

Gaussian-Process-based Modeling of Individual Human-Driven Vehicles from Real Data

Proposal for a Bachelor's or Master's Thesis Project

Safe crossing of intersections in mixed traffic, i.e., with both autonomous and human-driven vehicles, remains challenging due to the wide range of human driving behavior. However, the (predictive) controller of an autonomous vehicle requires a model to consider the future behavior of human-driven vehicles. Furthermore, multiple intentions, i.e., turning right or left or going straight on, and multiple driver profiles, e.g., fast or slow crossing, hard or less breaking in curves, etc., make it difficult to model one individual human-driven vehicle from a sequence of measurement data. To obtain meaningful models for the wide range of human driving behavior, clustering algorithms are to be used to split the demonstration data into clusters of similar behaviors. One way to model a standard driving behavior over each cluster is to employ Gaussian process (GP) regression. Besides this *nominal prediction*, i.e., the standard driving behavior, GPs yield simultaneously an uncertainty measure in terms of a Gaussian probability distribution that captures variations in the demonstrations.

The scope of this thesis is to derive multiple GP models of human-driving behavior. To this end, the demonstration data, i.e., trajectories of human-driven vehicles, shall be clustered to identify different groups of similar behaviors. Thereafter, an individual GP model of lower complexity is to be defined and trained over each cluster. Secondly, GP models with autoregressive structure, i.e., considering sequences of past measurements of several lengths, shall be designed to predict individual driving behaviors. As a final step, this thesis includes the validation of all models for single- and recursive multiple-step predictions, whereupon approximation approaches described in literature have to be employed for multiple-step predictions.

The following prerequisites will be useful for the project:

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| Experience with / knowledge about: | Gaussian process regression, (trajectory) clustering |
| Programming skills: | Matlab or Python |
| Language: | German or English |

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