R&D project defense Jaswanth Bandlamudi

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Title: Comparison between Fixed-weight Neural Network and Bayesian Neural Network for 3D Object Detection in Autonomous Driving

Abstract:
Deep learning methods are capable of learning complex representations from the provided data, thereby solving various real-world problems. Though these methods provide high-quality predictions, they do not provide a reliable estimate of the confidence or uncertainty in the prediction. This uncertainty prediction is especially important in safety-critical applications. In this research and development project, we study an object detection problem in the perception part of the autonomous driving stack. We also investigate whether a reliable uncertainty estimate can be provided as an output of the model.

We precisely chose to solve the problem of 3D object detection using Frustum-PointNet architecture which consumes inputs from LiDAR and camera. The 3D object detection model is trained and tested using the Lyft dataset. The model performed well on the test data with the average box accuracy values of 56.46%, 46.33%, and 38.61% on easy, medium, and hard IoU limits respectively. Additionally, we investigated if a bayesian model of the Frustum-PointNet can be modeled using the Flipout layers from the Tensorflow probability library, and the uncertainty in detection is measured using the mean of Shannon entropy and the total variance. Surprisingly, the bayesian approach has under-fitted on the same frustums used to train the fixed-weight model of the Frustum-PointNet.

We converted the last two stages of the Frustum-PointNet into the Bayesian models and observed that the model did fit well and the performance of the model is similar to the fixed-weight model. To extract epistemic uncertainty, we performed ten Monte-Carlo sampling inference runs and an average of Shannon entropies and total variance of the detections is used as the epistemic uncertainty. From the experimental values, the model detected cars with lower epistemic uncertainty, cyclists and pedestrians with higher uncertainty.