CSE523 Machine Learning

Weekly Report

Project 5: Identify Hard stop and momentary stop using vehicle trajectory dataset.

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1. Introduction:

In this study, our primary aim was to determine the optimal ranges of velocity and acceleration to accurately identify soft stops while ensuring clear differentiation from hard stops. Soft stops, indicative of minor decelerations, play a crucial role in understanding vehicle behavior and improving overall safety measures. By utilizing the Gaussian method, we sought to define these ranges with precision, thus minimizing the possibility of overlap between soft and hard stops. This approach not only enhances the effectiveness of stop classification but also provides a foundation for developing robust strategies for mitigating potential safety risks associated with vehicle decelerations. Through meticulous analysis and experimentation, our objective was to establish distinct boundaries that facilitate the identification of soft stops while maintaining clarity in differentiation from hard stops, thereby contributing to the advancement of predictive maintenance and safety protocols in transportation systems.

2. AIM:

The aim of this study is to determine the optimal ranges of velocity and acceleration to accurately identify soft stops in vehicle dynamics while ensuring clear differentiation from hard stops. Soft stops, representing minor decelerations, are pivotal in comprehending vehicle behavior and enhancing overall safety measures. Leveraging the Gaussian method, our objective is to precisely define these ranges, minimizing the potential overlap between soft and hard stops.

3. Approach:

To initiate our approach, we conducted an exploratory analysis by examining the distribution of velocity and acceleration versus frequency within the range of coordinates corresponding to soft stops. Through this analysis, we observed that the plots exhibited characteristics akin to Gaussian distributions, suggesting a structured pattern in the data. In our endeavor to pinpoint the optimal ranges of acceleration, we introduced weights to each distribution and computed the effective mean and standard deviation. Following a predefined rule, we delineated the range of velocity and acceleration such that the lower bound was set as the mean minus the standard deviation, while the upper bound was defined as the mean plus the standard deviation. This method allowed us to establish precise boundaries that encapsulated the variability within the data, ensuring that the identified ranges effectively captured the essence of soft stops while maintaining a clear demarcation from hard stops.

We employ a machine learning model that utilizes features extracted from vehicle telemetry data, specifically focusing on two key metrics: velocity (Vxy_smoothed) and acceleration. These features are indicative of the vehicle's motion characteristics during a stop. Our labeling function, 'assign_label(row)', implements the following logic:

- For stops characterized by low velocity (Vxy_smoothed < 1) and moderate acceleration (-1 <= acceleration <= 1), the label assigned is "hard". This condition captures instances of sudden stops with relatively low speeds, which may signify urgent braking or aggressive driving maneuvers.
- Stops occurring within a certain velocity range (5 <= Vxy_smoothed <= 10) and exhibiting negative acceleration (acceleration < 0) are classified as "soft". Such stops represent smoother deceleration patterns often observed in routine driving scenarios.
- Any stops not meeting the above criteria are labeled as "other", encompassing instances that do not fit the defined patterns of "hard" or "soft" stops.

By iteratively applying this labeling function to a dataset containing vehicle telemetry data, we aim to train a machine learning model to accurately distinguish between different types of stops.

Future work:

Further refinement and optimization of the Gaussian method can be pursued to enhance its precision in defining the ranges of velocity and acceleration characteristic of soft stops. We will try to involve fine-tuning parameters such as means and standard deviations to better capture the vehicle deceleration patterns.