
Preface

This is the third edition of an introduction to game theory and its applications from the perspective of an applied mathematician. It covers a range of concepts that have proven useful, and are likely to continue proving useful, for mathematical modelling in the life and social sciences. Its approach is heuristic, but systematic, and it deals in a unified manner with the central ideas of both classical and evolutionary game theory. In many ways, it is a sequel to my earlier work, *A Concrete Approach to Mathematical Modelling* [210],¹ in which games were not discussed. The mathematical prerequisites for a complete understanding of the entire book are correspondingly modest: the standard calculus sequence, a rudimentary knowledge of matrix algebra and probability, a passing acquaintance with differential equations, some facility with a mathematical software package, such as Maple, *Mathematica*[®] (which I used to draw all of the figures in this book) or MATLAB—nowadays, almost invariably implied by the first three prerequisites—and that intangible quantity, a degree of mathematical maturity. But I have written the book to be read at more than one level. On the one hand, aided by over 90 figures (half of them new to this edition), those with a limited mathematical background can read past much of the mathematics and still understand not only the central concepts of game theory, but also the various assumptions that define the different models and the conclusions that can be drawn from those assumptions. On the other hand, for those with a strong enough background, the underlying mathematics is all there to be appreciated. So I hope that my book will have broad appeal, not only to mathematicians, but also to biologists and social scientists.²

Among other things, mathematical maturity implies an understanding that abstraction is the essence of modelling. Like any model, a game-theoretic model is a deliberate simplification of reality; however, a well designed game is also a useful simplification of reality. But the truth of this statement is more readily appreciated

¹Bold numbers in square brackets are references listed in the Bibliography, pp. 373–386.

²Books that cover the prerequisite material well include Bodine et al. [31] and Neuhauser and Roper [244] from a biological perspective, and Kropko [164] from that of a social scientist.

after evidence in its favor has been presented. That evidence appears in Chapters 1–8. Further discussion of this point is deferred to Chapter 9.

Reactions to the first and second editions of this book have been both positive and pleasing. I haven't fixed what isn't broken. But I have paid attention to feedback, and I have extensively rewritten and restructured the book accordingly; in particular, Chapter 2 is almost entirely new.³ As in the previous editions, I aim to take my readers all the way from introductory material to the research frontier. I have therefore included a number of game-theoretic models that were not in the second edition because they are based on more recent work; this new material reflects my interest in the field of behavioral ecology,⁴ where game theory holds great promise. Again with the research frontier in mind, I have brought the end-of-chapter commentaries and the bibliography right up to date. By design, the references are still selective: it would be against the spirit of an introductory text to cite all potentially relevant published literature. Yet I have tried to make the vast majority of it easily traceable through judicious references to more recent work.

There exist several excellent texts on game theory, but their value is greatest to the mathematical purist. Practices that are *de rigueur* to a purist are often merely distracting to a modeller—for example, lingering over the elegant theory of zero-sum games (nonzero-sum conflicts are much more common in practice), or proving the existence of a Nash equilibrium in bimatrix games (for which the problem in practice may be to distinguish among a superabundance of such equilibria); or, more fundamentally, beginning with the most general possible formulation of a game and only later proceeding to specific examples (the essence of modelling is rather the opposite). Such practices are therefore honored in the breach. Instead, and as described more fully in the agenda that follows, the emphasis is on concrete examples, and the direction of pedagogy throughout the book is predominantly from specific to general. This downplaying of rigor and generality facilitates the appropriate emphasis on the subtle process of capturing ideas and giving them mathematical substance—that is, the process of modelling. In that regard, I continue to hope that my book not only helps to make game-theoretic models accessible, but also conveys both their power and their scope in a wide variety of applications.

³I have also corrected all known errors (and tried hard to avoid introducing any new ones), and I have added several new exercises. Brief answers or hints for only about a third of the exercises appear at the end of the book; however, a manual containing complete solutions to almost all of the exercises—as well as 13 additional problems and 16 additional figures—is available to any instructor. Please send mail to textbooks@ams.org for more information.

⁴See p. 217.