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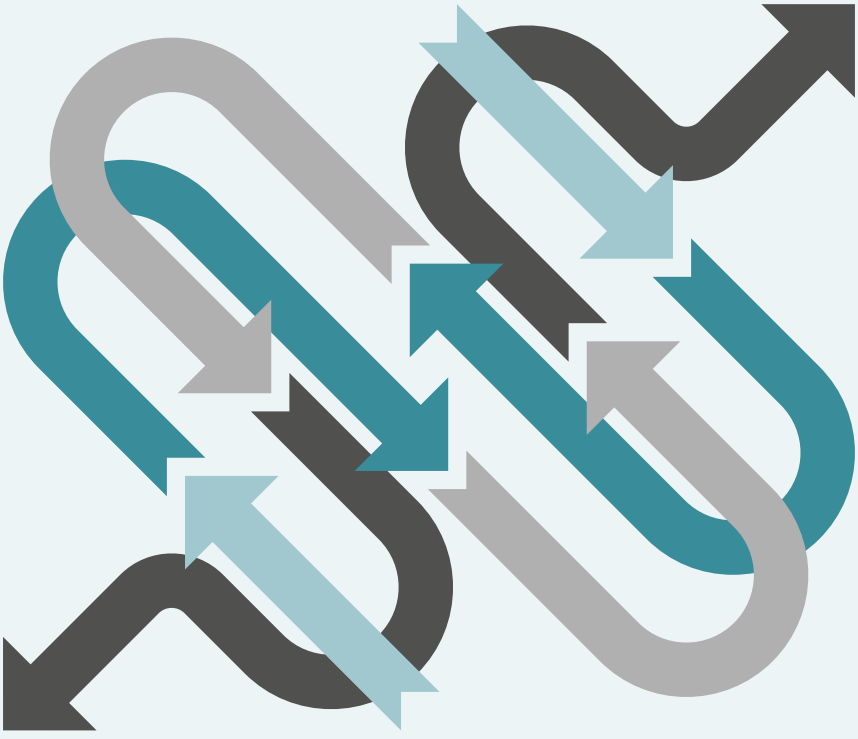
USEFUL GAME THEORY

Fundamentals of Decision Making



Jay Prag
Amanda Ishak Prag

Palgrave Executive Essentials

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Jay Prag · Amanda Ishak Prag

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ISSN 2731-5614 ISSN 2731-5622 (electronic)
Palgrave Executive Essentials
ISBN 978-3-031-75153-0 ISBN 978-3-031-75154-7 (eBook)
https://doi.org/10.1007/978-3-031-75154-7

This Palgrave Macmillan imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Synopsis

Using parables, famous songs, and classic expressions, *Useful Game Theory: Fundamentals of Decision Making* takes readers on an exploration of human nature and the long road of choices known as "life." Prag and Prag turn a mathematical discipline into a digestible (dare we say "enjoyable") read, with a little wit, a lot of sarcasm, a humanist approach—and almost no math. From nuclear disarmament to Friday movie nights, each chapter guides you through a Game Theoretic analysis of the decisions humans make every day.

A grandmother's wit and wisdom are never lost, especially if her grandkids are writers.

Granny Jean
Granny Sue
Sitou Augenie
Sitou Assene

We love and miss you.

Robert, Thomas, and Julianna: it's all for you.

—J&A, 2024

Preface

Using parables, famous songs, and classic expressions, *Useful Game Theory* takes readers on an exploration of human nature and the long road of decision-making known as "life." Prag and Prag turn a mathematical discipline into a digestible (dare we say "enjoyable") read, with a little wit, a lot of sarcasm, a humanist approach—and almost no math. From nuclear disarmament to Friday movie nights, each chapter guides you through a Game Theoretic analysis of the decisions we make each day.

While this book will occasionally wander into the realm of controversy, our hope is that it makes some of the world a little less confusing. Game theory as an intellectual exercise is math-heavy, hypothetical, and full of controls that can render it almost useless. This book takes a more practical approach, applying the tools and lessons of game theory to the real world—a place that is controversial, complicated, uncontrolled, and very confusing.

In these pages, you'll find an approach that's relatable and not heavily analytical. Our goal is to enhance your understanding of game theory by applying it to the decisions and problems humans face every day. Some applications in this book are uncomfortable and challenging to navigate, topics like politics, religion, violence, and societal dysfunction. There are also unconventional uses of economics, sociology, public relations, management, and other academic disciplines. Game theory exists at the nexus of these practices, and it is at the heart of the humanity-based decisions we make every day. We didn't want to show only the good stuff. After all, the human experience is both good and bad.

