

SNS COLLEGE OF ENGINEERING

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING IOT Including CS&BCT COURSE NAME : DISTRIBUTED LEDGER TECHNOLOGY

TOPIC: Pareto Efficiency (Game Theory)





Introduction to Pareto Efficiency

Pareto Efficiency, also known as Pareto Optimality, is a concept in economics and game theory that describes a situation in which no individual can be made better off without making someone else worse off. In simpler terms, a state is Pareto efficient if there is no way to improve someone's situation without harming someone else. This concept is named after the Italian economist Vilfredo Pareto, who first used it to describe economic efficiency in market outcomes. Pareto efficiency is important because it provides a benchmark for assessing the efficiency of outcomes in a variety of strategic interactions.





Pareto Efficiency in Game Theory

In game theory, Pareto efficiency is used to evaluate the outcomes of a game or strategic interaction between players. It helps to identify outcomes where no player can improve their payoff without hurting another player's payoff. A Pareto-efficient outcome is one where it is impossible to make any player better off without making someone else worse off. Key Points:

- A Pareto Optimal Outcome is where no player can improve their payoff without sacrificing another player's payoff.
- Nash Equilibrium and Pareto Efficiency are different concepts, though some Nash equilibria can be Pareto efficient.
- In multi-player games, a Pareto improvement occurs when at least one player benefits without anyone else being harmed.





: Example of Pareto Efficiency (Prisoner's Dilemma)

Consider the Prisoner's Dilemma, a classic example in game theory. Two criminals are arrested and offered a deal: if one betrays the other (defects), they go free, while the other gets a harsh sentence. If both cooperate and stay silent, both get a light sentence. If both betray each other, both get moderate sentences.

The Pareto Efficient Outcome occurs when both prisoners cooperate and stay silent. However, from an individual perspective, each prisoner has an incentive to betray, leading to the Nash equilibrium where both defect. This outcome is not Pareto optimal because both could have been better off if they had cooperated, making the cooperative outcome the Pareto optimal one.





Importance of Pareto Efficiency in Decision-Making

Pareto efficiency is important in strategic decision-making and resource allocation. It serves as a guideline for making decisions that maximize overall welfare. However, it's important to note that Pareto efficiency does not always lead to fairness or equality. An outcome can be Pareto efficient even if it is highly inequitable. Thus, while Pareto efficiency is useful in maximizing resource allocation, it is often paired with other concepts like equity or justice to assess the overall desirability of outcomes.

Key Points:

- Maximizing Social Welfare: Helps in identifying outcomes that maximize total utility.
- Equity vs Efficiency: Pareto efficiency focuses on efficiency, but may not be fair or equitable.
- Applications: Used in economics, policy-making, and negotiations to evaluate optimal strategies.



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