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A Data-driven Algorithm Development Framework Leveraging an Interactive Multi-simulator

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In the past, machine learning in autonomous driving has primarily been used for recognition tasks, but recently, data-driven planners achieving decision-making have been gaining attention. Data-driven approaches that learn driving maneuvers from driving data do not require rules or mathematical models, but their performance heavily depends on the quantity and diversity of training data. However, it is extremely difficult to acquire sufficient data for edge cases that occur infrequently in real-world environments and involve complex interactions.

In this study, we propose a development framework that acquires required functions from a small amount of training data generated by an interactive multi-simulator. To address the constraints of data volume, the framework shown in Fig. 1 introduces a process of analyzing the acquired data and separating the application domains of rule-based or model-based methods from those of data-driven methods. Specifically, rule-based or model-based methods are applied to functions that can be represented by a small number of features, while data-driven approaches are applied to complex decision-making domains. Subsequently, these independently designed functions are ultimately integrated. By incorporating the processes of data analysis, segmentation, and integration, the acquisition of required functions is achieved using a small amount of training data.

As an example, we apply the proposed framework to a right-turn scenario at an intersection for validation. In this scenario, the data-driven approach is applied to two specific functions: decision-making on whether to stop within the intersection, and speed planning. In the driving scenario classification, the evaluation results after data selection (Table 1) confirmed that correct decisions were predicted at all inference start positions, thereby realizing safe decision-making. In the speed prediction, it was confirmed that highly accurate prediction maintaining continuity is possible.

The proposed framework enables the acquisition of required system functions from extremely limited driving data of approximately one hour by limiting the application domain of the data-driven approach.

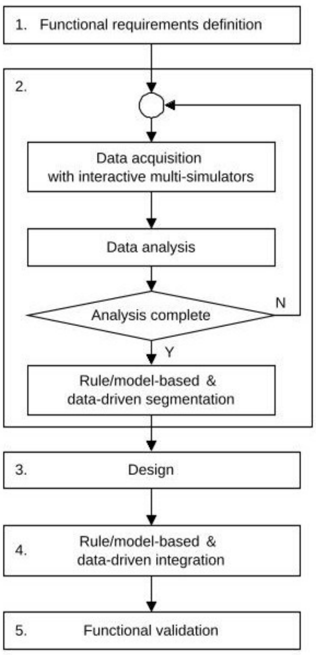

Fig. 1 Development framework

Table 1: Evaluation after data selection

Status	Stop position for oncoming vehicle	Inferential start position	Stop probability	No stop probability
Stop	③	[1]	96.79%	3.21%
		[2]	96.57%	3.43%
		[3]	96.33%	3.67%
		[4]	66.64%	33.36%
	④	[1]	85.72%	14.28%
		[2]	82.81%	17.19%
		[3]	81.72%	18.28%
		[4]	95.00%	5.00%
No stop	⑥	[1]	11.62%	88.38%
		[2]	1.92%	98.08%
		[3]	0.29%	99.71%
		[4]	0.03%	99.97%