Annals of Operations Research
https://doi.org/10.1007/s10479-025-06985-y

EDITORIAL

Game theoretical models and applications (SING 18)

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Abstract
This special issue of *Annals of Operations Research* presents a collection of 31 papers that emerged from the 18th European Meeting on Game Theory (SING 18), held in Messina, Italy, in June 2023. The contributions span the full breadth of game-theoretical research, from foundational developments in cooperative and non-cooperative game theory to innovative applications in supply chain management, healthcare, finance, environmental policy, and emerging technologies. This collection demonstrates the vitality and relevance of game theory in addressing contemporary challenges across diverse domains, highlighting the synergy between theoretical advances and practical problem-solving. The papers showcase the evolution of game-theoretical methods, incorporating modern computational techniques including artificial intelligence, deep learning, and quantum computing, while maintaining strong connections to classical game-theoretic principles.

Keywords Game theory · Cooperative games · Non-cooperative games · Supply chain management · Artificial intelligence · Evolutionary games · Network games · Operations research applications

1 Introduction

The European Meeting on Game Theory, widely known by its acronym SING (Spain-Italy-Netherlands Meeting on Game Theory), has established itself as one of the premier venues for game-theoretic research since its inception in 1983. Originally confined to Italian venues

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Published online: 17 December 2025

for its first thirteen meetings, the conference evolved into a truly European gathering when Spanish scholars joined the organization in 2001, followed by Dutch colleagues in 2005, leading to the adoption of the SING acronym. The conference further expanded its European character when Polish researchers became involved in the organization, prompting the official renaming to European Meeting on Game Theory, while retaining the cherished SING acronym as a tribute to its origins. Since its renaming the conference has been held in various European countries.

The 18th edition of this conference, held in Messina, Italy, in June 2023, continued the tradition of bringing together leading researchers, early-career scholars, and doctoral students from around the world. The conference provided a platform for presenting cutting-edge research across all areas of game theory, fostering interdisciplinary dialogue and collaboration. This special issue represents a carefully curated selection of 31 papers that underwent rigorous peer review, reflecting the highest standards of scholarship in the field.

The diversity of contributions in this special issue reflects the current state and future directions of game-theoretic research. The papers can be broadly organized into several thematic areas: cooperative game theory and solution concepts, non-cooperative strategic interactions, supply chain and operations management, game theory applications in emerging technologies, environmental and public policy applications, and computational and algorithmic game theory. This introduction provides an overview of these contributions, highlighting their main findings and placing them within the broader context of game-theoretic research and operations research applications.

2 Cooperative game theory and solution concepts

A substantial portion of this special issue is devoted to advances in cooperative game theory, reflecting the continued importance of understanding coalition formation, value distribution, and stability concepts in strategic settings. These contributions extend classical solution concepts and develop new approaches for modern applications.

Martinez and Sanchez-Soriano (2023) examine order preservation with dummies in the museum pass problem, addressing fundamental questions about fair allocation in cultural consortia. Their work contributes to the literature on cooperative games with externalities, providing new insights into how dummy players should be treated in allocation mechanisms. This has important implications for the design of cultural tourism passes and similar cooperative arrangements.

Armijos-Toro et al. (2024) develop new generating functions to compute power measures for weighted majority games. Their contribution advances the computational toolkit available for analyzing voting situations and political systems, with applications to corporate governance and collective decision-making. The use of generating functions provides computational advantages over traditional methods, particularly for large-scale problems.

Gavilán et al. (2025) introduce a position value for multigraphs, extending classical cooperative game theory to network structures with multiple connections between nodes. This generalization is particularly relevant for modeling modern communication networks, transportation systems, and social networks where multiple types of relationships coexist between agents.

Bouwhuis et al. (2024) present a strategic approach to bankruptcy problems based on the TAL family of rules. Their work bridges cooperative game theory and bankruptcy law, providing new perspectives on creditor coordination and fair distribution in insolvency situations. The strategic analysis reveals how different allocation rules affect creditor behavior and overall efficiency.

