Review of Game-Theory Models of Freeway On-Ramp Merging

高速道路合流のゲーム理論モデルのレビュー

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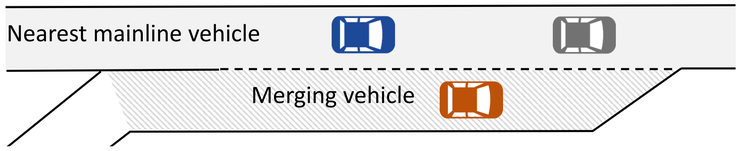
1. Introduction

- The driving behaviour in merging sections is one of the most complex and significant driving behaviours
- The merging interactions in traditional and mixed traffic have not been extensively studied
- Game-theory models can capture the mutual impact of the merging and through lane vehicles on their decisions

2. General formulation of a game-theory model

- A one-step non-cooperative game under complete information
- Players: **merging** and **mainline** vehicles
- Actions: **merge or not**, and **yield or block**
- The payoffs: depend on various driving conditions



3. Classification of the game-theory models of merging

Author	Equilibrium	Impacting factors	Gap selection	Acceleration behaviour	Dynamic /Static
Kita (1999)	Nash Equilibrium	Time to collision to nearest vehicles and time to reach end of on-ramp section	N/A	N/A	Static
Liu et al. (2007)	Nash Equilibrium	Initial and future speeds and accelerations, gap sizes, and remaining distances to end of on-ramp section.	N/A	N/A	Static
Talebpour et al. (2015)	Nash Equilibrium	Accelerations to prevent collision, normal acceleration, and speed differences with nearby vehicles	N/A	Partly	Static
Ali et al. (2019, 2020)	Nash Equilibrium	Accelerations	N/A	Partly	Static
Kang and Rakha (2020)	Nash Equilibrium	Merging driver: safety and forced merging payoffs. Mainline vehicle driver: safety payoffs	N/A	N/A	Dynamic
Arbis and Dixit (2019)	Quantal Response Equilibrium	Anticipation of action of other driver, speeds, remaining distance to end of on-ramp section, velocity differences with surrounding vehicles	N/A	N/A	Static
Yoo and Langari (2013)	Stackelberg Equilibrium	Gap sizes, speed difference with lag vehicle, distance to end of on-ramp section, sufficient distance for merging, time headway, and aggressiveness	N/A	Separately	Dynamic
Yu et al. (2018)	Stackelberg Equilibrium	Safety and space	Yes	Included	Dynamic
Wang et al. (2005)	Minimum of Joint Cost	Safety, deviation from car-following speed, driving comfort, travel efficiency, route following, lane preference, and lane switch costs of both vehicles	N/A	Included	Dynamic

4. Conclusion

It is important to consider different aspects of merging behaviour in future models:

- gap selection prior to merging
- strategic interactions with mainline drivers
- adjusting acceleration for merging in a chosen gap

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