional strategic thinking and promote reflective, collaborative learning practices in schools.



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sciforum-123624: The effect of heterogeneity on vaccination decisions

Jan Rychtar ¹, Dewey Taylor ², Oyita Udiani ², Daniel Stephenson ³, Oleg Korenok ³, Guillermo Alvarez-Pardo ⁴ and Hyunju Oh ⁵

¹ Virginia Commonwealth University

² Department of Mathematics and Applied Mathematics, Virginia Commonwealth University, Richmond, VA 23284, USA

³ School of Business, Virginia Commonwealth University, Richmond, VA 23284, USA

⁴ Mathematics Department, Cuesta College, San Luis Obispo, CA 93405, USA

⁵ Division of Mathematics and Computer Science, University of Guam, Mangilao, GU 96923, USA

Vaccination game theory typically assumes homogeneous populations. In this paper, we develop and solve a vaccination game for an infinite population of agents with non-homogeneous preferences. We assume that agents may vary in how susceptible they are to the disease and how they perceive the cost of the disease and cost of the vaccination, and they may also vary in how they perceive vaccine effectiveness. We encode this heterogeneity by a quantile function describing the distribution of the net relative vaccination cost and give an explicit formula for the Nash equilibrium of the game. We show how this theory can be applied to real-world data and we compare our method to its homogeneous counterpart. We observe that overall, our method outperforms the homogeneous method; the difference in the performance is especially striking when only a small number of survey results are available. Overall, our method is also more robust and provides smaller prediction errors.



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sciforum-139770: The Power of Stories: Narrative Priming in Multi-Agent Networked Public Goods Games

Gerrit Großmann ¹, Larisa Ivanova ^{1,2}, Sai Leela Poduru ^{1,3}, Mohaddeseh Tabrizian ^{1,3}, Islam Mesabab ¹, David Selby ¹ and Sebastian Vollmer ^{1,3}

¹ Department of Data Science and Its Applications, German Research Center for Artificial Intelligence (DFKI)

² Department of Language Science and Technology, Saarland University

³ Department of Computer Science, University of Kaiserslautern-Landau (RPTU)

Research suggests that large-scale human cooperation is driven by shared narratives that encode common beliefs and values. This study explored whether such narratives can similarly nudge large language model (LLM) agents toward collaboration through a (networked) finitely repeated public goods game after priming them with different stories.

Our method employed LLM agents playing repeated networked public goods games characterized by collective optimality, individual incentives, and iterative adaptation properties. We implemented two complementary variants: single-pool experiments used one shared pool to test the scaling effects across group sizes and robustness to defection, while multi-pool experiments introduced strategic complexity through overlapping pools. We manipulated the behavioral homogeneity through narrative priming, where agents received a story-based behavioral context via system prompts. The story corpus comprised eight cooperation-themed narratives emphasizing teamwork and collective benefits, plus four control conditions. Depending on the experimental condition, the agents either received identical stories (homogeneous condition) or randomly sampled distinct stories (heterogeneous condition).

The results demonstrate that story-based priming affects collaboration. Common stories improved collaboration and benefited all the participants, while priming using different stories reversed this effect, favoring self-interested agents. In homogeneous groups, using cooperation-themed stories achieved near-perfect collaboration scores, significantly outperforming the baseline controls. In heterogeneous groups, self-interested agents achieved the highest cumulative payoffs while cooperation-primed agents obtained the lowest returns. These patterns persisted across network sizes and structures in both single-pool and multi-pool architectures.

The findings reveal that narrative coherence among agents influences the viability of cooperation, with implications for multi-agent coordination and AI alignment in networked environments.

The code is available at <https://github.com/storyagents25/story-agents>.



