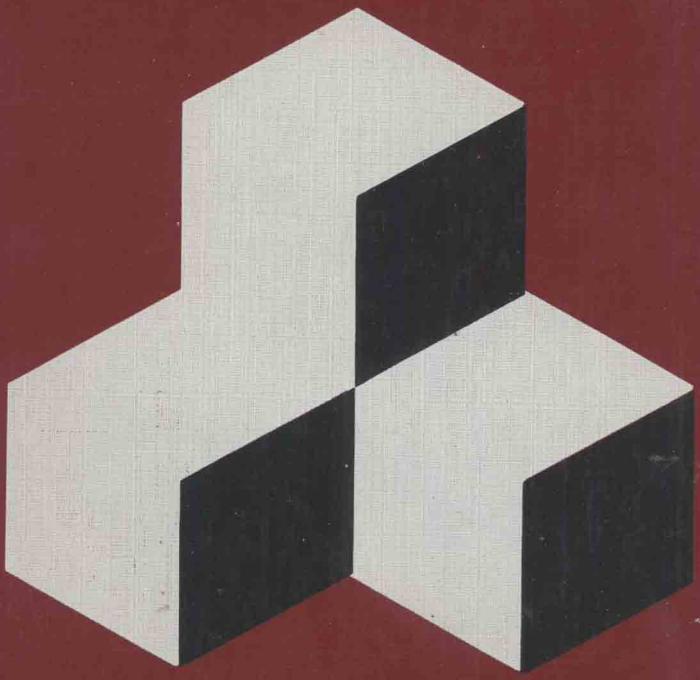
JAMES A. SCHELLENBERG

PRIMITIVE GAMES



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James A. Schellenberg

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PREFACE

In this book I try to do two things: (1) outline a simplified form of game theory that I describe with the adjective of "primitive," and (2) show how such primitive games may be applied to specific areas of empirical research. The first five chapters are primarily devoted to the first of these two objectives, while the second objective is pursued in the last five chapters.

The first five chapters may be broadly called theoretical in the sense that they show how primitive games relate to the broader framework of the theory of games; they further provide a general discussion of the different types of primitive games. We begin in Chapter 1 with a general and appreciative introduction to the theory of games. Chapter 2 turns more critical in pointing to serious limitations in classical game theory, especially related to the conceptualization of utility. In Chapter 3 we present our conception of primitive games and show how primitive models may avoid some of the problems previously identified. In Chapters 4 and 5 we present a general taxonomy of primitive games and discuss illustrations of all main types of such games; Chapter 4 includes the extreme types (pure conflict and no-conflict games), and Chapter 5 covers the more numerous forms in between (mixed-motive games).

The last five chapters deal with applications of primitive games to particular areas of social research. In Chapter 6 we examine an experimental study which shows that the dynamics observed in primitive games are not simply reducible to those of rank-order formats. Chapters 7 and 8 together deal with the search for a general solution to predicting bargaining outcomes; Chapter 7 introduces the nature of "the bargaining problem," and Chapter 8 presents empirical work designed to test several models which predict different resolu-

tions of that problem. Chapter 9 shows how primitive game formats may be applied to cases of international conflict. Finally, in Chapter 10 some general conclusions are drawn about the relationship of primitive game models to real world events.

Four appendices follow the main text of this book. Appendix A gives a listing and summary characterization of each of the strategically distinct forms of 2 x 2 primitive games. Appendix B provides formulas for measuring the degree of conflict of interest in two-person primitive games. Appendix C provides a further analysis for an effect identified in Chapter 8 as the "exchange bonus," dealing with how the provision of side payments may sometimes extend the range of mutually positive outcomes. Appendix D shows how primitive games may be extended to consider ranked preferences.

In presenting these materials, I have an audience of social science professionals and students primarily in mind. I say "social science" because the implications of these ideas extend far beyond those of any one discipline. Although I claim sociology and social psychology as my own home disciplines, the work here presented should be equally of interest to economists and political scientists--and anthropologists, historians, and philosophers should also be among those who find materials of interest for their areas.

Technically, of course, game theory arose as a branch of mathematics. However, I consider mathematicians as likely to be less interested in this work than social scientists, given our deliberate removal of most of the numerical qualities of game theory. In fact, no special mathematical knowledge is assumed on the part of readers. Whatever mathematics is required is provided as we go along, including the general introduction to game theory provided by Chapter 1. This does not mean that the materials presented will always be simple to understand, only that no special previous mathematical skills will be required beyond that of a normal secondary education. I also avoid assuming other forms of specialized technical competence on the part of readers. I do so because I see readers as likely to be a varied lot in terms of areas of academic backgrounds; therefore, I try to assume only a willingness to explore the ramifications of this particular (and quite simple-minded in its basic assumptions) approach to the study of strategic interaction. In order to keep most of the main text on a level which may be easily understood, I have usually placed my more technical comments in the notes (found following each chapter) and in the appendices (at the back of the book).

