An Economics of War & Peace

Adam Hamdan

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Abstract

This paper is meant to provide the reader with a brief historical account of Game Theory's creation, while contextualizing some of the discipline's most notable academic ambitions, political intentions and practical limitations.

Keywords: game theory, strategy, atomic war, conflict resolution.

Introduction

Game Theory is the mathematical analysis of strategic behavior and interaction amongst rational decision-makers, referred to as players. By making several simplifying assumptions, the game theoretic approach attempts to reduce complex problems to very simple ones, which are then solved by finding an equilibrium point through rigorous mathematical models. Popular amongst scholars, gamblers and military thinkers alike, few disciplines have had a range of applications as diverse as that of Game Theory. Since its creation in the early 20th century , this method of problem solving has been used extensively in several fields such as computer science, biology, political science, philosophy and most notably, economics (Leonard, 1995).

This paper first provides the reader with a brief historical account of Game Theory's inception and expansion through the Cold War. It will then focus on one of Game Theory's applications, namely by discussing how game theoretic approaches have been used to reach cooperative outcomes. Finally, we will tackle the question of Game Theory's usefulness, by analyzing some of the discipline's limitations in most practical contexts.

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Rigorization of a Social Science

While the study of strategic games has indeed been carried out before John Von Neumann – notably with French mathematician Émile Borel's series of 1921 papers on *"la théorie du jeu"* – the field of Game Theory is said to be officially born out of Von Neumann's 1928 paper, *Theory of Parlor Games*, which included his famous *minimax theorem* (Poundstone, 1993:41). A few years after his publication, Von Neumann decided to leave Europe and became an appointed professor at the Princeton Institute for Advanced Study where he remained for several years. There, the Hungarian polyglot, logician, quantum physicist and mathematician carried out many projects of remarkable scope, which include contributions to the Manhattan project and the development of the first digital computer to name a few (Poundstone, 1993:76). It was also at the Institute that Von Neumann first collaborated with Austrian mathematician Oskar Morgenstern, with whom he would eventually co-author the ground-breaking book, *Theory of Games and Economic Behavior* (Von Neumann & Morgenstern, 1944). According to Robert Leonard, this seminal book came as a result of the authors' shared ambition to rigorize economics (Leonard, 1995). Through Game Theory, Von Neumann hoped to provide a sound axiomatic system able to tackle all problems of economic nature, in an effort to establish economics as an exact science. This kind of goal was not uncommon amongst many scholars of this period, who amidst an era of mathematical formalism, attempted to extend the axiomatic approach to many disciplines (Leonard, 1995). As for Morgenstern, one can sum up his stance on the importance of mathematical rigour through his crude criticism of John Maynard Keynes' economic approach, calling him "a scientific charlatan" in a diary entry dating back to 1942 (Leonard, 1995).

After four years of collaborative effort, *Theory of Games and Economic Behavior* was finally published for the Princeton University Press in 1944 (Poundstone, 1993:6). Today, it is considered to be one of the most influential mathematical works of the 20th century and continues to serve as a foundation for most contemporary game-theoretic research.

The Atomic Game

In a 1956 paper titled, *Theory of Games of Strategy*, featured in the Applied Mechanics Review, Melvin Dresher describes the new Theory of Games as one which follows models "patterned on actual parlor games such as chess and poker" (Dresher, 1956). One can indeed trace the development of Game Theory as a direct consequence of Von Neumann's interest in the social interactions of such strategic games and their potential mathematical treatment (Leonard, 1995). But despite its innocent beginnings as a tentative theoretical analysis of card games, Game Theory's first practical application took place during the second World War, and concerned itself with potential bombings against the Japanese forces (Poundstone, 1993:68). By developing a series bombing schemes, mathematicians John Tukey and Merrill Flood used Von Neumann's existing work on Game Theory to optimize the efficiency of the nuclear weapon when used against Japan (Poundstone, 1993:68). Von Neumann, who had been nurturing his military consulting experience since 1937 (Leonard, 1995), was not only contributing to the deployment of the atomic bomb but to its design as well. In 1943, he worked with theoretical physicist J. Robert Oppenheimer at Los Alamos to create the implosion bomb, which would eventually be the model used on Hiroshima and Nagasaki (Poundstone, 1993:67).