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Session 3. Learning, Evolution, Market Design and Auctions

sciforum-121265: None of your business! Efficient disclosure policies with heterogeneous audiences

Charles Pebereau

Toulouse School of Economics

This paper studies the efficient disclosure of performance information by a principal about an agent who has career concerns vis-à-vis heterogeneous employers. We consider a two-period model with career concerns la Holmstrom (1999) where, in the second period, employers hire for jobs more or less similar to the job the agent is evaluated for and thus value information differently. The principal trades off effort incentives and the agent's welfare, and does not internalize the audiences' payoffs. In equilibrium, the principal discloses information differentially and information structures are non-decreasing in job similarity. Setting high evaluation standards for less similar jobs is only efficient for incentivizing high effort. The results are robust to imperfect competition between effort-maximizing principals and generalize to setups with fixed or output-contingent transfers. The model can rationalize laws differentially restricting access to worker and consumer personal data, such as criminal records or credit scores, and inform debates regarding privacy protection.



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sciforum-139605: Assessment of Collaborative Problem-Solving Competencies in Engineering Through Cooperative Game Theory

Partha Protim Borthakur, Pranjal Sarmah and Keshab Biswakarma

Mechanical Engineering Department, Dibrugarh University, Dibrugarh, Assam, India, Pin: 786004

Introduction:

The integration of Cooperative Game Theory (CGT) into engineering education has increasingly emerged as a transformative approach to assessing collaborative problem-solving (CPS) competencies. Unlike traditional individual-based assessments, CGT fosters a cooperative learning environment by aligning individual incentives with collective goals, thereby promoting communication, critical thinking, and teamwork among students.

Methods:

This study explores the application of CGT-based evaluation models—such as CoGame and the Cobb–Douglas framework—within undergraduate engineering courses. A range of gamified tools, including intergroup competitions, commercial board games (e.g., Pandemic), and simulation-based activities, were implemented to measure CPS behaviors. Quantitative models were employed to track student engagement, individual contributions, and team dynamics, while reflective tools such as peer assessments and learning journals were used to validate learning outcomes.

Results

The findings indicate that CGT-based assessments significantly improve academic performance and student engagement. Participants demonstrated enhanced CPS skills, particularly in task planning, communication, and collaborative execution. Behavioral indicators derived from gameplay data enabled real-time monitoring of group interaction and revealed the value of balancing individual and group evaluation. Notably, students exposed to gamified learning environments reported higher motivation and lower performance anxiety compared to those in traditional settings.

Conclusions:

Cooperative Game Theory provides a robust and flexible framework for evaluating collaborative problem-solving in engineering education. Its practical application not only enhances technical and soft skills but also supports fairer, more interactive assessment methods. While challenges remain in implementation and design complexity, CGT offers a promising pathway for cultivating essential 21st-century engineering competencies.



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sciforum-130667: Evolutionary Game Modeling of Collusion in Public Procurement

Juan Camilo Lesmes ¹, Christian E Schaerer ² and Rocio Botta ²

¹ Rosario University, Bogotá, Colombia

² Polytechnic School, National University of Asuncion, San Lorenzo, Paraguay.

Collusion and corruption in public procurement undermine competition, inflate contract prices, distort the allocation of public resources, and reduce the social value of awarded projects. These practices pose persistent regulatory challenges, especially in institutional contexts where enforcement is imperfect and agent behavior evolves over time.

We propose an evolutionary game model using replicator dynamics, in which three types of agents interact within the procurement process: the contracting authority, the bidders, and the regulatory agency. Each agent has two available strategies and seeks to maximize its payoff, which depends on its own decisions and those of the other agents. In our setup, bidders may engage in collusive behavior, and the contracting authority may act corruptly, capturing real-world scenarios such as bid rigging facilitated by bribery or informal agreements.

Evolutionary game theory provides a dynamic framework to study how strategies like collusion and corruption emerge and persist in populations of boundedly rational agents. Unlike static equilibrium models, it captures adaptive behavior through imitation and selection processes, without assuming full information or perfect foresight. This makes it particularly suitable for analyzing regulatory environments where incentives, sanctions, and behaviors evolve jointly.

The model parameters reflect the benefits, costs, and potential sanctions associated with each strategic combination, representing the institutional trade-offs faced by agents in diverse settings. We conduct a stability analysis of the system, characterize the eight pure-strategy equilibrium points, and explore dynamic trajectories through simulations under various relevant parameter configurations, allowing us to examine the evolution of strategies over time.

