Game theory explained

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Game Theory – Games and applications

Game theory began as a small branch in the financial industry with a great book written by John von Neumann and Oskar Morgenstern “ Game Theory and Economic Behavior” on zero-sum games. The main focus is the analysis of decisions in strategic situations (games) and interactions in which the loss of one player will be equal to the win of player two.

In addition, game theory is fully integrated in the field of applied mathematics and its applications are many and interesting. Many other scholars have contributed to the development of this theory, such as John Forbes Nash, whose life was turned into a movie called “ A Beautiful Mind,” who generalized the problem to non-zero-sum games and offered as a solution, the Nash Equilibrium. Reinhard Selten is also very important when it comes to game theory, as he paved the way for a satisfactory solution of the problem in dynamic games, with the concept of Subgame Perfect Nash Equilibrium and trembling hand perfect equilibrium. Lastly, the other scholar that played a huge role in the development of game theory is John Harsanyi, who dealt with games under partial information. For their work Nash, Selten and Harsanyi were awarded the 1994 Nobel Prize.

The last 30 years, game theory has found wide applications in economics, where whole sectors based on methods such as industrial organization, planning mechanisms, the most important sub-sector planning auctions and many more. Also, game theory has been used in political economies and especially in the theory of collective action, which explains any cooperation between different players. However, it is also widely used in other sciences such as evolutionary biology, psychology, sociology and others. In some games there is no cooperation, but it may occur spontaneously.

A famous example is the " prisoner's dilemma" which is the cooperation between two criminals who are suspected of being involved in a robbery and are arrested and interrogated separately. The investigator gives them 4 different choices and they have to pick one. The choices are as follows: If one player confesses and player two does not confess, player one will be free and layer two will serve a four year prison sentence. If they both confess, they will share the sentence which is three years each. If no one confesses, they will get the minimum, which is a one year sentence each. Both players have all the information, but are separated and cannot communicate.

For such games, Nash proved the existence of equilibrium. Equilibrium is a combination of the " best" strategies. In the prisoner's dilemma game, the Nash equilibrium is when both criminals confess. Indeed, the risk of imprisonment for four years is higher than the potential benefit from imprisonment for one year. The results of this kind of game may seem obvious, but the same calculation techniques can be applied to situations more complex, which provide results that are less obvious. However, the so-called " cooperative games" are extremely complex. For example, it is difficult to determine which of the many shareholders of a company has control, because the possible alliances make the situations unpredictable.

Suppose that the United States of America decided to privatize a company and it has to determine the percentage that can be sold in order to continue to have control. At first reading this problem seems that, holding 51% of shares means that the state remains the in control. Despite the obvious, is this decision economically smart? The answer is no. The country may continue to be at the helm of the company by holding 35% or even less. Of course this needs a lot of attention, because if the US keeps 35% and sells the remaining 65% to a tycoon, the company no longer belongs to the state, but the tycoon. If it wants to maintain control, then it must ensure that the remaining shares fall into the hands of thousands of small shareholders instead of one big company.

A measure of the ability to control a shareholder in the company, is the so-called “ power indicator”, which can be calculated in many ways. The most famous, is the index of Saplei, which is the name of the initiator, Lloyd Stogouel Saplei, who was also Nash’s classmate at Princeton. This index can be used for the sharing of profits, which is not necessarily based on the number of shares held by each shareholder. Here is a concrete example: If 100% of the shares have been split into four partners holding respectively 10%, 20%, 30% and 40%, the index of Saplei shows that the profits will be distributed as follows: 8% 3%, 25%, 25% and 41. 6%.

Another famous example of such games is the blackmailer paradox. Reuven and Shimon are given a $1000 and are told that they should decide how to allocate the money amongst themselves in order to get all of it. Reuven understands that this opportunity is very rare and tells Shimon that they should split the money equally. However Shimon does not want to negotiate and wants 90% of the money. He tells Reuven to either take the deal or if he didn’t Shimon would not mind leaving with nothing. Reuven tries to reason with Shimon and tells him to be rational, however Shimon insists on getting 90% or they both get nothing. After Reuven resolves his anger, he acknowledges that Shimon is prepared to leave with nothing unless he gets 90% and the only way Reuven would take at least some of the money is to agree to Shimon's deal. Reuven takes his 10% and leaves.

This game is called " the blackmailer's paradox" and the paradox appears when the reasonable Reuven is forced to act irrationally in order to win the maximum amount of money that was available to him. Shimon is able to convince Reuven to agree to the blackmail in order to ensure even 10% of the profit instead of nothing, and this is the reason for this strange results.

Lastly we will focus on the application of game theory in biology, where you can take the " best strategy" in the competition or cooperation between different species. In situations where it is difficult to predict the effects of natural selection, they use this method. It means that the " best strategy" for one species is depended on the actions of other members in a population.

Some of the techniques in game theory have already been used in simple models of " evolutionary games" in order to offer an explanation for the evolution of certain species and their characteristics. John Maynard Smith, a British biologist, made an evolutionary game theory which lead to the concept of " evolutionary stable strategy" which, if adopted by all or most of the members of a single population, no other strategy can perform better with regard to this. On the other hand, some people had already figured out that a perfectly rational being is not needed to identify what the best strategy is and thus, many scientists have tried to apply this theory to models of fundamental microbiological structures and interestingly, it was discovered that very small RNA molecules can engage in a simple two player game.

Game theory has many applications in the real world such as economics, biology, everyday life decisions, and this is all based on different games that are structured in a way to help people understand their actions and what is the best choice in very simple or very complicated situations. It is very useful and very interesting knowing that small games and ideas can solve and explain different situations.