KI DELTA LEARNING
Scalable AI for Automated Driving

Improving Replay-Based Continual Semantic Segmentation with Smart Data Selection

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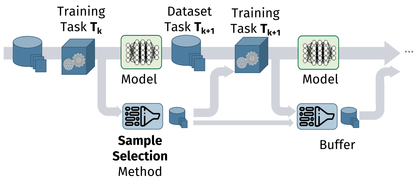
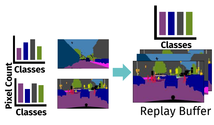
Introduction

Replay has proven to be effective in reducing forgetting for Semantic Segmentation. The most common sample strategy for Replay is random selection, which can result in unstable results. Our works aims to develop data selection strategies to minimize catastrophic forgetting and eliminate performance variance with current random selection.

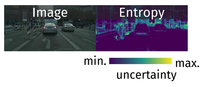


Methods

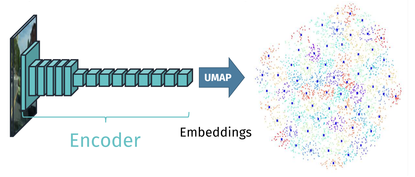
Class Balanced Buffer



Entropy-based



Representation-based Sample Selection

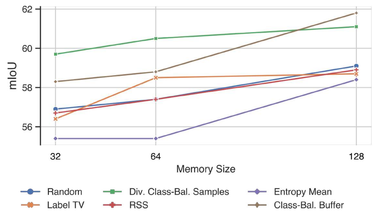


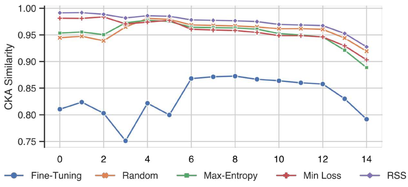
Results Domain-Incremental

Evaluation after training on BDD, CS (Buffer size = 64)

Method	$mIoU_{BDD}$ [%]	$mIoU_{CS}$ [%]	$mIoU_{Avg.}$ [%]
Offline Training	57.2	65.0	61.1
Fine Tuning	29.6	67.0	48.3
Random	44.0	68.4	56.2
Mean Entropy	45.0	**69.4**	**57.2**
Max Loss	25.4	**66.4**	45.9
Representation	**45.5**	69.0	**57.2**
Gradients	44.9	68.6	55.1
Ambivalent Cls.	42.2	67.6	54.9
Div. Class Bal.	41.7	68.6	55.1
Testsets	BDD100k	Cityscapes	Both

Evaluation





- the higher the similarity score, the better the method is suited to prevent forgetting

Results Class-Incremental

Evaluation after training on S1, S2, S3 (Buffer size = 64)

Method	$mIoU_{S_1}$ [%]	$mIoU_{S2}$ [%]	$mIoU_{S3}$ [%]	$mIoU_{All}$ [%]
Offline Training	82.6	65.3	79.2	69.0
CIL [1]	71.3	44.4	82.4	55.8
Random	76.0	49.7	81.7	57.4
Mean Entropy	75.5	43.1	80.9	57.2
Max Loss	76.3	48.3	82.8	57.6
Representation	73.0	52.7	81.7	57.4
Gradients [2]	74.1	**49.5**	80.0	56.6
Ambivalent Cls.	75.0	49.6	81.5	57.4
Div. Class Bal.	77.0	**58.7**	81.6	60.5
Testset	S1	S2	S3	All

[1] Klingner, Marvin, et al. "Class-incremental learning for semantic segmentation re-using neither old data nor old labels." *2020 IEEE 23rd international conference on intelligent transportation systems (ITSC)*. IEEE, 2020.
[2] Aljundi, Rahaf, et al. "Gradient based sample selection for online continual learning." Advances in neural information processing systems 32 (2019).

Conclusion

- Replay stabilizes internal representations
- Domain-Inc. most important Representational Diversity / Entropy
- Class-Inc. class-balancing most important
- **+9.0 mIoU for non re-occurring classes over random selection→** Strategic data selection is essential when classes are not balanced
- **Data selection is important especially for small memory sizes**

Paper

Training Strategies

Partners

External partners

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KI Delta Learning is a project of the KI Familie. It was initiated and developed by the VDA Leitinitiative autonomous and connected driving and is funded by the Federal Ministry for Economic Affairs and Climate Action.

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