



## Preface: International conference on game theory and optimization, June 6–10, 2016, Indian Institute of Technology Madras, Chennai, India

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### Abstract

A conference-cum-workshop on Game Theory and Optimization was held at the Indian Institute of Technology Madras, during June 6–10, 2016. One of the primary objectives of the event was to commemorate the 75th birthday of Professor T. Parthasarathy, fondly referred to as TP. A special session was devoted to his life and mathematical career. This provided a platform for many of TP's students and collaborators to share their experiences with the audience. The conference was made possible through funding from the National Mathematics Initiative. Additional funding was received from the Office of Alumni and International Relations, the Departments of Mathematics, and Management Studies, Indian Institute of Technology Madras (IIT Madras). Following is a brief overview of the contributions to this special issue, a biography of Professor TP, and a list of his publications. The Guest Editors would like to thank all the authors, *Annals of Operations Research* Editor-in-Chief, Endre Boros, and all referees who provided peer review. This special issue would not have been possible without their valuable time and input.

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## 1 A brief overview of the contents

The paper by Balbus, Jaśkiewicz and Nowak focuses on a discrete-time non-stationary decision model, wherein the preferences of the decision maker varies over time that are further described by quasi-hyperbolic discounting. They show that a time-consistent optimal solution of such a problem may be associated with Markov perfect equilibrium in a certain stochastic game that in turn may be calculated by employing a policy iteration algorithm. New existence results, in the case of one-period utilities and when the transition probabilities are independent of time, are obtained.

The paper by Chakraborty, Chandru and Rao is an excellent narrative drama on linear programming and traces the development since Fourier's work in 1823. The developments during 1940–1950 is mentioned in detail with due references to the works of Kantorovich, Dantzig, Koopmans and von Neumann. The authors provide a lucid account of the developments in the early 1970s starting with the work of Shor on ellipsoidal method, and Khachiyan who specialized it to prove polynomial time solvability of linear programming. Khachiyan's algorithm was a breakthrough but did not provide a viable alternative to the Simplex Method as the workhorse of linear programming. It was not until 1984, when Narendra Karmarkar, a young computer scientist of Indian origin, showed that an interior point method, invariant to projective transformations, could yield both a theoretically efficient and a practical method for linear programming.

The paper by Chuong deals with a nonsmooth, multiobjective bilevel optimization problem. By considering a relaxation, Chuong derives necessary optimality conditions for local weak Pareto solutions.

In their paper, Dubey and Neogy consider a quadratic programming problem (QP) induced by the resistance distance matrix of a simple graph. In addition to reformulating such a problem as a strictly convex QP and as a linear complementarity problem, they discuss computational issues and present an application to symmetric bimatrix games.

In their paper, El Ouardighi, Kogan, Gnecco and Sanguineti consider a two-player differential game model of transboundary pollution that accounts for time-dependent environmental absorption efficiency, allowing the biosphere to switch from a carbon sink to a source. They investigate the impact of negative externalities resulting from a transboundary pollution noncooperative game, wherein countries are dynamically involved.

In their paper, Flesch and Predtetchinski consider perfect information games with Borel measurable pay-off functions parametrized by points in a Polish space and show that the existence domain of a parameterized game is a Borel set. The family of existence domains is also shown to coincide with the family of projections of Borel sets. The authors also derive an upper bound on the set theoretic complexity of the existence domains.

A problem of interest during the last decade or so has been to investigate the integrated business activities of two complementary products in a duopoly market, in which the relationship between the channel members is either non-cooperative or cooperative. In their paper, Giri, Mondal and Maiti consider a duopoly market where two manufacturers produce complementary products separately, and sell the same through a common retailer. Assuming the demand to be a linear function of the prices of the two products as per their nature, the authors develop a mathematical model with the objective of maximizing prices to obtain optimal pricing strategies for both manufacturer and retailer. They further show the dominance of a pure bundling strategy of prices over the individual prices and validate the same through numerical experiments.

The paper by Gowda, Song and Sivakumar deals with some results characterizing Z-transformations that keep a proper cone (in a finite dimensional space) invariant. One key result says that when the cone is irreducible, non-negative multiples of the identity transformation are the only such transformations. Applications to symmetric cones in Euclidean Jordan algebras are also described.

The paper by Hingu studies the problem of asymptotic stability of strongly uninvadable faces generated by finite Borel sets in a continuous strategy space of an evolutionary game. The author shows that such a face is asymptotically stable for the corresponding replicator dynamics.

In their paper, Hingu, Rao and Shaiju revisit some notions of superiority and weak stability of population states in evolutionary games with continuous strategy space. Among other things, they prove a general stability result for replicator trajectories, extending corresponding results in the literature.

