



KIDELTA
LEARNING

Scalable AI for Automated Driving

Final Event | March 09, 2023

Shared Backbones with MultiTask CenterNet

Falk Heuer



Contents

1. Challenges in ADAS

2. MCN: Methods

3. Performance Evaluation

4. Knowledge Distillation for Automotive Multitask Datasets





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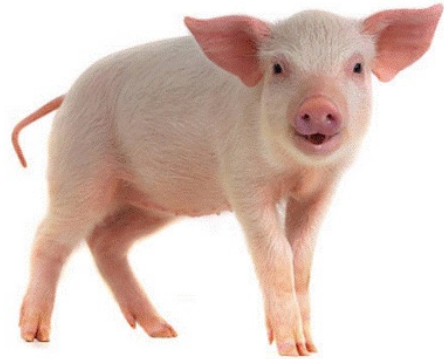
Challenges in ADAS

Tasks in Autonomous Driving

Safe ADAS/AD requires to perceive the environment via a large and versatile amount of Computer Vision Tasks.

But Hardware Resources are limited.





Why create many animals that share attributes...



Tasks



Path Prediction



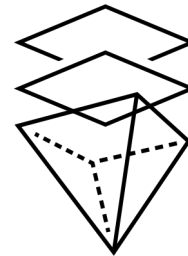
Semantic Segmentation



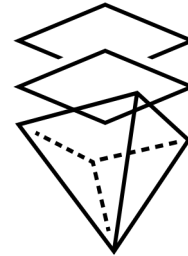
Object Detection



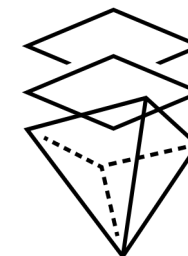
Pose Estimation and more



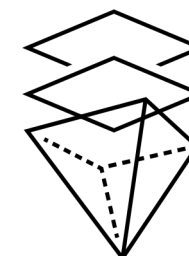
Splines



Segmented Image



Bounding Boxes



Pose Keypoints



Neural Networks



When you can have the "Eierlegende Wollmilchsau"?



Tasks



Path Prediction



Semantic Segmentation



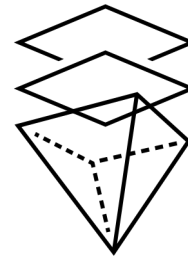
Object Detection



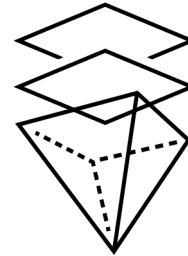
Pose Estimation



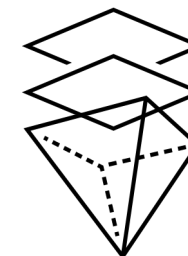
and more



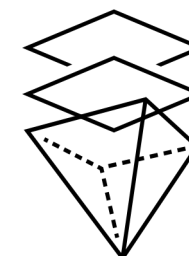
Splines



Segmented Image



Bounding Boxes



Pose Keypoints



and more



Neural Networks

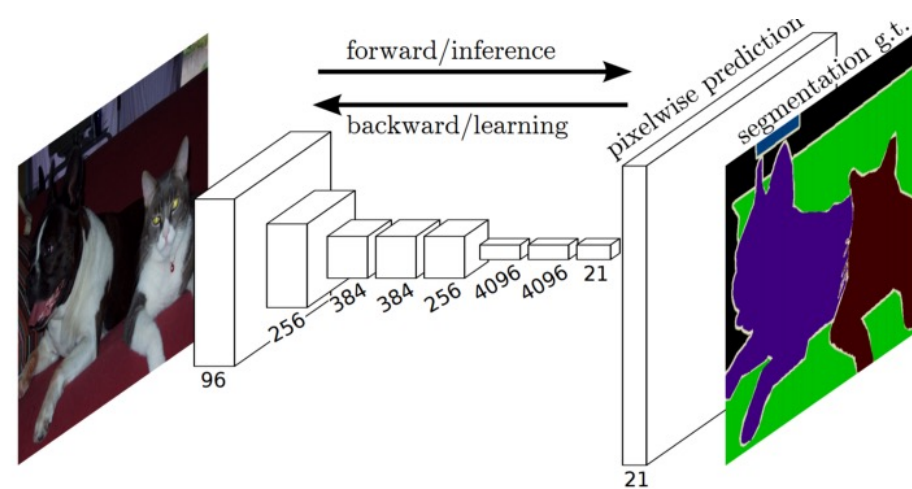
2



MCN: Methods

Semantic Segmentation

- Pixelwise Classification of the whole image in image space
- Application: Recognizing Surfaces, Areas, Sizes and Regions
- Network: Fully convolutional networks, using a CNN/Transformer Backbone, upsampling and a softmax head



