Reducing redundancy in Semantic-KITTI using data augmentation within AL

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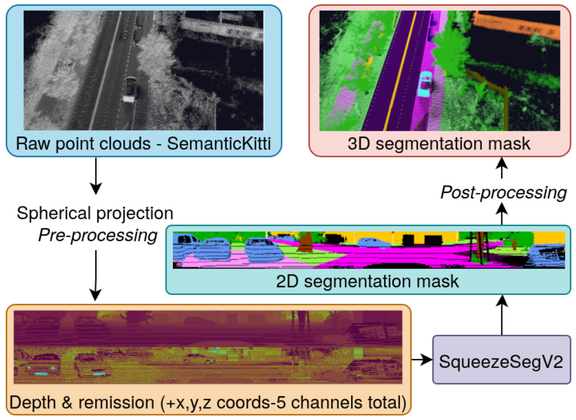
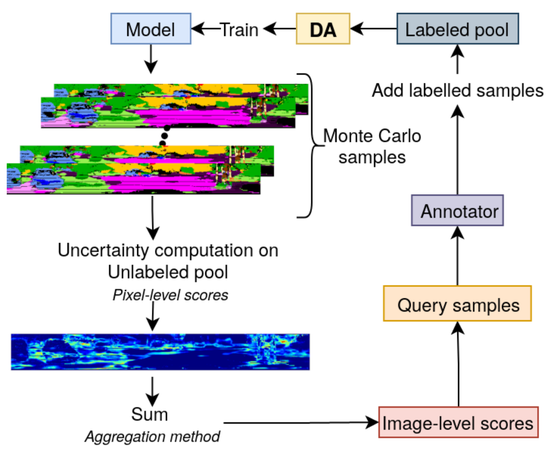
Introduction

- **Problem**: Large-scale datasets contain high redundancy.
- **Motivation**: Data augmentation (DA) models the redundant generative process that gives similar samples in autonomous driving datasets.
- **Our focus**: Evaluate the effect of DA on uncertainty sampling and labeling efficiency in active learning (AL) for large-scale point cloud semantic segmentation datasets.

Model & Dataset



Active Learning Loop

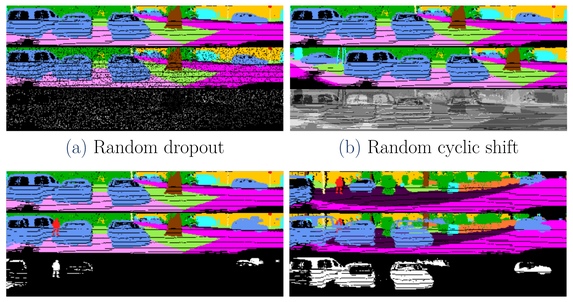


Pool	Test	Init	Budget	AL steps
6000	2000	240	240	25

Experiments settings

Heuristic functions:
Random, BALD (*avg[entropy(preds)] - entropy[avg(preds)]*)