Fight or Acquiesce

Unfortunately, this was only the beginning of Game Theory's long streak of military purposes. A few years after their pioneering publication, both Von Neumann and Morgenstern took up research positions at the RAND corporation, an American think-tank that supported the United States' military efforts against the Soviet Union (Poundstone, 1993:94). Considered by many as a prime example of "modern Machiavellianism" (Poundstone, 1993:83), the RAND corporation was notorious for the incredible amount of intellectual freedom it gave its scientists and for its aggressive agenda. Employing researchers and academics from a wide range of fields, it quickly became the home to the world's most prominent game theorists and analysts. In the 1940's, MIT professor and RAND consultant John F. Nash went on to study non-cooperative games and extended Von Neumann's analysis of the equilibrium concept. Nash focused on non-zero-sum two-person games, as well as games with multiple players, and proved that every two-person finite game has at least one Nash Equilibrium for which no player can be made better off without changing the other player's choice (Poundstone, 1993:99). In 1950, two fellow RAND mathematicians by the names of Merrill Flood and Melvin Dresher sought to challenge Nash's equilibrium theory. In doing so, they devised what would become the most researched and best-known game of conflict to exist, the famous *Prisoner's Dilemma*.

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Cold Solutions for a Cold War

When it came to Von Neumann's stance on the Cold War, the mathematician held the firm belief that preventative war against the USSR was the only right option. A quote of his featured in a 1950 issue of *Life* magazine reads: "If you say why not bomb them tomorrow, I say why not today? If you say today at 5 o'clock, I say why not one o'clock?" (Poundstone, 1993:143). But although most of Von Neumann's contributions to Game Theory were used to perpetuate warfare in one way or another, this was not the case for all game theorists. Some academics, much less cynical than Von Neumann, attempted using a game theoretic framework to reach cooperation, rather than achieving victory, in situations of conflict. Thomas Shelling – an American economist and political strategist – is a remarkable example of such thinkers. In his book, *The Strategy of Conflict*, published in 1960, Schelling introduces several new concepts such as "focal points" and "credible commitments" to paint a more realistic picture of conflict situations. He also highlights the importance of interdependent decisions in game theory models and provides the reader with insight concerning the different methods by which cooperation can be reached in games (Schelling, 1960). His later works *Strategy and Arms Control* (1961) and *Arms and Influence* (1966) would also emphasize the importance of limiting of nuclear warfare and the possibilities of promoting nuclear deterrence through Game Theory.

Tit for Tat

Another prominent economist whose contributions to peace research and the study of cooperation are worth noting is Anatol Rapoport. In a 1965 research paper titled *War Hawks and Peace Doves: alternate resolutions of experimental conflicts*, Rapoport and three of his colleagues designed a modified version of the prisoner's dilemma in which players chose a degree of cooperation rather than total defection or total collaboration. This modified game also took into account the personality traits of the participants and proved that circumstances played a great role in determining the likelihood of cooperating (Rapoport et al., 1965). Fifteen years later, Rapoport devised a simple strategy called *Tit for Tat* in which a player would collaborate in the first period then mimic what the other player did on the preceding move for all subsequent periods. The strategy gained recognition after its remarkable performance when it was tested in a series of computer experiments concerning the potential outcomes of a repeated prisoner's dilemma. These experiments, which were conducted by a

Professor of Political Science and Public Policy at the University of Michigan named Robert Axelrod in 1980, consisted in multiple computer "tournaments" in which scholars from all over the world were invited to submit a strategy of their choice and compete in an iterated version of the prisoner's dilemma (Poundstone, 1993:236). The submitted strategies would then go up against one another in a tournament-like fashion to see which strategies would result in the highest amount of cooperative outcomes over 200 periods (Axelrod & D. Hamilton, 1981). Rapoport's *Tit for Tat* strategy was the simplest of all the candidates' strategies and yielded the highest cooperative score during tournaments. Most importantly however, it established a game theoretic justification for biological instances of cooperation while hinting at the promising applications of flexible strategies that urged players towards a reciprocal cooperative outcome (Axelrod & D. Hamilton, 1981).