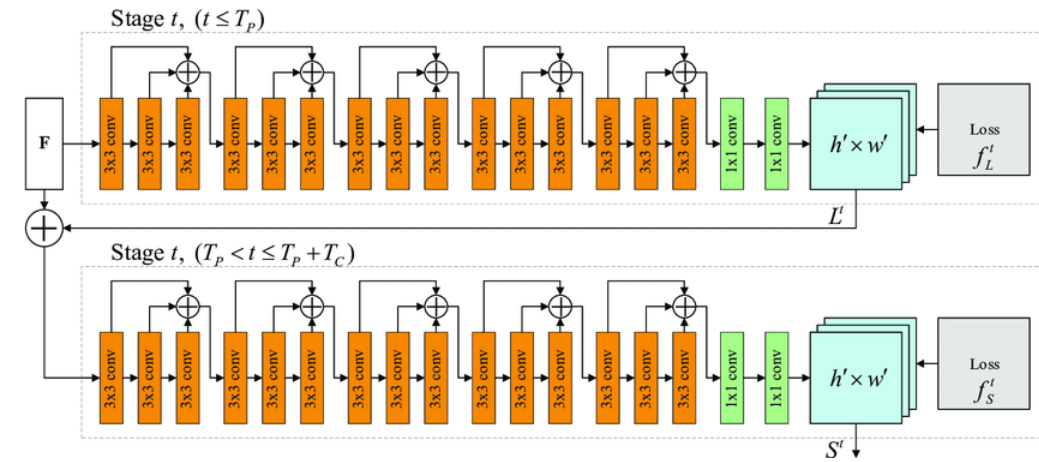
Fully convolutional network for semantic segmentation. Image credits: <https://arxiv.org/abs/1411.4038>



Inference with a semantic segmentation network. Image credits: Cityscapes

Human Pose Estimation

- Detection of a fixed number of human joints
 - Top down: Detect persons, then detect individual joints
 - Bottom Up: Detect all joints, then assemble a human representation
- Application: Recognize precise pedestrian behavior and action on the road
- Network (top down): CNN Backbone, complete box detection heads + joint location + joint offset regression



Network architecture of a human pose estimation network. Image credits: <https://arxiv.org/abs/1812.08008>