For those in academia who are uncomfortable with our anecdotal adoption of your areas of study, we offer this advice: focus on the goals of game theory. The discipline grew from a desire to formalize how human beings (from individuals to groups to companies to countries) make decisions. If you're so into math you forget it's about the human experience, you've missed the point. All academic disciplines stem from casual observations of the real world. So, focus on game theory, chill out, and remember: game theory is just another way of thinking about situations. It exists side-by-side with other ways of thinking. It is not a substitute; it is a complement. If applied science is a test of empirical knowledge, let's take the test.

For students of game theory, a bit of advice as well: we're going for breadth, not depth. In the pantheon of game theory games, this book focuses on a relatively small number. There are many complex games that are, more or less, for AI only. There are others that are less complex, but also less relevant to the choices you make every day. We are going to analyze a dozen or so games that resonate with your day-to-day life, and we'll apply those results to quite a few real-world situations.

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Acknowledgments This book was made possible through the partnership and commitment of Bronwyn Geyer and the editorial team at Palgrave Macmillan.

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Amanda Ishak Prag is Director of Marketing for one of the largest architecture and engineering conglomerates in the nation. A marketer for more than two decades, she has helped firms streamline internal and external communications and develop structures for organizational growth. Her research focuses on M&A integration and mass communications strategies. Amanda holds a Ph.D. in Management from the University of California, Riverside, an M.B.A. in Strategy from Claremont Graduate University, and Bachelor of Arts in Economics and Bachelor of Arts in Public Relations from the University of Southern California. She is a coauthor of *Covid-U* and additional empirical works.

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What Is Game Theory?

Your Granny knew game theory. She may not have called it "game theory," and she probably didn't review a whiteboard of advanced calculus to make every decision… But, Granny used it every day. We know this because she understood people. From the nosy neighbor to the annoying aunt to the helpful clerk at the grocery store, Granny knew how to navigate the world and get what she needed. She did it with a lot of wit and the goal of being helpful. We're willing to bet you'd take your Granny's advice over the predictions of a mathematical model any day.

Granny really knew game theory. So did Shakespeare, Aesop, Confucius, Machiavelli, most country singers, and the writers of every major children's book in history. From *The Art of War* to "In the Jailhouse Now," many of the songs, expressions, and parables we heard growing up are actually solutions or approaches to the games we play in everyday life.

Game theory, also known as strategic decision-making, is a simple concept: you and another person make decisions, and together your choices determine a specific outcome. That's really it.

So, why do game theory books have so much darn math? Well, it turns out that all the little things matter. For example: *How many people are making decisions? Are they all choosing at the same time? Do I get to choose first and, maybe, more than once? How often am I choosing, and with whom?* These factors (and so many more) impact how a decision turns out for you, and math can help us quantify and model these factors to get to a predictable outcome. Math is useful, just not in this book. Here, we'll focus on understanding the basics. So, game theory helps us understand the structure and

J. Prag and A. I. Prag, *Useful Game Theory*, Palgrave Executive Essentials,
https://doi.org/10.1007/978-3-031-75154-7_1

probable outcomes for things like which freeway to take, how to get a raise, and how to choose a movie on a Friday night.

Game theory doesn't teach you how to *win* games. It teaches you how to set them up to maximize the likelihood of your best option. What's the difference? Well, as much as mathematics and logic can provide humanity, they're not foolproof. A game theory model can do its best to include all possible variables, but when human beings are making decisions in the real world, things get missed. When people read a book or take a class in game theory, they are often disappointed to discover they aren't learning how to win every game. There are no books or classes to teach you such strategies. All game theory can provide is a way to understand the structure of a game and ways to increase the *likelihood* of your best outcome.

Long before Brouwer, Morgenstern, von Neumann, and John Nash, governments and societies set rules to increase the likelihood of best societal outcomes for situations that happen every day. Laws determine how people in modern society are allowed to play a game. When you drive up to an intersection with stop signs on every corner (a four-way stop), why not just always go through first? That's an approach to solving the game, right? Well, yes, but it's a unilateral decision. It doesn't consider what other players might do (and if everyone followed that approach, there would be a lot of crashes at that intersection). So, the government says you have to stop at a stop sign and look around, and society has given you a preferred way of making a choice (usually, the first person to arrive or the person to the right—in the US—goes first). Rules help set up a game by providing a framework for the players, and any decision strategy is bound by those rules.

Organizations do it too. Disneyland welcomes thousands of visitors daily—visitors from different cultures and countries with different expectations of waiting in line. The thing is, it's Disney. You're going to wait in line. So, how does the mouse make sure things run smoothly? Each park sets up clear boundaries with ropes, walls, fences, and hedges, to guide visitors where they need to go. A trip around the Magic Kingdom shows you there is no ambiguity about what visitors are expected to do. Compare this level of control to your local grocery store the Wednesday before Thanksgiving and you'll start to see organizational boundaries in action.