From Warfare to Welfare

The Evolution of Cooperation, written by Robert Axelrod in 1984, investigates the social and biological structures that dictate the natural behaviors of humans in situations of conflict and cooperation. In Chapter 7, Axelrod summarizes several ways to alter the setting of an interaction in order to encourage cooperative outcomes. These methods include alterations to the players' payoffs schemes, modifying the players' opinions and perceptions of reciprocity and altruism, and most notably extending the "shadow of the future" (Axelrod, 1984:126). The repetition of interactions creates a relationship between the players which makes them more likely to settle on mutual cooperation. Similar ideas to those of Schelling and Rapoport would be explicitly and implicitly used in deterring the use of nuclear arms. Additionally, Schelling would dedicate much of his later work to the proliferation of cooperation. In his 2005 Nobel Prize lecture, the economist discusses the "legitimization" of nuclear weapons and how to prolong peace in future years (Schelling, 2006).

Limitations of Game Theory in Practice

Rational Choices, Irrational Assumptions

As promising as Game Theory seemed to be when it first came to life in the early 1900's, one can hardly claim that its founders achieved their goal of establishing a new exact science of economics. This is mainly due to the many factors that limited the theory's precision and applications, which include bias and unsupported assumptions amongst other things. As Rapoport put it in the *Scientific American*, "[...] of what practical use are results based on arbitrary assumptions?" (Poundstone, 1992:171). Of these assumptions, perhaps the most concerning one is the Rationality assumption. Most game theoretical models indeed assume that players are perfectly rational and that the outcomes of their games will be purely determined by their payoff matrix. However, both experimental studies and real-life applications have shown this assumption to be very unreliable (Poundstone, 1992:173). In a response to these criticisms, Oskar Morgenstern insisted that, like any other mathematical model, Game Theory tries to find a balance between simplicity and accuracy, and hence its simplified assumptions will never portray an accurate description of all social interactions (Morgenstern, 1964).

Playing for Fun?

Thorough reflections concerning the impact that Game Theory had on wartime decision-making led many to regard the discipline as an exemplary case of the dangers that a reductionist approach poses to ethics. As Poundstone writes, some went as far as calling it a "tool for justifying the nuclear war." (Poundstone, 1992:168). This opinion was also expressed by many scholars at the time. In 1970, Anatol Rapoport published a paper titled *Can peace research be applied?* in which he outlines the struggles that come with institutionalizing research and getting public support (Rapoport, 1970). In an earlier paper on Game Theory and its applications, Rapoport also insisted on the importance of discerning between the discipline's theoretical strengths and its applicability (Rapoport, 1962). Several decades later, many academics still challenge Game Theory's theoretical claims, and accuse certain game theoretic models of perpetuating the game theorists' bias and hindering our understanding of conflict situations (Stone, 2001).

Discussion

By the end of the Cold War, the study of cooperation and defection had become a subject of interest to researchers across many disciplines. The frameworks and examples that Game Theory provided were seen as useful and intuitive tools to better understand the ethical questions posed by situations of conflict. From a historical standpoint however, one could argue that Game Theory's elegant approach might have come at a worrisome cost. Since Von Neumann's *Theory of Parlor Games*, over a dozen economists have received the Nobel Prize in Economic Sciences for research relating to Game Theory. Today, certain economists are even using Game Theory to help better the design of markets, reduce inequality, and tackle pressing issues such as climate change (Kominers et al., 2017). Whether Game Theory's usefulness lies in its theoretical importance as a mathematical synthesis of most economic problems, or in the perspective it brings to any study of human behavior, the discipline continues to have an irrevocable impact on the entire field of economics, one whose advantages and downfalls must be acknowledged by the academics who choose to further its applications.

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