The results provide insights into how the interaction between collusion and corruption shapes procurement outcomes and inform the design of regulatory policies aimed at fostering more transparent and efficient environments.



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sciforum-139737: Gamified Auction Systems: Enhancing Learning and Evolution in Digital Market Environments

Yusuf Hotagua

Accounting and Finance, Njala University Bo campus, Sierra Leone

Abstract

This paper explores the intersection of game theory, evolutionary learning, and auction-based market design in digital environments. With the rapid expansion of e-commerce, NFTs, and decentralized finance platforms, auction systems have evolved from traditional formats into dynamic, gamified models that impact participant behavior and market efficiency. We analyze how learning algorithms embedded in auction games can simulate evolutionary behavior, leading to optimized bidding strategies and fairer market outcomes.

Drawing on experimental game simulations and real-world data from online auctions, we assess the effectiveness of various gamified features such as reputation systems, adaptive pricing, and incentive-driven participation in shaping user engagement and learning curves. The study also examines the implications of market design choices on long-term user behavior, particularly in environments where asymmetric information and strategic adaptation are prevalent. By blending behavioral economics with artificial intelligence and auction theory, the paper offers new insights into how digital auction platforms can be engineered to promote transparency, trust, and sustainability. These findings contribute to the design of next-generation online markets where learning and evolution are not by-products but central to user experience and economic efficiency.



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sciforum-126930: Perceptual Rationality

Mohammad Salahshour ^{1,2,3}

¹ Max Planck Institute of Animal Behavior, Konstanz, Germany

² Department of Biology, University of Konstanz, Konstanz, Germany

³ Centre for the Advanced Study of Collective Behavior, University of Konstanz, Konstanz, Germany

Background and Objectives

Traditional evolutionary game theory has relied on bounded rationality. While this approach has led to important insights, it has often neglected the fact that individuals' decisions are shaped by their perception. We propose a perceptual rationality framework in which the agents are rational and play the Nash equilibrium of their game, however, based on their evolvable perception of the game payoffs and possibly on socially acquired information. We apply this to public goods games to explore how evolving perceptions and social learning drive the emergence of cooperation, diversity, and consistent personality traits.

Methods

In N-player public goods games (with the group size g), each agent evolves personal cost and benefit perceptions and plays the Nash equilibrium of the game. Equally, an evolvable social trait weights the private and group-averaged perception. We perform evolutionary simulations in both well-mixed and lattice-structured populations and use replicator-mutator dynamics and an evolutionary stability analysis to gain theoretical insights.

Results

Without social learning, cooperation requires the enhancement factor $r > g$. Introducing social susceptibility fosters the cooperation at a lower r , especially for networks. Even simple games yield power-law distributions of the perceived benefit-to-cost ratios (exponent ≈ -2), and social learning amplifies the perceptual and social diversity. Agents with prosocial private perceptions become more social, while antisocial perceptions correlate with individualism—showing consistency in emergent personalities. No pure evolutionarily stable strategy exists in the binary model; instead, polymorphic cyclic dynamics emerge via complementary roles (conditional cooperators, defectors, randomizers). High perceptual/social diversity can hinder the cooperation under strong dilemmas but enhance it when the dilemmas weaken; models with a single evolvable perceptual trait achieve higher cooperation. Stochastic multiplicative processes reproduce macroecological laws (species lifespans ~ -2 , abundance ~ -2.5 , Taylor's exponent ~ 1 , $1/f$ spectral scaling), and evolving sociality shifts these exponents, linking the social structure to biodiversity patterns.

Conclusions

Perceptual rationality unifies rational decision-making with evolvable perception and social learning, explaining cooperation, power-law diversity, consistent personalities, and macroecological patterns in a single framework.