Unilateral decisions, rules, organizational boundaries—now we're getting somewhere. Game theory is very much a byproduct of human evolution. History, anthropology, and biology are full of examples where unilateral decisions (ex, I should kill you before you kill me) gave way to more cooperative solutions that helped our species thrive. When other people make choices that ultimately determine an outcome, self-interest can turn out poorly for

everyone. It's why Granny told us "Do unto others as you would have others do unto you." Granny knew game theory.

Strategic decision-making is not only limited to games here and now. On the contrary, many of the choices we make are playing games with our "future selves" (as Doc Brown might have said to Marty McFly: you have to think fourth-dimensionally). Your choices today combine with your future choices to determine an outcome later in life. The marketing slogan "What happens in Vegas stays in Vegas" is an attempt to convince you that your current choices do *not* affect your future outcomes. One trip to Sin City makes it clear that the slogan isn't really true. Most of the time the only thing that stays in Vegas is the money that you gambled away.

Game theory in a classroom is rooted in mathematical theory. Strategic decision-making, on the other hand, is the system we humans have grown up within. You learn a lot about life through experience and daily trial-and-error. That's the point of many of Granny's expressions. She's trying to save you from some potentially painful learning curves. On a good day, Granny understood context and how to set up a game for her benefit. When you told her you were going to Vegas, she might have said, "waste not, want not." She was warning you about the value of saving and the risks of gambling. On the other hand, if she was really cool, she might have just asked you to put $10 on red.

Granny and all of the purveyors of worldly wisdom give us approaches to problem-solving, but they didn't have time to teach all of the nuances: when does that approach work? Why is it better? Why does setup matter? This book will fill in a few of those details.

Many games that Granny played during her lifetime look different today. We'll teach the game theory behind the expressions to see when, or if, they still apply in the modern world. When Granny's Granny taught her "be careful what you ask for, you might get it," there was no Internet, Facebook, AI, or screenshotting. Granny might not know that in the current world, the expression is cautionary in a lot of new ways.

"You can't tell a book by its cover" is an expression that teaches us not to overstate the importance of external factors. Arguably, this was Granny's way of saying "don't be prejudiced," but it's going to have special meaning in this particular book. This book's title makes game theory seem folksy and perhaps even easy. It is not. Game theory is complicated, subtle, and easy to get wrong. Granny was smarter than any PhD. So, we might as well start with her best hits.

What *Is* Game Theory?

Spoiler Alert: it's not really a game, and it isn't really a theory.

Game Theory is an attempt to formalize the structure and outcomes of a situation when two or more people are making choices that together lead to an outcome. No one player can unilaterally determine the outcome; it depends on the decisions of both people. *Strategic Decision-Making* is the process of making choices and decisions knowing that there are other "players" making their own choices and decisions, and that the combination determines how you all end up. Game theory is the discipline that looks at how these decisions are made, with an eye toward how to achieve mutually beneficial outcomes.

That's easy! In everyday life, we always think strategically, analyze a situation accurately, run the numbers, and make the best choices, right? Nope.

In the real world, we are emotional, spontaneous, unpredictable, and sometimes wrong. You use game theory every day. It's innate, it's automatic. You do it when you're in a relationship. You do it when you are a parent. You do it when you are driving. You do it when you decide to have another helping of ice cream *with* sprinkles. Game theory began by observing human decision-making and applying math to explain patterns and predictability. At its foundation, though, is the thought process (or lack thereof) we engage in multiple times a day.

Let's do the four-way stop game, now with more detail.

A Four-Way Conundrum

You're driving your new car, and you arrive at an intersection at the same time another car arrives perpendicular to you (across from you) signaling its intention to turn across your path (in the US, it has its left blinker on). Clap those hands, it's game theory time.

If you both go, you're going to crash. Let's assume that's not the outcome either of you wants.

If neither of you go, you'll just wait there forever. That too is not, you know… a great outcome.

You might be thinking "there are driving rules and regulations that tell us what to do." Are you sure both of you know the same rules and always use them correctly?

You're not in a hurry and you're driving your brand-new car, so you wave at the other driver to go. They turn out of your way first, you drive through

the intersection second, there are no collisions, and everyone makes it to their destination.

You just did a lot of game theory! You and the other driver made choices—you waited and the other driver proceeded—and that combination of choices led to a good outcome. You and your car made it to your destination and you're happy with how things turned out. In the game's payoff matrix, a list of potential outcomes, you are both better off. The other car used a literal signal to tell you where it needed to go. You used a signal, a wave, indicating you would let them go first. All is well.

