Identification of Driving Heterogeneity with Machine Learning: A Literature Review and Future Perspectives

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Driving heterogeneity greatly influences traffic flow performance. It has been shown to exacerbate traffic congestion, leads to accidents and increases fuel consumption and emissions. Driving behaviour is a key contributor to this heterogeneity and requires further study. Due to the increased availability of driving behaviour data, Machine Learning (ML) methods are being widely adopted to identify driving heterogeneity. This paper provides a systematic survey of the identification of driving heterogeneity with ML. Studies and concepts related to driving heterogeneity are reviewed and descriptions for driving heterogeneity are provided. Based on this, a framework is proposed for the identification of driving heterogeneity with ML. This includes steps on trajectory data preparation, traffic feature identification, ML method implementation, driving behaviour profiling, and performance evaluation. The benefits and drawbacks of various methods in each step are comprehensively discussed, and future research directions are provided. This literature review aims to facilitate the dialogue among the research community with a common interest in comprehending driving heterogeneity and to offer insightful information for individuals seeking a comprehensive understanding of the topic. The identification of driving heterogeneity can serve as a valuable resource for traffic administrators to improve their understanding of traffic users and formulate more effective traffic management strategies. Additionally, this research constitutes a fundamental contribution towards the advancement of traffic theories with a forward-looking perspective within the context of mixed traffic environments.

Current approaches to identifying driving heterogeneity face challenges in capturing the diversity of driving characteristics and understanding the fundamental patterns from a driving behaviour mechanism standpoint. We introduce a comprehensive framework for identifying driving heterogeneity from an Action-chain perspective. First, a rule-based segmentation technique that considers the physical meanings of driving behaviour is proposed. Next, an Action phase Library including descriptions of various driving behaviour patterns is created based on the segmentation findings. The Action-chain concept is then introduced by implementing Action phase transition probability, followed by a method for evaluating driving heterogeneity. Employing real-world datasets for evaluation, our approach effectively identifies driving heterogeneity for both individual drivers and traffic flow while providing clear interpretations. These insights can aid the development of accurate driving behaviour theory and traffic flow models, ultimately benefiting traffic performance, and potentially leading to aspects such as improved road capacity and safety.