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sciforum-127122: Repeated prisoner's dilemma with errors and option to leave

Luis R. Izquierdo ¹, Segismundo S. Izquierdo ² and Robert Boyd ³

¹ Department of Management Engineering, Universidad de Burgos, 09001 Burgos, Spain

² Department of Industrial Organization and BioEcoUVa, Universidad de Valladolid, 47011 Valladolid, Spain

³ Arizona State University School of Human Evolution and Social Change, Arizona State University, Tempe, AZ 85281, USA

We study a population of players who are coupled up to play a repeated prisoner's dilemma, with the possibility of making errors in the implementation of their strategies. The partnerships may be broken due to external factors (exogenous separation) or because one of the partners decides to leave (endogenous separation). Players who separate and go solo are randomly matched with another single player and keep on playing the game with their new partner.

Strategies in this setting map the histories of play within the partnership to one of the following actions: Cooperate, Defect or leave. We focus on memory-1 strategies, which are strategies in which players condition their actions on the outcome of their last interaction with their partner. Some examples are Tit-For-Tat, Win-Stay-Lose-Shift, Grim and AllD. With the option to leave, there are 162 memory-1 strategies, since one must decide on their initial action in a new partnership (Cooperate or Defect) and what to do (Cooperate, Defect or leave) after each of the four possible outcomes in the game. Consequently, there are $2 \times 3^4 = 162$ strategies.

We consider an evolutionary setting where players occasionally revise their strategies. When revising them, players preferentially switch to strategies that are performing well, and they may also try new ones (experimentation).

We study the levels of cooperation and the success of each strategy, and we compare models with and without the option to leave. With low probabilities of an exogenous breakup, cooperation is significantly greater and more robust with the option to leave than without it. Furthermore, classical strategies that support cooperation in the repeated prisoner's dilemma without the option to leave do not fare well when players are allowed to leave their partner: with moderate probabilities of error and experimentation, classical strategies—which do not include leaving—are basically wiped out in the population.



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Session 4. Non-Cooperative and General Game Theory

sciforum-130799: From Q-Learning to Quantum Models: The Evolution of Game Theory through Artificial Intelligence

Mrinmoy Maity and Subrata Mahanty

Sanaka Educational Trust's Group of Institutions, Durgapur 713212, India

The convergence of artificial intelligence (AI) and game theory has opened up transformative possibilities regarding how systems adapt and interact in dynamic strategic environments. This paper presents a comprehensive summary of current developments where deep learning, reinforcement learning, and optimization algorithms have redefined traditional game-theoretic models. AI has now enabled adaptive decision-making in both competitive and cooperative scenarios, such as cybersecurity and autonomous driving, by combining knowledge from neural-network-based strategy formulation and multi-agent reinforcement learning. Special focus is employed with regard to the implementation of deep Q-networks and Q-learning, which allow agents to create ideal strategies through iterative self-learning in uncertain and complex situations. This study also highlights the ethical concerns, transparency, and bias present in strategies created by AI. By conducting algorithmic evaluations using tools such as TensorFlow and OpenAI Gym, the practical feasibility of these methods has been proven in various game scenarios. Despite challenges in scalability, interpretability, and incomplete information, the results confirm that AI methods not only enhance strategic modeling but also push the boundaries of what autonomous systems can achieve in interactive decision-making. This paper aims to contribute a combined understanding of how AI is revolutionizing game theory and outlines future research directions involving hybrid learning models, self-organizing systems, and quantum strategies, for more intelligent, ethical, and effective game-based decision systems.



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sciforum-139506: Analysis on Fractional-order Asymmetric games with varying interaction rates

Fatma zohra Daoud

Department of mathematics university of tiaret Algeria, Algeria

Introduction:

Complex adaptive systems (CASs) consist of interacting adaptive agents whose collective behavior leads to emergent properties not found in individual components and not caused by external forces. Examples include the brain, immune system, and economy. Understanding such systems requires a holistic approach rather than traditional reductionism. Due to their memory and nonlocal behavior, fractional differential equations are well-suited for modeling CASs. However, studies on fractional-order CASs remain limited. In this paper, we investigate the existence, uniqueness, equilibrium points, and uniform stability of fractional-order differential equations in games with non-uniform interaction rates.

Method and results: Let f_i exist and be bounded on D . Condition (2) implies that the functions f_i satisfy the Lipschitz condition where α_i and β_i .