The paper on linear production games by Le, Nguyen and Bektas deals with efficient computation of Shapley value using linear programming sensitivity analysis (LPSA) for such games. The authors also propose a randomised algorithm combining the LPSA and stratified sampling, and compare the same with existing algorithms. One observes that these methods can also be useful in other games associated with minimum spanning trees, assignment and network synthesis.

The paper by Leppänen studies the problem of partial commitment in an endogenous timing duopoly. In duopolistic price competition, endogenous moves give rise to a coordination problem with two non-Pareto ranked subgame perfect equilibria (SPE), wherein both firms prefer followership to leadership. The author shows that a unique SPE can be found if firms use partial commitments to their timing announcements.

In their paper, Litan, Marhuenda and Sudhölter provide sufficient and necessary conditions for the generic finiteness of the number of distributions on outcomes, induced by the completely mixed Nash equilibria associated to a bimatrix outcome game form. They formulate these equivalent conditions in terms of the ranks of two matrices constructed from the original game form.

The past decade has seen the emergence of social storage systems as an alternative to existing backup systems. In their paper, Mane, Ahuja and Krishnamurthy model social storage systems as a strategic network formation game and use utility functions, defined specifically in this context, to analyse the game. They also propose the concept of bilateral stability to capture the notion of mutual consent for addition and deletion of links in the storage system. Finally, they obtain necessary and sufficient conditions for bilateral stability. After developing the theoretical framework, they discuss evolution and efficiency of stable networks based on the number of agents.

The paper by Mondal deals with computation of vector-valued and pure optimal stationary optimal policies using linear programming for multichain semi-Markov decision process.

In their paper, Murthy, Sivakumar and Sushmitha present a compilation of the contributions of TP to the complementarity problem. An overview of TP's results in connection with linear complementarity problem, is presented in an expository style.

Singh, Gupta and Mehra, in their paper contribute to the ongoing research in linguistic modelling. They propose a unified approach that uses linguistic linear programming (LLP) model and use it to solve a constant-sum linguistic matrix game. They also apply the unified framework to solve the linguistic multi-attribute decision-making (MADM) problem. The authors also discuss the advantages of the game theory

approach to solve the MADM problem where multiple decision makers have different opinions about a set of attributes.

In their paper, Weibelzahl and Märtz contribute to the energy market literature by discussing different market congestion management regimes. They study the effects of various zonal designs and evaluate both absolute investment levels and locations of corresponding facility investments. The focus of their paper is to analyse the interplay of transmission and storage facility investments in a multistage game that is translated into a bilevel market model. Through numerical experiments, they show that both under nodal and zonal pricing, storage investments may have the potential to reduce network extensions as compared to the no-storage case.

## 2 A biography of professor Parthasarathy

Thiruvengkatachari Parthasarathy was born on 1 March 1941, in Chennai (formerly, Madras) in the southern state of Tamil Nadu. He received his B.Sc. and M.Sc. degrees (in Statistics) from Madras University. He then joined the Indian Statistical Institute (ISI), Kolkata, where he wrote his Ph.D. thesis entitled, “Minimax Theorems and Product Solutions for Simple Games,” under the guidance of Professor C.R. Rao. He has visited many internationally acclaimed institutions and has held academic positions at University of California, Berkeley; Case Western Research Institute, Ohio; and University of Illinois, Chicago from 1967 to 1979 where he taught courses in Statistics, Probability and Operations Research.

Professor Parthasarathy joined the Indian Statistical Institute, Delhi Centre, in 1979 and retired in February 2003. He then shifted his base to Chennai and has been actively involved in research and teaching at institutions such as ISI, Chennai Mathematical Institute (CMI) and IIT Madras. His research areas include Game Theory, Mathematical Programming, and Univalence Theory. He has published many research articles, reviews, and survey articles in a variety of journals of national and international repute. He is a co-author of a book on game theory (with T.E.S. Raghavan) and has authored two research monographs (one on Optimization, and another on Univalence Theory) published by Springer Verlag. Professor Parthasarathy has guided many students in their M.S. and Ph.D. degrees from ISI, CMI and IIT Madras.

Professor Parthasarathy has conducted several international conferences on the topics of Game Theory and Optimization at the ISI. He served as an Associate Editor for the *International Journal on Game Theory* and is an Associate Editor of *Games and Economic Behaviour*. He has served on many selection and other committees of CSIR, NBHM and other agencies in India, in a variety of positions. He was a president of the Indian Mathematical Society.

Professor Parthasarathy received the S.S. Bhatnagar Award for Mathematical Sciences in 1986. He was elected as a Fellow of the Indian Academy of Sciences in 1988 and as a fellow of the Indian National Science Academy in 1995. Professor Parthasarathy continues to contribute through teaching and mentoring at the CMI, where he is an adjunct professor.

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