The structure of the four-way stop above is what we call a two-player, two-choice, simultaneous game: you each made choices at the same time. Game theory will help us break down other variations of this everyday choice. For example, would you have done the same if you were in a beat-up, hand-me-down car instead? If you were in a rush? As we will see, structure combines with preferences to determine an outcome.

Four-Way Stop—Rush Hour Version

While the four-way stop is a nice, generally painless type real-world game, we can complicate things by adding more information. When you and another driver get to a four-way stop at 1:30pm on a lazy Thursday afternoon, there's usually a lot of cooperation and the game solves quickly and easily. If you play the same game with the same people and at the same intersection at 7:45am when people are trying to get to work or get their kids to school (or both!), things are very different.

As the clock ticks toward "you're late," you find yourself blowing your horn at drivers. That's a very different type of signal. You might also coast through the sign, rather than stopping. Your nice, generous wave changes to a not-so-nice one-finger gesture. Time is just not on any player's side.

There's a deeper issue here. As we discuss our games and work through the paths to solutions, think about how choices and outcomes change with factors like duress. How you perceive and play games changes with the circumstances under which the game is being played.

Game Structure

When we talk about structure, we mean all of these nuances and factors that can affect players, choices, and outcomes. Let's not wander too far from our first game, the four-way stop. What was the structure of the game? There were two drivers, so two decision-makers; they had two choices (wait or go); and they both had some internal desired result. They also had constraints: they were in a hurry, or they worried about their new car. Implicit and important to the outcome is an assumption of what's often called rationality. There's more to rationality (a lot more), but for now, let's just say neither had an incentive to crash.

Zero-Sum Games

The payoff of a game should be familiar for most of us: it is the set of possible outcomes for each player based on their decisions. If you're a sports fan, a payoff is the potential score from a play or series of games. More often, though, it's simply a matter of somebody winning and somebody losing.

This is called a zero-sum game, where there's one winner and one (or many) losers. Zero-sum games got their name by applying numbers to a win/loss combo: a win is + 1, a loss is − 1, so, technically, the sum is zero. There is no middle ground. There's no possibility for everyone to come out a winner. These definitions are perfectly fine when we're thinking about payoffs (ex, 0/1), but the vast majority of interpersonal games we play every day, the sort of games we'll be discussing, are not zero-sum games.

Arguably, zero-sum games are easier to figure out. More points = win; not very much to unpack here. Having no middle ground between winning and losing removes having to think in terms of "better off" or "worse off." Real-world problems are not so easy to solve. When *you* "get your way" in a decision with your significant other, are you both always better off? You won! But it doesn't always feel like a win, right? Does getting your way ever conflict with your relationship dynamic?

Sometimes, we wish we could resolve every conflict with a game of pickup basketball, but that's not real life. The thought process you just went through is precisely why zero-sum games are easier than most interpersonal games, and why most games in life are not zero-sum.

What's in a Game?

The traditional approach to game theory starts by defining three elements present in every game: the **players**, their **choices** (often called a "choice set"), and the **outcomes**. We call these the "who," "how," and "what" of a game, something like this (Fig. 1.1):

Most books start with the outcomes. These are called payoffs, or simply the results of the game. Remember, the goal of game theory is to find the "best possible outcome" and see how, if at all, players can get there.

Starting with outcomes is, well, backwards.

Humans evaluate their environment every minute of the day. *Then*, they make choices. In this book, we show that the setup of the game—understanding the players and the choices—is, in fact, the most important aspect for players. If we want to test theories and apply them to the real world, we should take the same approach humans do in everyday life. Think of it like this: you can negotiate a four-way stop better now than you did when you first started driving. Why? Even though the outcome is the same (don't crash), your older, wiser, more-experienced self knows how to read other players and the potential choices better. Understanding players and choices *first* helps you win more games.

Our goal is to examine the "best possible setup," to achieve an outcome that may change over time. So, let's start with the Players, then Choices. In theoretical games, the outcome only needs be proven (usually mathematically) once. In applied game theory, results need to be repeated to have any validity. At the end of this book, we hope the reader has a broader understanding of how to evaluate players and choices toward better outcomes across many types of games.

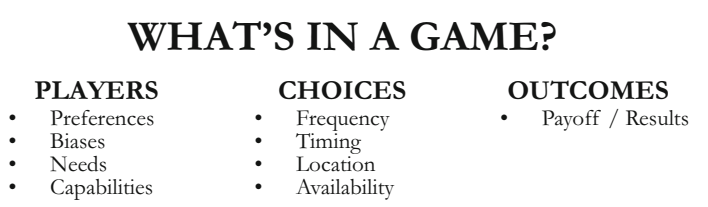

Fig. 1.1 What's in a game? Elements of games in game theory