Theorem 1: (Existence and uniqueness) Let the assumptions (1)-(2) be satisfied. Then, the initial value problem has a unique solution.

Theorem 2: (Games with non-uniform interaction rates) Let α_i . Then, the initial value problem has a unique solution.

Theorem 3: (Asymmetric games) The initial value problem with the initial data ϕ_i has a unique solution.

Conclusion: The results confirm solution reliability for diverse fractional game models with complex interaction structures.



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sciforum-136759: Coordinating the pharmaceutical supply chain with a two-invoice mechanism: A differential game approach

Jun Wu ¹, Meng Wang ¹, Lijuan Ding ¹, Jiqin Ren ¹ and Ernesto D. R. Santibanez Gonzalez ²

¹ School of Economics and Management, Beijing University of Chemical Technology, Beijing 100029, China

² Department of Industrial Engineering, University of Talca, Curicó, Chile

Introduction: It is well known that the pharmaceutical industry is crucial to human health as well as social well-being. This paper uses a differential game approach to investigate coordination strategies in China's pharmaceutical supply chain under a two-invoice mechanism.

Methods: Using a differential game approach, this paper modeled a three-tier system to analyze dynamic interactions between R&D effort, logistics effort, market demand, and quality evolution. A state equation described drug quality evolution, influenced by R&D effort, logistics service effort, and natural decay rate. A market demand function (positively related to quality, negatively to retail price) and long-term profit functions (with quadratic convex costs for R&D and logistics) were established. Three scenarios were examined: centralized optimization, decentralized Stackelberg game, and a novel combination contract incorporating government subsidies and cost-sharing. For each scenario, optimal strategies, drug quality trajectories, and profits were derived using backward induction and solving differential equations. Finally, numerical experiments were conducted to verify the models by comparing key indicators.

Results: Drug quality converges to a steady state independent of initial levels. Outcomes vary significantly: centralized decision-making yields the highest quality and profit, followed by the combination contract, with decentralized decision-making the lowest.

Conclusions: This paper integrates pharmaceutical supply chain performance and drug quality with time by using differential games. The convergence of drug quality to a steady state indicates that long-term quality depends on decision behaviors, not initial conditions. The combination contract effectively coordinates decentralized decision-making, improving quality, efforts, and profits, making it more feasible.



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sciforum-130552: Games with Costly Endogenous Separation

Alejandro Gutiérrez-Mielgo ¹, Luis Rodrigo Izquierdo Millán ² and Segismundo Samuel Izquierdo Millán ³

¹ Instituto de Matemáticas (IMUVA), Universidad de Valladolid

² Department of Management Engineering, Universidad de Burgos

³ Department of Industrial Organization and BioEcoUva, Universidad de Valladolid

Introduction Games with costly endogenous separation (GCEs) are repeated games where players have the option to leave their current partnership and form a new one with a random partner, incurring a cost in the process. Thus, in these games, partnerships may be broken not only due to causes that are not related to the players' choices (exogenous separation), but also due to players' decisions (endogenous separation). We extend the framework of symmetric two-player games with endogenous separation by adding costs to the separation process and studying its influence on the existence of stable equilibria.

Methods We study the existence of Nash and Neutrally Stable (NS) equilibria in the general case of symmetric two-player games with costly endogenous separation, with applications to the GCE version of the prisoner's dilemma and the hawk-dove game.

Results Fully cooperative strategies can support an NS equilibrium in both the prisoner's dilemma and the hawk-dove game when the cost of endogenous separation is large enough. However, in order to achieve a fully cooperative equilibrium, a considerably large cost is needed.

Conclusions GCEs may provide a good approach to modelling many real scenarios with freedom of association and search costs and can help explain cooperative or partially cooperative equilibria in social dilemmas.



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sciforum-136539: More recycling to save the planet?

