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Game Theory: Types, Impacts, Strategies, Applications And Limitations

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ABSTRACT

A subfield of applied mathematics called "game theory" examines strategic scenarios in which participants make decisions on how to best maximize their gains. It is now a common instrument used in many different types of investigations. The attempts have been made to give a group of people who have distinct objectives in mind a normative guidance to rational behavior. The only quantitative method for problem analysis that has been devised to yet is game theory. It is the only field in which concepts with fairly divergent logic may be formally represented while utilizing the highest level of mathematical complexity. We were motivated to work on game theory because of its broader applications, its ability to identify conflicts and problems in real life, and its scientific investigation of these issues to provide a feasible solution. We have discovered that a player's ability to make a personal move that is successful in a given scenario depends on their deliberate selection of one of the available movements. In a class game, each move could be interpreted as a private game. As each player carefully selects one of the options available for a certain piece position on the board in turn.

Keywords: Game theory, players, standard tool, mathematical sophistication.

INTRODUCTION

All that game theory is the study of decision-making that is interactive. When a group of people's decision-making dilemma is interdependent, they are said to be players, teams, corporations, or countries in a game. Therefore, in a multi-agent framework, each agent's behavior is dependent on how one agent's actions impact the other agent(s)' payout. We covered game theory in relation to company competition in the previous unit. Many real-world scenarios featuring strategic interdependence, in which multiple agents participate in decision-making, can be encountered (such as in games of baseball, football, or soccer). To solve issues involving strategic scenarios, economists use a variety of general tools. Across actuality, game theory has been applied across a wide range of disciplines in recent years, including political science, sociology, computer science, and biology, in addition to economics.

The Game Theory

Augustine Cournot's analysis of an imperfectly competitive market in 1838 is credited with

laying the groundwork for game theory. The Theory of Games and Economic

Behavior by Neumann and Morgenstern, which was published in 1944, is the first comprehensive attempt. John Nash made the next significant advancement when he proposed the idea of "Nash Equilibrium." In an effort to provide a theoretical response to the issues raised by uncertainty in games of chance where rational players make decisions in an interdependent setup, game theory was developed. It consists essentially of a formal framework and a collection of methods for examining how logical agents interact in strategic situations.

When anything is referred to be a "rational agent," it means that a single ZKR is presumed to consider all relevant data, event probabilities, and possible costs and benefits in order to carry out the action that will provide the best predicted result for itself out of all viable options. A "strategic scenario" is characterized by a situation in which the activities of one person impact the utility or payout (or reward) of other people. Many different aspects of human behavior in social, political, and economic contexts can be modeled using game theory. Models based on game theory aim to simplify complex strategic situations. Like in case of Perfect competition, Monopoly and Imperfect competition, game theory involves generalising the methods used earlier and with the help of some specific language arrive at a mathematical representation of the strategic situation. Let us now discuss some preliminaries related to the topic.

A theoretical framework known as "game theory" is used to create social settings involving competing players. Game theory is, in a sense, the science of strategy, or at least the best way for independent, rival players to make decisions in a strategic environment. Mathematicians John von Neumann and John Nash, along with economist Oskar Morgenstern, were the main proponents of game theory. The study of how and why people and other entities—referred to as players—make decisions in various contexts is known as game theory. It is a theoretical framework that helps with the creation of social settings with rival actors.

Game theory can be thought of as the study of strategy, or at least the best way for independent, rival agents to make decisions in a strategic environment. A wide range of circumstances are mapped out and their most likely outcomes are predicted using game theory. For example, businesses can use it to decide how to handle a litigation, decide whether to acquire another company, and set prices.

The Basics of Game Theory

The game is the center of game theory since it represents an interactive scenario between logical participants. The fundamental idea of game theory is that the outcome for one player depends on the other player's strategy. The game presents the identities, preferences, and available strategies of the players along with the ways in which these strategies impact the result. There may be more prerequisites or presumptions depending on the model.

Applications of game theory are numerous and include business, politics, economics,

psychology, and evolutionary biology. Game theory is still a new and evolving field, despite its many breakthroughs.