Puccetti et al. (2025) propose MinCovTarget plus, a fast heuristic algorithm for fair allocation. The algorithm addresses the computational challenges of finding fair allocations in large-scale problems, with applications to risk sharing, cost allocation, and resource distribution. The computational efficiency of their approach makes it particularly suitable for real-time decision support systems.

Bimonte et al. (2024) investigate efficiency and the core in NTU games in partition function form. Their contribution extends traditional cooperative game theory by incorporating externalities between coalitions, a feature increasingly important in modern economic applications where coalition formation affects non-members. This work provides new stability concepts for situations with significant spillover effects.

Aleandri and Dall'Aglio (2025) develop a coopetition index for coalitions in simple games. Their work formalizes the notion of coopetition (cooperation among competitors) in voting and political contexts, providing quantitative measures of the dual nature of competitive-cooperative relationships. This has applications to political science, business strategy, and organizational behavior.

Aparicio et al. (2024) examine the game of agents in transportation problems. Their work contributes to the intersection of cooperative game theory and logistics, providing new solution concepts for situations where multiple agents cooperate in transportation networks. The results have implications for freight consolidation, ride-sharing platforms, and public transportation planning.

3 Non-cooperative strategic interactions and equilibrium analysis

Several papers in this special issue advance our understanding of non-cooperative strategic interactions, exploring equilibrium concepts under various forms of uncertainty, information asymmetry, and dynamic considerations. These contributions extend classical Nash equilibrium analysis to more complex and realistic settings.

Wang et al. (2024) establish the existence of robust weak Nash equilibria for leader–follower games with uncertainty. Their work addresses a fundamental challenge in game theory: how to characterize strategic equilibria when players face model uncertainty or ambiguity about the game structure. The robust equilibrium concept they develop has applications to mechanism design, contract theory, and strategic decision-making under deep uncertainty.

Brun and Doncel (2025) analyze the inefficiency of atomic splittable routing games over parallel links. Their contribution to the price of anarchy literature quantifies the efficiency loss resulting from selfish routing in network congestion games. The results have direct implications for internet traffic routing, transportation network design, and telecommunications systems.

Bharadwaj and Amit (2024) develop Aumann-Shapley pricing for baggage ancillary services. Their work applies cooperative and non-cooperative game theory to the airline industry, addressing the strategic problem of pricing unbundled services. The Aumann-Shapley approach provides a principled method for cost allocation that satisfies desirable fairness and incentive properties.

Chen et al. (2025) address computing perfect pairwise stable networks. Their work contributes to network formation theory by developing efficient algorithms for finding stable network configurations. The results have applications to social networks, collaboration networks, and strategic alliance formation in business contexts.

Aliano and Ragni (2025) present game-based modeling of delayed risk contagion in cryptocurrency exchanges. Their innovative approach combines game theory with network analysis to understand systemic risk in digital asset markets. The model captures how strategic behavior of exchanges and traders can amplify or mitigate contagion effects, providing insights for regulatory policy and risk management in the rapidly evolving cryptocurrency ecosystem.

4 Supply chain management and operations research

Supply chain management emerges as a major application domain in this special issue, with multiple papers applying game-theoretic insights to coordination problems, contract design, and risk management in supply chains. These contributions demonstrate the practical value of game theory in addressing real-world business challenges.

Chu et al. (2023) develop a game theory approach for secured supply chain management in effective trade management. Their work addresses the strategic dimensions of supply chain security, analyzing how different parties can coordinate to achieve resilience against disruptions while maintaining efficiency. The framework they develop is particularly relevant in an era of increasing supply chain complexity and vulnerability.

Zheng and Xiao (2024) examine the interaction between rebate strategy and wholesale-ordering contracts under retailer optimism and information asymmetry. Their analysis reveals how behavioral biases (retailer optimism) interact with strategic considerations and information structures to affect contract design and supply chain performance. This behavioral game-theoretic approach provides new insights into why certain contract forms emerge in practice.

Zhang and Xu (2024) analyze agency contracts with incentive mechanisms considering supplier risk aversion in a dynamic platform supply chain. Their work extends principal-agent theory to platform economies, addressing the unique challenges of coordinating multiple suppliers with heterogeneous risk preferences in dynamic environments. The results inform platform design and governance in e-commerce and sharing economy applications.

