Review of[1]
Models of Conflict and Cooperation
by Rick Gillman and David Housman
American Mathematical Society
417 + xi pages, hardcover

Review by
Mark C. Wilson, mcw@cs.auckland.ac.nz
University of Auckland

1 Introduction

Game theory, which deals with modelling (optimal) decisions made by sets of interacting agents, has proved useful in many fields, in particular economics, political science, and biology. Although its predictive value is in many cases much less than one would hope for, it remains an essential tool for analysing strategic interaction. In the last decade or so applications in computer science, under the name of Algorithmic Game Theory, have been prominent, and this has led to a renewed interest in computational questions in economics.

The standard textbooks on game theory are almost all written by economists with little computational perspective. More recently the short introduction by Shoham and Leyton-Brown has appeared, and it should prove useful for researchers from graduate student onward. Despite the appearance of more popular accounts of game theory and game theorists, a book that thoroughly covers the basics of the subject in detail for a general non-mathematical audience did not exist, to my knowledge, until the book under review.

2 Summary

The book is organized into 8 chapter of which the last 3 are more difficult than the others. Chapter 1 discusses "deterministic games" (sequential games of perfect and complete information, where win, loss or draw is the only outcome for a player). The key example is the game of Nim which is completely solved affter a thorough discussion of heuristics and strategies. Backward induction and Zermelo's theorem are presented in detail. Chapter 2 gives a detailed discussion of player preferences, giving 5 types including ordinal and cardinal utilities. Chapter 3 deals with strategic (simultaneous or sequential) games, introducing such basic concepts as dominated strategies, maximin solution, Nash equilibrium, game trees, equivalence between game tree and payoff matrix representations. Chapter 4 introduces "probabilistic" (mixed) strategies" and shows how to find Nash equilibria in two-player games, when one of the players has at most 2 pure strategies. Chapter 5 moves on to discuss cooperation, the Prisoners' Dilemma and its repeated version. Chapter 6 examines how binding agreements can lead to improved payoffs for the players, giving detailed discussion of bargaining solutions such as those named after Raiffa and Nash. Chapter 7 deals with "coalition" (cooperative) games and solution concepts such as the Shapley allocation method and the nucleolus. Chapter 8 concludes the book with a treatment of the problem of fair division, dealing with 5 "fairness" axioms including efficiency and envy-freeness, and four solution methods.

The authors have taught a course for general undergraduates based on the material in this book for over ten years. A notable feature is that several chapters open with an extensive Dialogue between characters (presumably meant to be undergraduate students) which previews and motivates the material in the chapter by means of a concrete problem. Emphasis throughout is on the process of mathematical modelling, followed by investigation of basic properties of the model, and then (in the later chapters) axiomatic characterizations and theorems.

3 Opinion

The book succeeds admirably in presenting material to its intended audience, which is, roughly speaking, North American undergraduates in the final two years of a degree who have a general interest in the topic. Explanations are careful and detailed, and the exercises contain a huge number of interesting applications. The material is developed logically, in a lesisurely conversational style and with regard to what the reader can absorb. Each section comes with an explicitly stated learning goal. The mathematical requirements are minimal and much of the book would be appropriate for interested high school students. Students with very limited mathematical background would presumably develop confidence in elementary mathematics as a byproduct of studying the book, and this is apparently an aim of the book. It would also be very appropriate for self-study. The text is very clear and free from errors. The table of contents, index and typesetting are all good. More mathematically-oriented readers impatient with the slow pace would still learn much, as the key results are clearly signposted.

Apart from the deep thought which has clearly gone into the presentation, some of the content is unusual for a book at this level. In particular, the chapter on preferences covers very nicely a topic that is skipped over in most texts. I recommend this book very highly.

For computer science students and (potential) researchers interested in proceeding further, clearly considerable extra reading will be required. One possible minor difficulty would be that the book under review occasionally uses idiosyncratic (or at least nonstandard) terminology.

List of recommended further reading after finishing the book under review:

- T. Roughgarden, *Algorithmic Game Theory*, Comm ACM, July 2010;
- T. Roughgarden, *Computing Equilibria: A Computational Complexity Perspective*, invited survey for Economic Theory, 2010;
- K. Leyton-Brown, Kevi and Y. Shoham, *Essentials of Game Theory: A Concise, Multidisciplinary Introduction*, Morgan & Claypool Publishers 2008 (also available free online);
- Y. Shoham, *Computer Science and Game Theory*, Comm. ACM, August 2008;
- *Algorithmic Game Theory*, edited by Noam Nisan, Tim Roughgarden, Eva Tardos, and Vijay Vazirani, Cabridge University Press 2007 (also available free online).