Game Theory Definitions

Any time we have a situation with two or more players that involve known payouts or quantifiable consequences, we can use game theory to help determine the most likely outcomes. Let's start out by defining a few terms commonly used in the study of game theory:

- Game: Any set of circumstances that has a result dependent on the actions of two or more decision-makers (players)
- Players: A strategic decision-maker within the context of the game
- Strategy: A complete plan of action a player will take given the set of circumstances that might arise within the game
- Payoff: The payout a player receives from arriving at a particular outcome (The payout can be in any quantifiable form, from dollars to utility.)
- Information set: The information available at a given point in the game (The term information set is most usually applied when the game has a sequential component.)
- Equilibrium: The point in a game where both players have made their decisions and an outcome is reached

How Game Theory Works

Explaining the strategic moves made by two or more players in a scenario with predetermined rules and consequences is the aim of game theory. When there are two or more players involved and there are known payouts or measurable repercussions, game theory can be used to assist identify the most likely outcomes. The game, which is an interactive scenario with rational players, is the main subject of game theory. The fundamental idea of game theory is that the outcome for one player depends on the other player's strategy.

The game presents the identities, inclinations, and available strategies of the participants together with the ways in which these strategies impact the result. There may be more prerequisites or presumptions depending on the model.

Applications of game theory are numerous and include business, politics, economics, psychology, and evolutionary biology. Game theory is still a new and evolving field, despite its many breakthroughs.

Game theory states that every participant's decisions and actions have an impact on the final result of each. It is presumed that game players are logical and will work to optimize their winnings.

Useful Terms in Game Theory

Here are a few terms commonly used in the study of game theory:

- Game: Any set of circumstances that has a result dependent on the actions of two or more decision-makers (players).
- Players: A strategic decision-maker within the context of the game.
- Strategy: A complete plan of action a player will take given the set of circumstances that might arise within the game.
- Payoff: The payout a player receives from arriving at a particular outcome. The payout can be in any quantifiable form, from dollars to utility.
- Information set: The information available at a given point in the game. The term "information set" is most usually applied when the game has a sequential component.
- Equilibrium: The point in a game where both players have made their decisions and an outcome is reached.

The key pioneers of game theory were mathematician John von Neumann and economist Oskar Morgenstern in the 1940s. Mathematician John Nash is regarded by many as providing the first significant extension of the von Neumann and Morgenstern work.

The Nash Equilibrium

When a Nash equilibrium is attained, no participant can unilaterally change their decisions to boost payoff. In the sense that the player will not look back on a decision they have taken, even after taking the implications into account, it can also be considered a "no regrets" outcome.

Normally, the Nash equilibrium is reached gradually. The Nash equilibrium won't be altered after it has been attained, though. Examine the effects of taking a unilateral action in such a situation. Does that even make sense? Because it shouldn't, the Nash equilibrium result is referred to as having "no regrets."

In general, a game can have more than one equilibrium. But this frequently happens in games when there are more intricate choices than just two made by two players. After some trial and error, one of these numerous equilibria is reached in simultaneous games that are replayed throughout time.

In the business sector, this situation of making different decisions over time until reaching equilibrium is most frequently seen when two enterprises are deciding on prices for highly interchangeable goods, such airline tickets or soft drinks.

Types of Games

Non-cooperative versus Cooperative Games

Cooperative and non-cooperative game theory are the two subfields of game theory. In accordance with the cooperative game theory, teams or subsets of players come to a legally-binding agreement to determine a solution that benefits the group as a whole and is distributed equitably among the participants. On the other hand, participants cannot create legally

enforceable contracts in non-cooperative game theory. Each player acts as an individual who is typically supposed to maximize his personal utility without caring about the repercussions of his choice on other participants in the game.

participants are motivated by self-interest. On the other hand, every player's selected strategy determines the game's outcome collectively.

Therefore, the choices made by other players in the game have an impact on each player's well-being. Two businesses negotiating a combined investment to develop new technologies is an example of a cooperative game. A non-cooperative game is one in which two rival companies, each determining its own prices, consider the actions of the other.

The optimal result for the players as a whole does not always result from self-serving behavior. This will come up when we talk about the various game illustrations. Although economists utilize cooperative game theory more frequently than non- cooperative game theory, both types of games have been used to analyze political processes and negotiating games.

Games of Complete and Incomplete Information

The payoffs, strategies, and player types in comprehensive information games are well-known. The idea of complete information is that every player in the game knows the rules, tactics, and rewards for each round. With this knowledge at hand, players can make informed plans to maximize their personal gains or payoff at the conclusion of the game. Nash equilibrium or Sub-game perfect Nash equilibrium are the notions of equilibrium solutions, depending on whether the game is sequentially moving (dynamic) or simultaneously moving (static). These ideas will be covered in more detail in the sections that follow.

