KI DELTA LEARNING
Scalable AI for Automated Driving

Incremental Multi-Task learning by means of SSD Object Detection using Distillation Techniques

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WP 2.1

Networks

Use-Case in Delta Learning

Perception for Autonomous Driving (AD) requires to solve for a set of different specific recognition tasks that can include dense prediction (e.g. semantic segmentation, depth estimation, etc.), as well as object-centric tasks such as recognition of regulatory infrastructure, traffic participants, gesture recognition, and specifics such as 3D bounding box detection. Due to this trend, we can observe an increasing interest in multi-task learning, methods that aim at sharing computational resources by training a single network for all tasks at once. The subject of this work is the ability to incrementally add new tasks to an existing multi-task network.

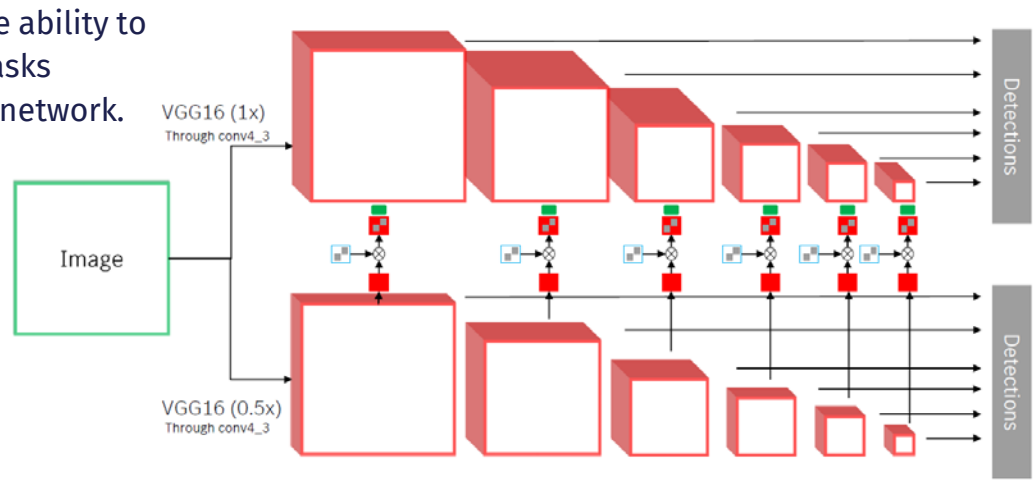

Figure 1: Architecture of our proposed KD using imitation masks in SSD to distil mid-level information

Technical Problem

It is often desirable to add new tasks to an existing multi-task network, but a major problem that arises is that performance deteriorates on old tasks where labeled data might not be available, a phenomenon called 'Catastrophic Forgetting'. Knowledge Distillation (KD) [1] has been proven to be a successful solution to this problem in domains such as classification [1], detection [2], and segmentation. In order to further investigate the usefulness for AD, we study the effect of Distillation in Multi-Task Networks that solve for multiple object-centric as well as dense prediction tasks. Since the single-shot detector (SSD) [3] is a prominent choice In the context of autonomous driving due to its great trade-off between accuracy and runtime our work focuses on task sets including SSD.

Table 1: Results on COCO. Trained mobilenetv2 [6] with all (teacher) or half amount of channels (all others). The students are trained with only groundtruth (left), additional output boxes given by the teacher (middle) or a combination of output boxes and intermediate feature supervision (right).

	Teacher	GT	Boxes	Ours
mAP [%]	16.6	15	15.4	15.6

Technical Solution

In the context of this work, we can use the principle of KD to supervise the multi-task model using the single-task networks, an approach that seems promising to (1) avoid catastrophic forgetting and (2) allows for the use of task-specific datasets. Unfortunately, existing KD cannot trivially be adapted to SSD due to SSD's dense and multi-scale architecture. This work thus proposes to adapt KD and imitation masks [5] together with an optimized incremental multi-task learning schedule. View Figure 1 for an overview of the architecture.

Evaluation

This work focuses on two benchmarks: Cityscapes as an AD-specific dataset and MSCOCO to study the generality of the proposed approach. We select one dense and one object-centric task to study the incremental task-learning setup: semantic segmentation and object detection. As the first step, we investigate our KD method in a standard KD setup (see table 1), second, we will optimize the baseline performance, as well as our joint (in contrast to incremental) multi-task training setup.

Outlook

As the next step, our proposed KD adaptation approach is implemented, evaluated, and optimized, as well as compared thoroughly to the baselines in two settings: (1) training the multi-task network solely with KD on the same as well as additional unlabeled data (2) incrementally adding tasks.

References:

[1] Hinton, G et al. "Distilling the Knowledge in a Neural Network.", arxiv 2015
[2] Wang, T: "Distilling Object Detectors With Fine-Grained Feature Imitation CVPR 2019
[3] Liu, W:"SSD: Single Shot MultiBox Detector", ECCV 2016

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Partners

External partners

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