

Praxis der Forschung

Conformal Motion Prediction for Autonomous Driving

Methods for Big Data, Scientific Computing Center

Advisor

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Examiner

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Possible Start

As soon as possible

Background

Motion prediction is a key component of autonomous driving systems, enabling the anticipation of future behavior of surrounding traffic participants. Recent advances have led to highly capable multi-agent motion prediction models based on transformers and graph neural networks that achieve state-of-the-art performance on large-scale benchmarks. However, these models typically rely on heuristic confidence scores and evaluation procedures based on a fixed number of predictions (e.g., Top-K trajectories). When confidence estimates are not well calibrated, they provide limited guarantees regarding the coverage of plausible future behaviors. This can be particularly problematic in safety-critical and ambiguous traffic scenarios where uncertainty-aware decision making is essential.

Conformal prediction has recently emerged as a powerful framework for uncertainty quantification with finite-sample coverage guarantees. Conformal prediction uses calibration data to construct prediction sets that contain the true outcome with a user-defined probability under mild assumptions. While conformal methods have been successfully applied to classification and regression tasks, their application to multi-modal motion prediction remains largely unexplored.

The goal of this thesis is to investigate conformal prediction methods for autonomous driving motion prediction. In particular, the thesis will explore how trajectory hypotheses generated by state-of-the-art motion prediction models can be transformed into calibrated trajectory sets with statistical coverage guarantees while maintaining high prediction quality and diversity. The work can be conducted using an **existing research software stack** in **Python and Pytorch** containing state-of-the-art motion prediction models, large-scale datasets, and evaluation pipelines for benchmark, long-tail, and OOD performance assessment.

Task Details

- Conduct a literature review on conformal prediction and multi-modal motion prediction.
- Develop and implement a conformal prediction approach for transformer-based motion prediction models.
- Analyze the trade-off between coverage guarantees, prediction accuracy, trajectory diversity, and prediction set size.

- Compare the proposed methods on large-scale autonomous driving benchmarks, including long-tail and ambiguous traffic scenarios, against non-conformal baselines.
- Discuss strengths, limitations, and future research directions towards uncertainty-aware planning and decision making.