On the other hand, in a game where information is not fully disclosed, participants are not fully aware of their opponents. Certain players have access to confidential information, which is something that other players should consider while assuming certain behaviors from those players. An auction is a common example, where each player is aware of his own utility function (i.e., the item's valuation), but is unaware of the utility functions of the other players. The notions of equilibrium solution are either Perfect Bayesian equilibrium or Bayesian Nash equilibrium, based on whether the game is sequentially moving (dynamic) or simultaneously moving (static).

Zero-sum versus Non-Zero Sum Games

A zero-sum game is one in which each player's gain is precisely equal to each other's loss and occurs at the other player's expense. Put another way, the two participants' combined payoffs always add up to zero. A buyer-seller transaction at cost can be considered an economic application. When one player's gain or loss does not come at the other's expense, the game is said to be non-zero sum. An illustration of this might occur if more advertising results in greater earnings for both businesses.

Simultaneous-move versus Sequential-move Games

In game theory, the sequence in which moves are made matters. A game's outcomes can vary depending on whether players move concurrently or sequentially. In a simultaneous-move game, each player moves simultaneously without being aware of the other player's choice of action. This occurs when both players move simultaneously. For example, in the Cournot model of oligopoly, each firm simultaneously determines the output levels that will maximize its profit. Sequential- move games, on the other hand, consider the order of moves. Here, one player makes a move first, which his opponent then sees.

The person or players who move after you get to watch and hear about what has happened in the game thus far, including the decisions made by other players. Instead of just selecting an action, the player might use these insights to determine his or her own ideal tactics. In this sense, players' strategies are based on what other players have already done.

Impact of Game Theory

Game theory is present in almost every industry or field of research. Its expansive theory can pertain to many situations, making it a versatile and important theory. Here are several fields of study directly impacted by game theory.

Economics

Because it solved important issues with earlier quantitative economic models, game theory revolutionized the field of economics. For example, neoclassical economics found it difficult to account for imperfect competition and to explain entrepreneurial anticipation. The focus of game theory shifted from steady-state equilibrium to the workings of the market.

Game theory is a common tool used by economists to describe the behavior of oligopoly firms. Anticipating probable consequences of specific actions taken by companies, such collusion and price-fixing, is beneficial.

Business

Game theory is useful in business to simulate conflicting behaviors among economic agents. Companies frequently have to make a number of strategic decisions that impact their capacity to generate profits. Businesses might have to decide whether to produce new products and retire their current ones or implement new marketing techniques, for instance.

Companies frequently have the option to select their rival. Some concentrate on outside factors and compete with other market players. Others make internal objectives and try to improve upon their earlier iterations. Companies constantly compete for resources, whether internal or external, try to lure top talent away from competitors, and discourage consumers from selecting rival products.

Game theory in business may most resemble a game tree, as shown below. A company may start in position one and must decide on two outcomes. However, there are continually other decisions to be made; the final payoff amount is not known until the final decision has been processed.

Examples of Game Theory

There are several games, or situations, that game theory analyzes. Here are a few:

The Prisoner's Dilemma

The prisoner's dilemma is the most well-known example of game theory. Consider the example of two criminals arrested for a crime. Prosecutors have no hard evidence to convict them. However, to gain a confession, officials remove the prisoners from their solitary cells and question each one in separate chambers. Neither prisoner has the means to communicate with the other. Officials present four deals, often displayed as a 2 x 2 box.

1. If both confess, they will each receive a three-year prison sentence.
2. If Prisoner 1 confesses, but Prisoner 2 does not, Prisoner 1 will get one year and Prisoner 2 will get five years.
3. If Prisoner 2 confesses, but Prisoner 1 does not, Prisoner 1 will get five years, and Prisoner 2 will get one year.
4. If neither confesses, each will serve two years in prison.

The most favorable strategy is to not confess. However, neither is aware of the other's strategy and, without certainty that one will not confess, both will likely confess and receive a three-year prison sentence. The Nash equilibrium suggests that in a prisoner's dilemma, both players will make the move that is best for them individually but worse for them collectively.

"Tit for tat" is said to be the optimal strategy in a prisoner's dilemma. Tit for tat was introduced by Anatol Rapoport, who developed a strategy in which each participant in an iterated prisoner's dilemma follows a course of action consistent with their opponent's previous turn. For example, if provoked, a player subsequently responds with retaliation; if unprovoked, the player cooperates.