Inference with a human pose estimation network. Image credits: OpenPose



Multitask CenterNet Architecture

Multitask CenterNet Architecture

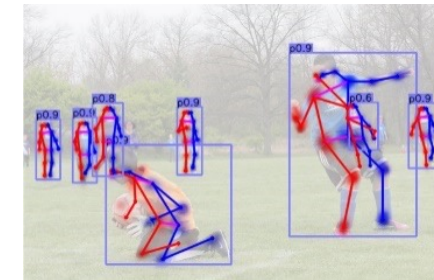
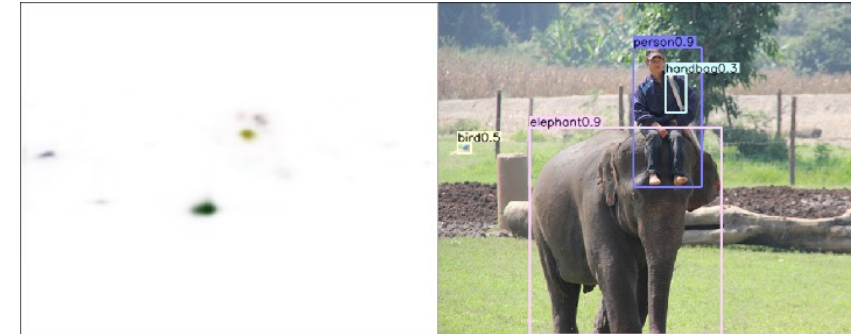
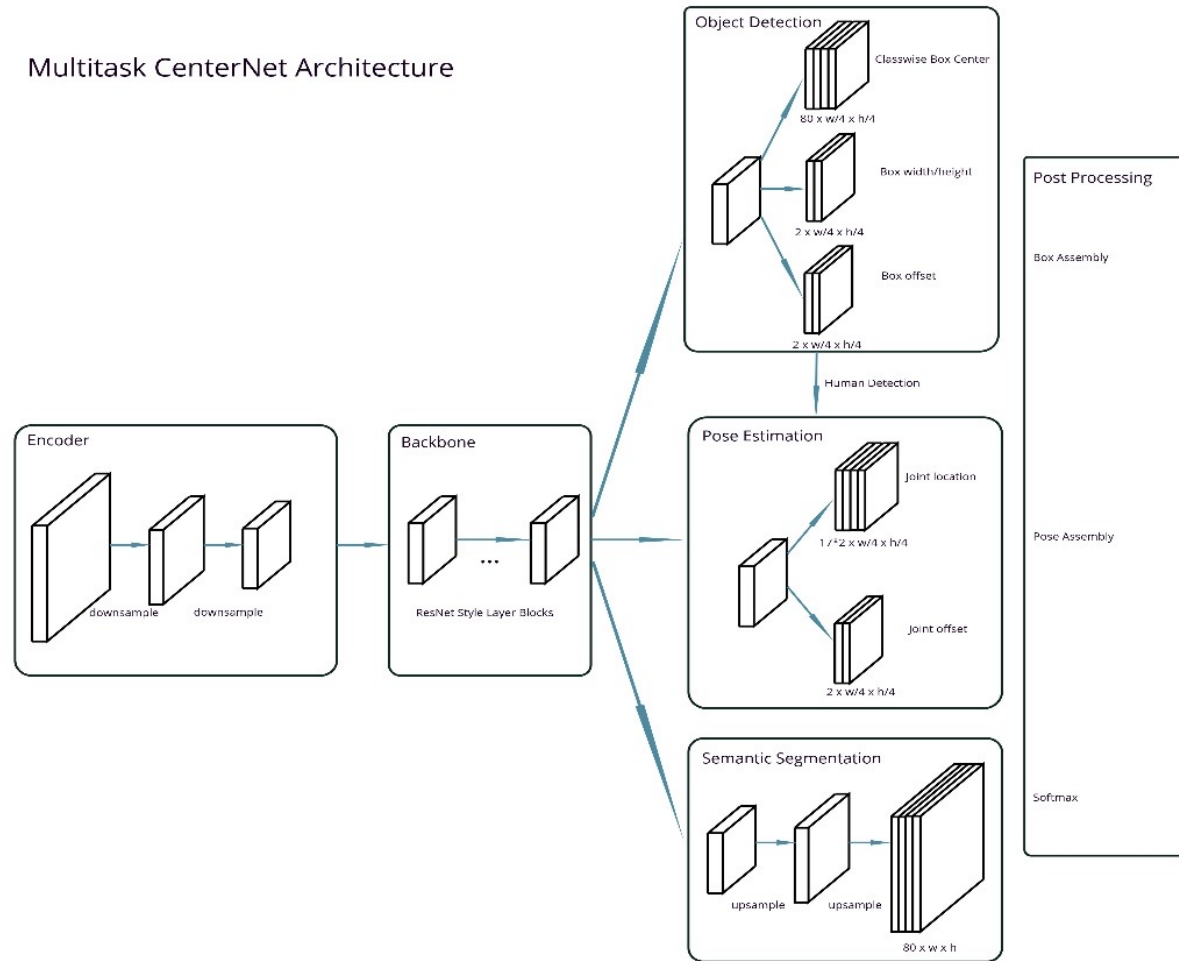