Zhang et al. (2024a) present a hybrid approach for risk-informed decision-making in supply chain projects. Their framework integrates game theory with risk analysis to support investment decisions in supply chain infrastructure and technology adoption. The approach is particularly valuable for evaluating projects with significant strategic interdependencies and risk-sharing considerations.

Barilla et al. (2024a) investigate duality for nonsmooth mathematical problems with vanishing constraints. Their work extends classical optimization theory to problems with complex constraint structures that arise naturally in game-theoretic contexts. The duality results they establish have implications for computational methods and sensitivity analysis in strategic decision problems.

5 Game theory meets artificial intelligence and emerging technologies

A distinctive feature of this special issue is the integration of game theory with artificial intelligence and other emerging technologies. These papers demonstrate how classical game-theoretic principles can be enhanced with modern computational methods, while game theory provides theoretical foundations for AI applications.

Xu et al. (2024) develop efficient QoS processing for Internet of Medical Things using non-cooperative game theory in a cloud framework. Their work addresses the critical challenge of resource allocation in healthcare technology infrastructure, where multiple medical devices and services compete for limited computational and communication resources. The game-theoretic approach ensures efficient resource utilization while meeting quality of service requirements.

Barilla et al. (2024b) propose a variational approach for a technology acquisition strategy model in the context of the Internet of Things. Their work bridges game theory, optimization theory, and IoT applications, providing a framework for strategic technology investment decisions in interconnected systems. The variational approach offers computational advantages for large-scale problems typical of IoT deployments.

Liu et al. (2024) present an innovative artificial intelligence and game-theoretic approach for target tracking in sensor networks. Their hybrid methodology combines the learning capabilities of AI with the strategic reasoning of game theory, resulting in more robust and efficient tracking algorithms. This work exemplifies the synergies between game theory and machine learning.

Wu et al. (2024) develop an evolutionary game-theoretic approach with deep learning for health decision-making in critical environments. Their framework combines evolutionary game dynamics with neural network learning to model and predict health-related strategic behavior. The application to critical care environments demonstrates the potential of integrated game-theoretic and AI methods for life-critical systems.

Sun et al. (2024) apply evolutionary game theory with deep learning-based target detection and tracking in sensor networks. Building on similar methodological foundations, their work focuses on distributed sensing applications where multiple sensors must coordinate their tracking efforts. The deep learning component enhances detection capabilities while game theory governs sensor cooperation.

Ma et al. (2024) explore non-cooperative game theory with generative adversarial networks for effective decision-making in military cyber warfare. This innovative work applies the adversarial training paradigm from machine learning to cyber defense strategies. The game-theoretic framework provides strategic insights while GANs generate realistic attack scenarios for testing defensive measures.

Zhang et al. (2024b) advance consumer insights through efficient sentiment analysis-based recommendation systems using multi-criteria decision-making with a game-theoretic approach. Their work demonstrates how game theory can enhance recommendation systems by modeling strategic interactions between consumers, platforms, and content providers.

The multi-criteria framework captures the complexity of consumer preferences in modern e-commerce environments.

6 Financial applications and dynamic games

Financial applications have long been a fertile ground for game-theoretic analysis, and this special issue continues this tradition with contributions addressing portfolio management, investment decisions, and environmental finance.

La Torre and Maggistro (2024) analyze multi-agent dynamic financial portfolio management using a differential game approach. Their work extends classical portfolio theory by incorporating strategic interactions between multiple investors who affect each other through market impact. The differential game framework captures the continuous-time nature of financial decisions while accounting for strategic considerations. This has implications for understanding market microstructure and institutional trading behavior.

Biancardi et al. (2024) propose a strategic options game approach to support PPP investment decisions under risk-sharing mechanisms. Their work applies real options theory and game theory to public–private partnership investments, addressing the question of how to optimally structure risk-sharing arrangements between public and private sectors. The strategic options framework captures both the flexibility value and strategic interactions inherent in PPP projects.

