Dominance in Game Theory and Its Applicability in Real-Life Scenarios

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Abstract- Dominance in game theory is a fundamental concept that identifies strategies yielding superior outcomes regardless of opponents' actions. This paper explores the principles of strict and weak dominance, iterated elimination of dominated strategies, and their role in simplifying strategic decision-making. We examine real-life applications in economics, business, politics, and biology, demonstrating how dominance guides optimal behavior in competitive environments. Additionally, we discuss limitations, including dependence on rationality assumptions and incomplete information. The study highlights the relevance of dominance in shaping strategic interactions while acknowledging scenarios where its applicability may be constrained.

Indexed Terms- Game theory, dominance, strict dominance, weak dominance, iterated elimination of dominated strategies, Nash equilibrium, strategic decision-making, economics, competitive environments.

I. INTRODUCTION

Game theory is a mathematical framework that studies strategic interactions among rational decisionmakers. It is widely applied in economics, political science, biology, and artificial intelligence. One of the foundational concepts in game theory is dominance, which helps players identify optimal strategies by eliminating inferior choices.

Definition of Dominance:

A strategy is considered dominant if it yields a better payoff than any alternative strategy, regardless of what other players do. Dominance can be classified into two types: 1. Strict Dominance: A strategy strictly dominates another if it always provides a higher payoff, no matter what opponents choose.

2. Weak Dominance: A strategy weakly dominates another if it is never worse and sometimes better than the alternative.

Example: Prisoner's Dilemma

In the classic Prisoner's Dilemma, two criminals must decide whether to confess or remain silent. Confessing (defecting) is a strictly dominant strategy because it leads to a shorter sentence regardless of the other prisoner's choice.

Dominance simplifies complex strategic interactions by allowing players to eliminate suboptimal strategies, leading to more predictable outcomes.

: Dominance in Different Types of Games

Dominance is applicable across various types of games, including:

- 1. Simultaneous-Move Games (Normal Form Games)
- Players choose strategies at the same time.
- Example: Prisoner's Dilemma (as discussed).
- 2. Sequential-Move Games (Extensive Form Games)

- Players take turns making decisions.

- Example: Stackelberg Competition (a leader-follower model in economics).

- 3. Zero-Sum vs. Non-Zero-Sum Games
- In zero-sum games, one player's gain is another's loss (e.g., poker).
- In non-zero-sum games, mutual gains or losses are possible (e.g., trade negotiations).

Iterated Elimination of Dominated Strategies (IEDS)

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A method to solve games by repeatedly removing dominated strategies until only the most rational choices remain.

Real-World Applications of Dominance Dominance is not just theoretical; it influences realworld decision-making in multiple fields.

1. Business & Economics

- Oligopoly Pricing: Firms in competitive markets (e.g., airlines, telecom) often engage in price wars where undercutting rivals becomes a dominant strategy.

- Advertising Wars: Companies may increase ad spending because not doing so risks losing market share.

2. Politics & Military Strategy

- Arms Race: Countries may invest in military buildup because failing to do so could leave them vulnerable (a Prisoner's Dilemma scenario).

- Election Campaigns: Negative campaigning can become a dominant strategy if it weakens opponents more than it harms the attacker.

3. Everyday Decision-Making

- Traffic Laws: Drivers following speed limits is a weakly dominant strategy because reckless driving risks fines and accidents.

- Public Goods (Tragedy of the Commons): Overfishing or pollution occurs when individuals prioritize personal gain over collective welfare. Limitations and Criticisms of Dominance

While dominance is a powerful concept, it has limitations in real-world applications.

1. Assumption of Rationality

- Game theory assumes all players are perfectly rational, but humans often act emotionally or irrationally.

2. Incomplete Information

- Real-life decisions often involve uncertainty, whereas dominance assumes full knowledge of payoffs.

3. Multiple Equilibria

- Some games (e.g., Coordination Games) have no dominant strategies, leading to multiple possible stable outcomes.

4. Ethical Concerns

- Dominant strategies may encourage selfish behavior (e.g., corporate fraud, tax evasion) at the expense of societal welfare.

Case Study & Conclusion

Case Study: Uber vs. Lyft Pricing Wars

Ride-sharing companies like Uber and Lyft often engage in dynamic pricing. Lowering prices can be a dominant strategy to attract more customers, but if both firms do it, profits shrink for both—a real-world Prisoner's Dilemma.

CONCLUSION

Dominance in game theory provides a structured way to analyze strategic interactions, offering insights into competitive behavior in economics, politics, and social dynamics. However, its real-world applicability is constrained by assumptions of rationality and perfect information. Recognizing dominant strategies can enhance decision-making, but real-life complexities often require adaptive, cooperative, or regulatory solutions to prevent suboptimal outcomes.

FUTURE IMPLICATIONS

- Behavioral game theory integrates psychology to address irrational decision-making.

- Mechanism design can incentivize cooperation over dominance in social dilemmas.

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