

Preface

This edited volume focuses on various aspects of dynamic game theory providing state-of-the-art information on recent conceptual and methodological developments. It also includes novel applications in different areas such as economics, ecology, engineering, and management science. Most of the selected papers were presented at the 15th International Symposium on Dynamic Games and Applications held in Byšice, Czech Republic on July 19–22, 2012. The symposium is held every two years under the auspices of the International Society of Dynamic Games. The list of contributors consists of well-established and young researchers working in different countries. Every submitted paper has gone through a stringent reviewing process. This volume is made of 15 chapters that we classified into three parts. The first one regroups papers dealing with some theoretical and/or computational issues in dynamic games; the second part includes four chapters applying dynamic games in different areas; and finally, the third part has five chapters on pursuit–evasion games. As in any clustering of papers of this type, the one proposed here is far from being unique.

Part I. Dynamic Games: Theory and Computation

Arapostathis, Borkar, and Kumar study zero-sum stochastic differential games and establish the existence of a solution to the Isaac’s equation for the ergodic game. They characterize the optimal stationary strategies without assuming the data and geometric ergodicity. The authors also study a relative value iteration scheme that takes the form of a parabolic Isaac’s equation and show that it converges to the elliptic Isaac’s equation as time goes to infinity under the hypothesis of geometric ergodicity. *Blueschke, Neck, and Behrens* present an algorithm (OPTGAME3) for the computation of Nash and Stackelberg equilibria, as well as Pareto-optimal solutions of dynamic games. The use of this algorithm is illustrated in the context of a stylized nonlinear two-country macroeconomic model of a monetary union for analyzing the interactions between fiscal (governments) and monetary (common central bank) policy makers, assuming different objective functions of

these decision makers. *Botkin and Turova* consider the problem of aircraft control during take-off in a windshear. A four-dimensional dynamic programming method is proposed and stable numerical algorithms for solving Hamilton–Jacobi–Bellman–Isaacs equations arising from differential games with state constraints are utilized for the design of controls.

Carlson formulates and proves a general existence theorem for an optimal solution for the class of bi-level optimal control problems, when both upper and lower level problems are described by ordinary optimal control models of Lagrange type. An interesting feature of the result is that it does not require the lower level to have a unique best response to each admissible strategy of the upper level problem. *Pachter* studies a two-player linear-quadratic game, where the players have some private information. Each player is able to formulate an expression for his/her expected payoff without the need, à la Harsanyi, to provide a prior probability distribution function of the game's parameter and without recourse to the player Nature. The paper characterizes the conditions under which the principle of certainty equivalence holds. Finally, *Zusai* investigates a variety of conditions to establish the connection between an interior convergence in regular payoff monotone selections and versions of proper equilibrium and use the connection for equilibrium selection.

Part II. Dynamic Games: Applications

De Giovanni studies a differential game involving a manufacturer and a retailer interacting in a supply chain. The retailer, who is the leader of chain, sets the price and the advertising budget, whereas the manufacturer chooses the level of quality improvement. The solutions of two scenarios are characterized and compared, namely, a coordinated case, where the retailer supports the quality improvement program, and the uncoordinated case, where he/she does not. *Ramsey* studies evolution of parental care using evolutionary game theory. This research was motivated by various types of parental care observed in mouth brooding fishes. These types of behavior include paternal mouth brooding where the male only holds eggs, maternal mouth brooding where the female takes eggs, or biparental care where both males and females care for eggs. Ramsey surveys and extends existing models in several directions. In particular, he compares a model where partners take decisions simultaneously with a model where one sex decides first. These models describe a complex feedback between the sex ratio and patterns of parental care. *Scheffran* studies value-cost dynamic games, where multiple agents adjust the flow and allocation of investments to action pathways that affect the value of other agents. He determines conditions for cooperation and analyzes allocation priorities and the stability of equilibrium. The approach is applied to the trading between buyers and sellers of goods to determine conditions for mutually beneficial market exchange.

Staňková, Abate, and Sabelis model interactions between predatory and prey mites during a season. In particular, they focus on the time when these species begin to enter diapause (a physiological state of dormancy to survive winter). Although entering diapause is induced by environmental factor such as low temperature and

short days, presence of predators can also induce diapause in prey mites as a survival strategy. Similarly, inability of finding dormant prey can induce diapause in predators, which leads to a game prey and predatory mites play. Authors argue that this is a Stackelberg game and they analyze the optimal behavior of prey and predators. *Troeva and Lukin* consider a differential game in which n players dump a pollutant, a by-product of their production process, in a water reservoir. The evolution of the pollution concentration level is described by a partial-differential equation. The authors prove the existence of an ε -Nash equilibrium for the class of piecewise-programmed strategies and illustrate their model with a series of numerical examples.

Part III. Pursuit–Evasion Games

Kamneva and Patsko deal with an open-loop solvability operator in two-person zero-sum differential games with simple motions. This operator, which takes a given terminal set to the set defined at the initial instant, possesses the semigroup property in the case of a convex terminal set. The authors provide sufficient conditions ensuring the semigroup property in the non-convex case and construct examples to illustrate the relevance of these conditions. *Kumkov, Patsko, and Le Ménec* deal with a zero-sum differential game, in which the first player controls two pursuing objects, whose aim is to minimize the minimum of the misses between each of them and the evader at some given instant. The authors consider the case where the pursuers have equal dynamic capabilities, but are less powerful than the evader, and provide some numerical results.

Le Ménec considers a team of autonomous vehicles, composed of a pursuing vehicle and of several unmanned aircraft vehicles (UAVs), using on-board sensors for tracking and intercepting a moving target. This situation is modeled as a zero-sum two-player pursuit–evasion differential game with costly information. The author solves the game for simple as well as complex kinematics and discusses the 4D guidance law and the coordination algorithm implemented for managing the UAVs. *Shinar, Glizer, and Turetsky* consider linear pursuit–evasion games with bounded controls. They analyze the cases of an ideal, a first-order, and a second-order pursuer against an ideal and a first-order evader and compare the values of these games. The authors show that replacing the second-order pursuer by a first-order approximation underestimates the value of the game.

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