Cardot et al. (2025) examine green bonds and certification, asking whether getting certified is always optimal. Their game-theoretic analysis reveals conditions under which certification creates value for issuers and investors, and when the costs of certification may outweigh its benefits. This work contributes to the growing literature on sustainable finance and ESG investing, providing insights for market design and regulatory policy.

7 Environmental policy and public goods

Environmental challenges and public policy applications provide another important theme in this special issue. These papers demonstrate how game theory can illuminate the strategic dimensions of environmental protection, public health, and sustainability.

de Frutos et al. (2024) analyze balancing mitigation policies during pandemics with economic, health, and environmental implications. Their differential game model captures the trade-offs between public health measures, economic activity, and environmental quality during health crises. The framework they develop can inform policy design for future pandemics, considering multiple objectives and strategic interactions between different levels of government.

Colivicchi and Iannucci (2024) examine insurance coverage and environmental risk in an evolutionary oligopoly. Their work combines evolutionary game dynamics with environmental economics to understand how firms strategically manage environmental risks through insurance. The evolutionary approach captures the dynamic adjustment of strategies over time, providing insights into the emergence of risk management practices in industries facing environmental liability.

Hao et al. (2025) unmask greenwashing in ESG disclosure using insights from evolutionary game analysis. Their work addresses the strategic incentives for firms to misrepresent their environmental, social, and governance practices. The evolutionary game framework reveals the conditions under which truthful disclosure emerges as a stable equilibrium, informing regulatory policy and market-based mechanisms for promoting corporate transparency.

8 Concluding remarks and future directions

The papers collected in this special issue demonstrate the continued vitality and expanding scope of game-theoretic research. Several themes emerge from this collection that point toward future research directions and challenges for the field.

First, the integration of game theory with artificial intelligence and machine learning represents a particularly promising frontier. Multiple papers in this issue show how these methodologies can be productively combined, with game theory providing strategic foundations while AI offers computational power and learning capabilities. This synergy is likely to intensify as both fields continue to evolve, opening new possibilities for addressing complex strategic problems in data-rich environments.

Second, the breadth of applications represented in this special issue reflects the maturation of game theory as a practical tool for decision-making across diverse domains. From supply chain management to healthcare, from environmental policy to financial markets, game-theoretic insights are increasingly embedded in operational decision support systems and strategic planning processes. This trend toward applied game theory creates opportunities for researchers to address real-world problems while contributing to methodological development.

Third, several papers in this collection address uncertainty, information asymmetry, and robust decision-making. These themes reflect the recognition that classical game-theoretic models often assume more information and certainty than is available in practice. The development of robust equilibrium concepts, solution methods under uncertainty, and approaches to learning and adaptation will remain important research priorities.

Fourth, computational considerations loom large in many contributions, reflecting both the opportunities and challenges created by big data and computational power. The development of efficient algorithms for computing equilibria, analyzing large games, and implementing game-theoretic mechanisms at scale remains an important research frontier.

Finally, this special issue exemplifies the productive dialogue between theoretical development and practical application that has characterized game theory since its inception. The papers show how theoretical advances enable new applications, while practical challenges motivate theoretical innovation. This virtuous cycle continues to drive the field forward.

The SING conference series has played a crucial role in fostering this dynamic research community, providing a venue where established scholars and early-career researchers engage in substantive dialogue across theoretical and applied perspectives. The papers in this special issue reflect the quality and diversity that have made SING a premier forum for game-theoretic research.

We hope that readers will find these contributions stimulating and that they will inspire further research at the intersections of game theory, operations research, and the many application domains represented in this collection. The future of game theory lies in addressing the complex strategic challenges of our interconnected world, and the papers in this special issue point the way forward.

Acknowledgements We would like to express our gratitude to all authors who submitted their work to this special issue, to the reviewers who provided thoughtful and constructive feedback, and to the editorial team of *Annals of Operations Research* for their support throughout the editorial process. We also thank the organizing committee of SING 18 for creating an excellent conference environment that fostered the research presented here. Finally, we acknowledge the Game Theory Society and the broader SING community for their continued commitment to advancing game-theoretic research and its applications.

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