Examples of DA on range images

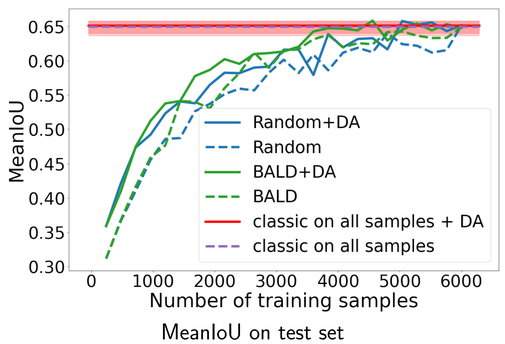


(a) Random dropout (b) Random cyclic shift

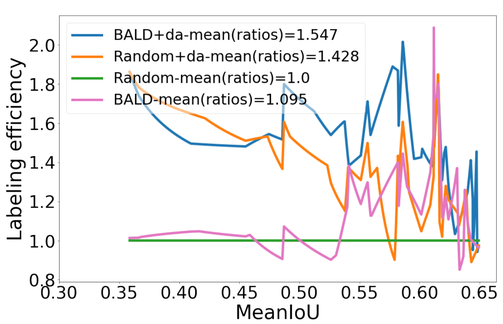
(c) Instance cut paste

Top: Original | Middle: Augmented | Bottom: Difference

DA evaluation



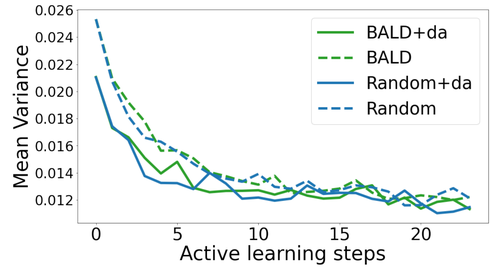
MeanIoU on test set



Labeling efficiency on test set

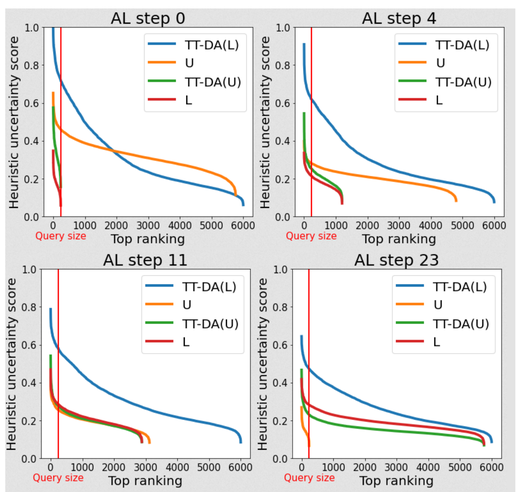
Results

- BALD with DA can achieve an important dataset compression, by using only 60% of the total sample pool.
- DA improves model generalization by regularization, making the sample selection more informative
- DA improves the stability of models.



Mean variance on test set

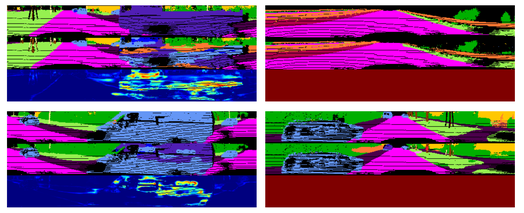
Aggregated heuristic evaluation



Aggregated heuristic score of samples sorted by decreasing value (using models w/o DA) over labeled pool(L), unlabeled pool(U), and Test-Time DA (TTDA) of L and U.

- **Goal**: Understand how the AL pipeline ranks and selects augmented vs normal samples w.r.t heuristic.
- **Result**: DA could generate high-score samples, but it could also provide transformed samples outside of the dataset distribution.

Top hardest samples



(a) BALD (b) Random

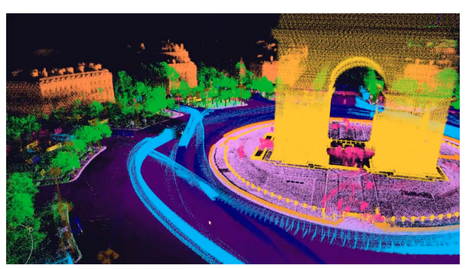
Top: Target | Middle: Prediction | Bottom: Heuristic score

Conclusion

- DA helped to select better informative samples, by improving the heuristic function stability.
- Improved labeling efficiency: With only 60% of the samples, we reached the accuracy of supervised training on full selected dataset.
- DA reduced annotation costs as well as reducing training time in production over large datasets.
- Similar gains have been observed using DA by [1] on CIFAR dataset for classification task.

[1] Nathan Beck et al. *Effective Evaluation of Deep Active Learning on Image Classification Tasks*. 2021. arXiv: 2106.15324 [cs.CV].

Upcoming Navya dataset



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