The image below depicts the dilemma where the choice of the participant in the column and the choice of the participant in the row may clash. For example, both parties may receive the most favorable outcome if both choose row/column 1. However, each faces the risk of strong adverse outcomes should the other party not choose the same outcome.

Dictator Game

In this straightforward game, Player A has to choose how to divide a cash prize with Player B; Player B cannot influence Player A's choice. Although this isn't quite a game theory tactic, it does offer some fascinating perspectives on human behavior. According to experiments, roughly 50% of participants keep the entire amount to themselves, 5% divide it equally, and the remaining 45% give the other participant a smaller portion.

The ultimatum game, in which Player A is granted a certain amount of money, some of which must be delivered to Player B, who has the option to accept or reject the amount given, is

closely linked to the dictator game. The hitch is that neither A nor B will receive anything if the second player declines the sum proposed. There are valuable lessons to be learned about generosity and altruism from the dictator and ultimatum games.

Volunteer's Dilemma

In the volunteer's dilemma, an individual must do a task or duty for the benefit of the group. If no one offers to help, the worst case scenario comes to pass. Take a corporation, for instance, where accounting fraud is pervasive but top management is oblivious to it.

Although several junior staff members in the accounting department are aware of the fraud, they are reluctant to alert upper management for fear that doing so will lead to the termination and probable prosecution of the fraudsters.

Later on, there can be certain consequences associated with being called a whistle- blower. However, in the case that no one steps up to volunteer, the massive fraud could lead to the company's ultimate collapse and the loss of all jobs.

The Centipede Game

In the extensive-form game Centipede, two players take turns taking the larger portion of a money stockpile that is steadily growing. The arrangement is such that a player receives less than they would have if they had accepted the pot if they give the stash to their opponent and they take it.

When one person takes the stockpile, the centipede game is over; that player receives the larger portion, while the other player receives the smaller portion. Each player is aware ahead of time of the game's predetermined total number of rounds.

Game theory exists in almost every facet of life. Because the decisions of other people around you impact your day, game theory pertains to personal relationships, shopping habits, media intake, and hobbies.

Types of Game Theory Strategies

Game theory participants can decide between a few primary ways to play their game. In general, each participant must decide what level of risk they are willing to take and how far they are willing to go to pursue the best possible outcome.

Maximax Strategy

In a maximax strategy, hedging is absent. Either they will win large or suffer the worst outcome; the player is all in or all out. Think of a brand-new startup business bringing fresh goods to the market. The market capitalization of the company can grow fifty

times as a result of its new products. Conversely, a botched product launch will force the business into bankruptcy. Even when the worst case scenario is conceivable, the participant is willing to take a gamble in hopes of attaining the best result.

Maximin Strategy

In game theory, a maximin strategy leads to the player selecting the best possible outcome out of all possible outcomes. The member has made the decision to avoid the worst case scenario by hedging risk and forgoing all benefits. Businesses frequently confront and embrace this tactic when thinking about suing. Companies accept a negative result when they settle out of court and avoid a public trial. If the matter had gone to trial, the result might have been worse.

Dominant Strategy

When using a dominant strategy, a player acts in a way that maximizes the play's potential, regardless of what the other players choose to do. In the business world, this could mean that an organization chooses to grow and enter a new market regardless of whether or not a rival has made the same decision. The most common tactic in Prisoner's Dilemma would be to confess.

Pure Strategy

The least degree of strategic decision-making is involved in pure strategy because it is merely a specified choice that is made independent of outside factors or other people's activities. Imagine a game of rock, paper, scissors where one player chooses to toss the same shape every time. The technique is described as pure since the participant's outcome is known ahead of time and can take one of two forms: either a certain shape or none at all.

Mixed Strategy

Although a mixed strategy may appear to be the result of chance, careful planning must be done when selecting which aspects or actions to combine. Think about the bond between a pitcher and hitter in baseball. The pitcher isn't allowed to pitch the same way every time. If not, the batter would be able to guess what would happen next. Instead, in order to provide a sense of unpredictability that they hope to capitalize on, the pitcher must vary their approach from pitch to pitch.

Applications of the Game Theory

In the earlier sections, we also encountered some key ideas related to equilibrium as well as a few game scenarios. This section aims to provide an overview of how it is applied to models of cooperation and conflict in the field of economics. In order to forecast significant trends, this theory is also frequently used in the fields of biology, sociology, political science, etc. Businesses that operate in an oligopolistic market structure, for example, are faced with a situation straight out of game theory: one in which businesses depend on one another. We may define the Cournot equilibrium with the aid of the Nash equilibrium idea that we learned about in this section.