I draw upon illustrative materials from a great variety of subjects to develop ideas about primitive games. In doing so I wish to point out how very widely the ideas of primitive games may apply--from family relationships to international conflict, and from incidental matters of everyday living to ultimate theological issues. This variety of cases (some posing very serious dilemmas and others admittedly presented with tongue-in-cheek) is intended to help

make the very serious point that similar structures of strategic interaction have their own special pattern of dynamics. These dynamics hold true for all cases of the same basic structure--regardless of the particular content that may be associated with an individual case. I hope that this idea comes across more clearly by presenting a wide variety of examples than it would with a more restricted range of subject matter.

Needless to say, I have drawn upon the work of a great number of scholars in writing this book. Most of these are indicated by my listing of references at the back of the book, though there are others who have also been influential--even though I haven't particularly cited their writings. At this time I would like to give special mention to several persons whose writings particularly stimulated me to think seriously about game theory, including both its values and its limitations for social science applications. Here I have in mind especially Kenneth Boulding, Steven Brams, Anatol Rapoport, and Thomas Schelling. I also wish to mention two persons closer to my own primary fields of sociology and social psychology who have had a more personal influence upon some of my work here shown. Here I think especially of Douglas Heckathorn, a sociological friend who has encouraged me in these more formal directions, and Daniel Druckman, a social psychologist who has helped to keep me aware of the limitations of formal models. Without naming particular names, I also wish to acknowledge the importance of the editors of journals (especially the *Journal of Conflict Resolution* and *Behavioral Science*) and persons promoting and participating in scientific meetings (including those of the Peace Research Society (International), the American Association for the Advancement of Science, the North Central Sociological Association, and the Midwest Sociological Society) in which some of these materials were first presented. Without this stimulus for development and critical evaluation, many of the ideas here presented would never have taken their present shape. Finally, I am especially appreciative of the staff at Westview Press for helping to shape this work into its final product.

James A. Schellenberg
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Part One

THEORY

Chapter One

THE PROMISE OF GAME THEORY

Few books in the history of social science have had an impact comparable to that of *Theory of Games and Economic Behavior* by John von Neumann and Oskar Morgenstern. The fully developed theory of games they presented created both a new branch of mathematics and a promising new intellectual tool for the social sciences (von Neumann and Morgenstern, 1944).

A mathematician with many scientific contributions (he was a pioneer in the early development of computers as well as a key contributor to both the atomic bomb and the hydrogen bomb), von Neumann had previously developed some of the central mathematical ideas of the theory of games.[1] But it was only through his collaboration with the economist Oskar Morgenstern that the full structure of the theory was set forth. Furthermore, the theory was presented not only as a mathematical treatise but also, as the title suggests, as a new way of dealing with the subject matter of economics. As the authors asserted in the preface to their first edition:

> Our major interest is, of course, in the economic and sociological direction. Here we can approach only the simplest questions. However, these questions are of a fundamental character. Furthermore, our aim is primarily to show that there is a rigorous approach to these subjects, involving as they do, questions of parallel or opposite interest, perfect or imperfect information, free rational decision or chance influences (p. v).

In other words, here were presented some very basic tools intended for the analysis of a wide range of fundamental questions in the social sciences.

Key Conceptual Contributions

Among the most basic contributions of von Neumann and Morgenstern was their reconceptualization of the nature of utility. The concept had been widely used for many years by economists, who recognized that the real desirability of an outcome was not to be equated with its monetary value. More than two hundred years before von Neumann and Morgenstern presented their work, Daniel Bernoulli had set forth the basic idea of subjective utility (though he called it "moral worth") as the fundamental basis of decision making.[2] What von Neumann and Morgenstern added was a better rationale for treating utility as something which could be measured on an interval scale. In so doing they presented a framework for the comparative evaluation of any object of human experience, not just those which are normally expressed in terms of monetary values.

We may start with the fact that persons can express preferences (or indifference, should there really be no preference) between possible outcomes. Assuming only that there will be consistency in the pattern of preferences, we can present a person with a series of hypothetical choices. Then from the responses given we can identify a rank order of preferences for all outcomes evaluated (incuding some tied ranks for cases of indifference). But this gives us only a ranking of preferences, not numerical measures of utility. How can we transform these ranks into numerical measures?