Hend Ghazzai ¹, Rim Lahmandi-Ayed ² and Nada Smeti ¹

¹ Mediterranean School of Business at South Mediterranean University and LR MASE (LR21ES21)

² ESSAI, Carthage University and LR MASE (LR21ES21) , Tunisia

This paper analyzes the economic and environmental implications of mandatory recycling policies within a dynamic duopoly framework. Using a two-period Cournot model with identical firms producing a homogeneous good, we explore the impact of an exogenously imposed recycling rate on firms' production decisions, profits, consumer surplus, welfare, and environmental damage. In the first period, firms rely entirely on fresh inputs. In the second, they are required to recycle a portion of their initial production, though they may also continue using fresh inputs. Three types of equilibrium emerge, depending on the costs' parameters and the recycling rate. In equilibrium, firms always produce positive quantities in the first period. However, in the second period, either they both produce using a mix of fresh and recycled materials, both rely solely on recycled materials, or one firm uses both input types while the other uses only recycled materials. Notably, the analysis uncovers counterintuitive effects: stricter recycling regulations do not always reduce the use of fresh inputs or environmental harm and can even decrease economic welfare. These findings underscore the importance of carefully calibrating recycling policies, as overly stringent mandates can have unintended negative consequences. The model offers a novel theoretical lens on circular economy interventions, contributing to the broader debate on the design of sustainable production policies.



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sciforum-139891: Technological Asymmetry and Cooperative Environmental R&D: A Game-Theoretic Analysis

Razika Sait

Research Unit LaMOS, Operational research Department, Faculty of Exact Sciences, University of Bejaia

The energy transition has become a strategic priority for industrial firms. In response to the climate emergency, rising fossil fuel prices, and increasing regulatory pressures, many industrial groups are investing in the development of cleaner technologies. In this context, cooperation in environmental R&D is emerging as a key lever to share costs, pool risks, and benefit from positive technological spillovers. Environmental policies and economic instruments, such as emission taxes, further strengthen this trend by encouraging firms to innovate toward low-carbon solutions. Industrial partnerships such as BMW–Toyota (hydrogen fuel cells), Tesla–Panasonic (electric battery innovation), and Renault–Nissan–Mitsubishi (electric vehicles) clearly illustrate this growing tendency toward cooperation in environmental R&D.

Our contribution builds on this dynamic by adopting a non-cooperative game-theoretic approach. We develop a three-stage game: the regulator first sets an emission tax, then firms choose their level of R&D investment, either jointly under a cooperative scheme (Joint Lab) or individually, and finally compete à la Cournot in the product market. We analyze how asymmetries in production efficiency affect the equilibrium R&D effort, the optimal tax, and overall welfare. The main result shows that as asymmetry increases, the joint R&D effort declines, which can diminish the environmental and welfare benefits of cooperation. Beyond a critical threshold, the cooperative regime may become less effective than non-cooperation.



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sciforum-139852: Tullock conflict with violence and asymmetric cost structures

Priyanka Khosla and Hargungeet Singh

Department of Economic Sciences, Indian Institute of Technology, Kanpur

<https://www.overleaf.com/read/rtyhfnfxcgrd#727801>

This paper develops a two-stage Tullock conflict model with two agents and a violence parameter that determines the onset of open conflict. Agents invest costly effort to compete for a valuable prize, awarded probabilistically following the standard Tullock formulation. The winning probability is the ratio of a player's effort (raised to a positive power) to the sum of both players' efforts raised to the same power. When this power equals one, the contest reduces to a lottery. In the canonical two-stage rent-seeking model with linear and symmetric effort costs, the Subgame Perfect Nash Equilibrium (SPNE) predicts that each player expends one-fourth of the prize value in case of open conflict, resulting in equal winning probabilities of one-half. We extend this framework by assuming quadratic effort costs. Under symmetry, equilibrium efforts remain positive and winning probabilities still equalize at one-half. However, we identify multiple equilibria depending on the prize value and the violence parameter. In some parametric settings, unilateral positive effort by one player is sufficient to win without triggering violent conflict. We then introduce cost asymmetry, allowing one player to face lower marginal effort costs. Our analysis shows that even an infinitesimal advantage leads the lower-cost agent to exert strictly higher effort, significantly increasing total effort in open conflict. This results in greater overall waste relative to the symmetric benchmark.



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4052 Basel
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