The characteristic of the Cournot equilibrium is that, given the choice of the other firm, each firm selects its optimal output for maximizing profits. Comparably, the Nash equilibrium in pricing strategies, or the mutually optimal response price strategy, is the Bertrand equilibrium. Taking into account the price it believes the other firm will set, each firm selects the best price to maximize its profit.

Limitations of Game Theory

The main problem with game theory is that, similar to most other economic models, it is predicated on the idea that individuals are self-interested, rational actors who maximize their value. We are social creatures after all, and we frequently cooperate at our own expense. Game theory is unable to explain why, depending on the social setting and the individuals involved, we might occasionally enter a Nash equilibrium and other times not. Furthermore, game theory frequently fails to take into account aspects of humanity like loyalty, integrity, or empathy. Even though the optimal course of action can be determined by statistical and mathematical calculations, humans may choose a different path because of unpredictable and intricate situations including manipulation or self-sacrifice. Game theory may analyze a set of behaviors but it cannot truly forecast the human element.

What Are the Games Being Played in Game Theory?

The goal of game theory is to provide an explanation for the strategic moves made by two or more players in a scenario with predetermined parameters. Game theory is employed in many fields, but it is most famously applied in the study of economics and commerce. The games could focus on how two rival companies would respond to price reductions from one another, if one company should buy another, or how stock market speculators might respond to pricing adjustments. These games can theoretically be classified as dictator games, hawk-and-dove games, prisoner's dilemmas, and Bach or Stravinsky games.

What Are Some of the Assumptions About These Games?

Game theory, like many economic models, is predicated on a number of rigid premises that, in order for the theory to be predictive in real-world scenarios, must remain true. First of all, every participant is a rational actor who maximizes their utility and is fully aware of the game's rules and repercussions. It is forbidden for players to speak or engage with one another. Not only are potential results known ahead of time, but they also cannot be altered. Although a game can theoretically have an endless number of players, most games only have two.

What Is a Nash Equilibrium?

A stable position in a game where no player can gain an advantage by unilaterally altering a strategy, provided the other players do not change their plans as well, is known as the Nash equilibrium. This is an essential topic. The idea of a solution in an adversarial, or non-cooperative, game is provided by the Nash equilibrium. It bears

John Nash's name, who was awarded the Nobel Prize in 1994 for his contributions.

Who Came Up With Game Theory?

The work of economist Oskar Morgenstern and mathematician John von Neumann in the 1940s is substantially responsible for the development of game theory. In the 1950s, a large number of additional academics and researchers developed it considerably. Even now, there is still a lot of ongoing applied science and study in this field.

REVIEW OF LITERATURE

Von Newman and Morgenstern [1] have made mounmerital work on game theory. The term solution plays very important role in game theory. It is used to describe some form analysis that has performed in a game among decision makers. J. R. Isbell [2] has presented a class of white solutions to certain games. Billera [3] has obtained a system of differential equation where solutions represent a continuous transfer of play off. Charnes and Kertanek [4] has shown the solution of such differential equations to converge to a number of solution concepts in game theory. Generally a game is determined by his formations, decisions and goals, which are fuzzy in nature. Firaman with immense entropy functions may err, setright and understanding a little may increase his understanding in the Pursuit of some knowledge. So in game, perfect informations, decisions and goals may not be feasible. So we have found the possibility of introducing fuzzy mathematical approach for solutions of games. For their fuzzification, the theory of Zacleh [5] has been followed throughout. Von Neumman et al. [6] made advanced solution in the original treatise on game theory singles out certain sets of apportionments called imputations each set being a solution of the given game. Shapley et al. [7] has advanced a method of singling out a single imputation of an N-person Cooperative game called Shapley value of game. Chen Shui Li and Cheng Ju-Shu [8] made study on fuzzy topological space that if □ be set

and T is a fuzzy called fuzzy topology on □ iff it satisfies the following conditions

□i□ □,□□T ; □ii□ Ai □T ,i □ 1, 2,3 □ Vi Ai □T

□iii□ A, B □T □ A □ B □T

The pair □ □,T □ is called a fuzzy topological space or fits for short. Every members of T is called a T open fuzzy set or simply open fuzzy set. A fuzzy set A is T - closed eff A' i.e. 1-A is T- open. As in ordinary topologies □□, x□ is called the indiscrete topology while the family of all fuzzy sets is called discrete fuzzy topology.