Von Neumann and Morgenstern use the idea of a lottery to move from a rank ordering of preferences to interval measures of utility. By combining preferences for outcomes with hypothetical probabilities of their occurrence, we can present persons with such choices as:

x. $100 for certain; or
y. a 50-50 chance of winning either $500 or nothing.

If we get any response except indifference to such a choice, we can continue by increasing (or lowering) the value of x until we get indifference. This would allow us some measure of a sure thing (as compared to risk) in monetary matters. By repeating choices using other amounts of money, we should soon be able to see how this person's utility curve compares with a curve of actual values of money (for most people, as Bernoulli pointed out long ago, equal increases in wealth are valued less by wealthy persons than the poor, so the utility curve would not continue to rise as fast as that for monetary values).

But we need not stop there. We can go on to compare sure things and probability mixtures for all kinds of outcomes. For example:

x. the certainty of a piece of cherry pie; or
y. going out for the football team with a one-in-ten chance of making the squad.

That this is a ridiculous choice to ask a person to make only shows the versatility with which we can expand our lotteries for hypothetical choices. *Any* object of repeated human experience can be included. And by varying the probabilities of lotteries presented, we can derive a measure of *how much* we prefer one object over another. We can, in other words, derive a set of numbers to represent the relative preferences of this person for anything we wish to include. These numbers can then become our measures of utility.[3]

Hypothetically, then, a utility scale can measure the relative preferences of any individual for any number or variety of possible outcomes. Obviously, such measures of utility are specific to the individual and therefore cannot be directly compared to those of other persons. They represent measures of an individual's relative preferences, and we can assume that the actual choices of the person will be toward objects identified with the highest measures of utility.

A second major contribution of von Newmann and Morgenstern was their reconceptualization of the idea of strategy. There is a long history of social science thinking that can be broadly characterized as "strategic." The author has elsewhere called this "the Machiavellian tradition," using the following justification:

> Machiavelli bases his analysis on real-world realities; he assumes that means must be considered realistically in relation to ends; that the likely behavior of others must be realistically assessed; and that from these considerations general policies of action may be formulated. These are all central elements in what is generally considered strategic thinking (Schellenberg, 1982, p. 152).

The theory of games also fits within this general tradition. However, the concept of strategy takes on a specific meaning within game theory which is much more restricted than what is generally implied when we refer to strategic thinking. To see how this occurs, we must take note of some of the assumptions usually made in the theory of games.

Among the primary assumptions used by game theory are these:

1. Games always involve two or more players, each with some ability to choose between alternatives.
2. Each available alternative is fully known to each player.
3. All possible outcomes which might occur to any player may be expressed in terms of numerical measures of utility.

4. Each player will make those choices which will allow him or her the maximum expected utility.[4]

Within these assumptions, any decision rule for how a person is to choose may be identified as a *strategy*. It is an important contribution of von Neumann and Morgenstern's theory to reduce the general notion of strategy to a more precise concept which may be subjected to a rigorous mathematical analysis. Game theory provides this mathematical framework for evaluating the effectiveness of different possible strategies for any situation that can be represented within its assumptions.

Escaping Moriarty

At this point, a reader not already familiar with game theory may find it helpful to see how a concrete situation may be turned into a formal game of strategy. For an example we use a case discussed by von Neumann and Morgenstern (1944, pp. 176-178), in turn taken from the Sherlock Holmes story, "The Final Problem" (Doyle, 1976).

In this episode Sherlock Holmes is seeking to escape from the cunning Professor Moriarty by going to the European continent. He boards the train at London for Dover, from which he plans to proceed to the continent by boat. But just as the train pulls out of the station, Holmes observes Moriarty on the platform. Suddenly Holmes realizes that the professor knows he is on the train and will be pursuing him to seek his destruction. Holmes takes it for granted that Moriarty has the means to arrange for a special train to pursue him, and that this is what will be done.

As Holmes considers the situation, he is well aware that his train has but one stop, Canterbury, on the way to Dover. He could simply get off at Canterbury. But Moriarty must surely know this too, so that he should direct his special train to stop at Canterbury if he senses that this will be Holmes' destination. Recognizing this, maybe Holmes is better off continuing on to Dover; but then Moriarty, realizing this as well, would probably go directly to Dover too, with the opportunity to attack Holmes there.

Once we identify all possible outcomes of a decision-making situation, we can show them in the form of a decision chart. For the episode we have just described, we can make the following representation: