A Multi-Agent Congestion and Pricing Model

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Introduction

Congestion is a phenomenon caused by multiple interactions between agents, where each agent's decisions (behavior and actions) are influenced by the actions of others. Congestion is often caused by the interaction of individual agents competing for limited resources (e.g., roadways, servers). This phenomenon is often observed in transportation systems, where agents (e.g., vehicles, passengers) compete for limited road capacity.

The consequences of this interaction are significant. The free flow of traffic can be disrupted, leading to increased travel times and costs. Additionally, congestion can lead to reduced road capacity and increased emissions. Understanding and managing congestion is crucial for the effective operation of transportation systems.

This paper presents a multi-agent model of congestion and pricing, which is a framework for analyzing the behavior of individual agents in transportation systems. The model is based on game theory, which is a mathematical framework for modeling strategic interactions between agents.

Methodology

The multi-agent model is developed using game theory, which is a mathematical framework for modeling strategic interactions between agents. The model is based on the idea that agents (e.g., drivers, passengers) make decisions based on their own interests, while simultaneously considering the decisions of others. This leads to a complex interaction between agents, which can result in congestion.

The model is solved using the iterative best response algorithm, which is a method for finding Nash equilibria in games. A Nash equilibrium is a stable state of the game where no agent can improve their outcome by unilaterally changing their strategy.

Results

The multi-agent model is used to simulate traffic flow in a transportation system. The results show that the model accurately predicts the behavior of agents in the system, including the formation of congestion and the incentive to use tolls to reduce congestion.

Conclusion

This paper presents a multi-agent model of congestion and pricing, which is a framework for analyzing the behavior of individual agents in transportation systems. The model is based on game theory, which is a mathematical framework for modeling strategic interactions between agents. The model is solved using the iterative best response algorithm, which is a method for finding Nash equilibria in games. A Nash equilibrium is a stable state of the game where no agent can improve their outcome by unilaterally changing their strategy.

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Policy Implications

The results of the model suggest that tolls can be used to reduce congestion in transportation systems. The model also shows that tolls can be designed to achieve specific social objectives, such as reducing emissions or improving traffic flow.

Further Research

Future research should focus on improving the accuracy of the model by incorporating additional factors, such as weather and vehicle characteristics. Additionally, the model should be applied to real-world transportation systems to test its effectiveness in practice.