METHOD

Each member of the universal set is given a value of either 1 or 0 by the characteristic function of a classical set, which allows for the distinction between set members and non-members. However, this function is generalized in the case of fuzzy concepts so that the values assigned to the universal set's elements fall within a given range of real

numbers in the interval□0,1□ . For Fuzzy set / subset □ be the universe of discourse and □0,1□ be the closed interval of the real numbers. Then a mapping A :□□□0,1□ is called a fuzzy set A or fuzzy subset A of □for which A□ x□ □ □ , where □ is member of □ and □ is a real number belonging to□0,1□ . Every member of □ is member of fuzzy set A with its grade□ . It is denoted by □□□ A or by □ X ,□ □□ A . Or by □A □ x□ □ □ . In

other words if X □ □a,b,c□ and A be a fuzzy set such that A□a□ □ 5, A□b□ □ 7 and A□c□ □ 1. Then fuzzy set A is written as A □□□a,5□,□b,7□,□c,1□□ where A is called the membership function and A□ x□ is called the membership grade of X □ X . We can also write

A □□□ X , A□ X □ X □ X □□.

Then fuzzy set A is written as

A □□□1,3□,□2,1□,□3,7□,□4,9□,□5,1□□

Representation of fuzzy set is

M1, A □ □□ X , A□ X □ X □ X □

M 2 , A □ □X , A□ X □□

This is same as M1 , but the domain is not explicitly specified

M3, A □ □ A□ x□ / X if the domain is finite

If X □ □a,b,c□ and A : X □□0,1□s.t.. A□a□ □ 0 , A□b□ □ □7 , A□c□ □ □4 , A□d □ □ □1

A □ 0 □ □7 □4 1

A□ X □

then

□

a b c

□ d , M 4 , A □ □ X

if the domain is continuous M5, A=

if the domain is finite and consists of n elements, M6 by means of above results. Fuzzy Power Set.

The set of all fuzzy sets on X is called the fuzzy power set of X and is denoted by

PF □ x□. i.e. PF □x□ □□A A : X □□0,□□.

RESULTS AND DISCUSSION

A random device is used by the player to select his strategy probabilistically. A combination of these strategies, referred to as mixed strategies, determines the probability distribution of the outcomes and, consequently, the expected payoffs that each player would receive. In that scenario, a player makes choices based on trying to maximize his anticipated rewards. Pure strategies are those that are not combined. The best player strategies are those that maximize or reduce a given player's potential average gain or loss over the course of several plays in a game. Modern game theory began in 1944 with the publication of the seminal work, even if some game theoretic notions have emerged throughout the previous few centuries.

A game is quadruplet

□ N,6,V , p □ consisting of a set N of decision makers called

players, a set of 6 strategies available to each player, a set of V of outcomes each of which is a result of particular choices of strategies made of the players on a given play of the game and a set P of payoffs accorded to each player in each of the possible outcomes. Game theory is now used in many diverse academic fields such as economics sociology, biology, psychology, philosophy, political science, management science and computer science. Game theory has

recently drawn attention from computer scientists because of its uses in artificial intelligence and cybernetics. It is used in the study of environment.

CONCLUSION

The study of game theory examines how participant behavior and competing strategies might affect how a scenario turns out. It has bearings on biology, warfare, and a host of other areas of existence. In business, game theory is used to depict strategic interactions where the course of action taken by one firm or product affects the outcome for another company or product.

We have chosen u □FM dry□ □ 4 , u □c□ □ 2 , which means u □FM wet □ must equal to 0. This is the situation in most version of utility theory, where we can choose the utility of two outcomes as we like, provided we reflect our preference, but the utilities of all other outcomes are then fixed completely by our preferences. A game is distinguished based on how many players it has, one-player games, and so on. However, when we refer to a game as being played by n people, we do not necessarily mean that n people participate in every play; rather, we simply mean that the rules of the game are such that the players are divided into n mutually exclusive sets so that one player in each set has the same interests. Just as a corporation is referred to be a person in law, so too are these groups of persons with similar interests.

Even though chess is typically played by two players, it can also be played by two teams, each with three players. If this were to happen, the game would still only be played by two players, not six. Similarly, bridge should be considered a two-person game rather than a four-person game. Given their shared interests, North and South are regarded as one person, while East and West are regarded as one person in a game. The results obtained were determined to be in good accordance with the ones obtained earlier.

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