Image credits: MS Coco 2017



Experiments on the MS COCO Dataset

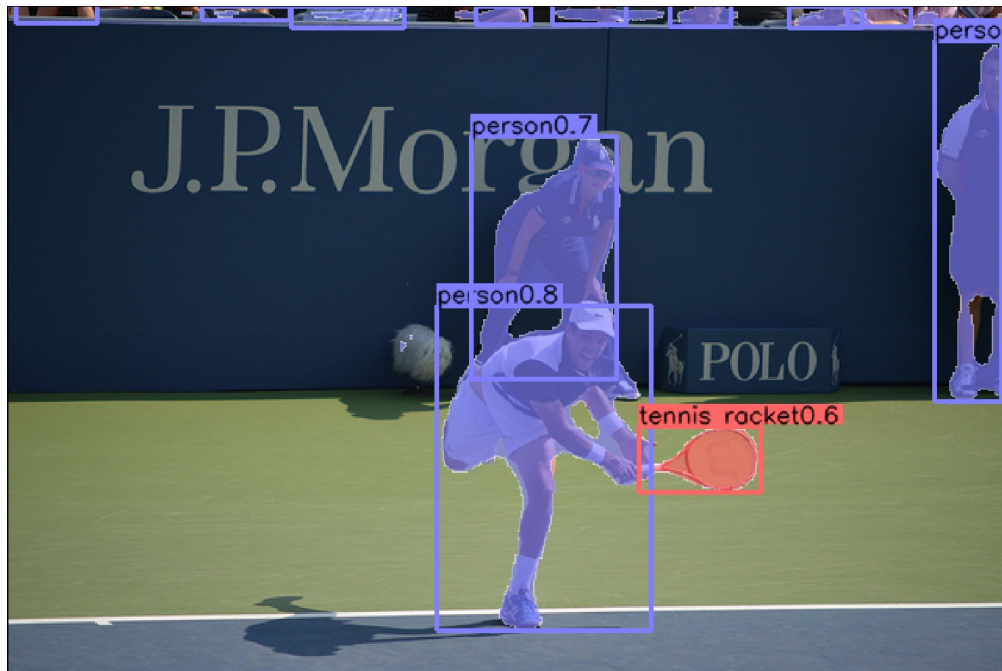
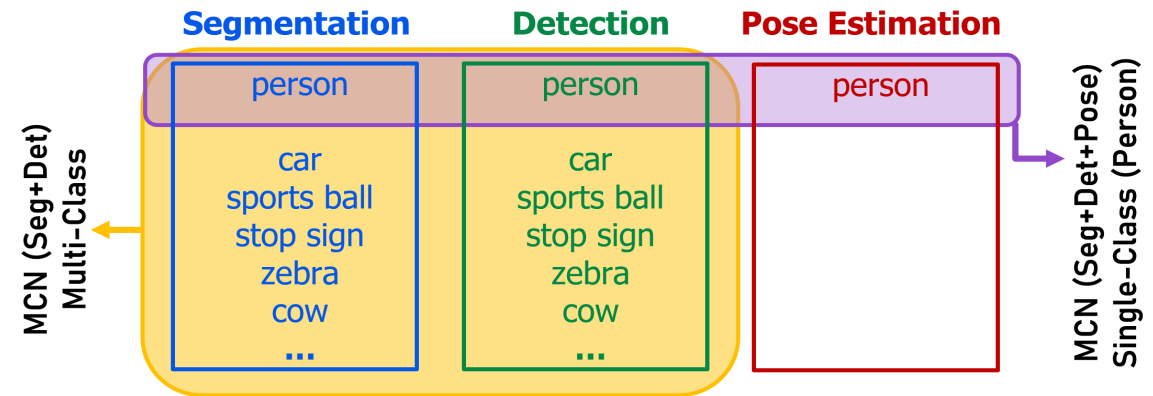


Image credits: MS Coco 2017



- Multi-Task CNN with a DLA-34 Backbone and heads for
 - Anchor-free Detection
 - Semantic Segmentation
 - Human Pose Estimation
- MS-COCO 2017 Instance Segmentation Dataset
 - 2D Bounding Box Detection
 - Semantic Segmentation
- MS-COCO 2017 Keypoints Dataset
 - 2D Bounding Box Detection
 - Human Pose Estimation
 - Semantic Segmentation

3



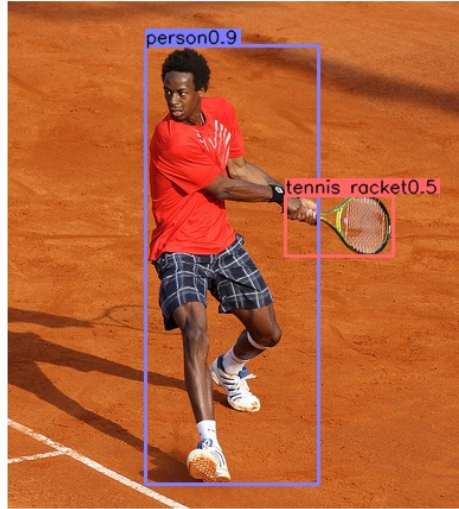
Performance Evaluation



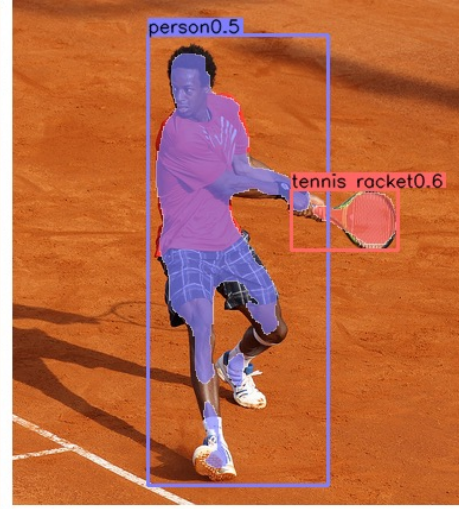
Inference Samples



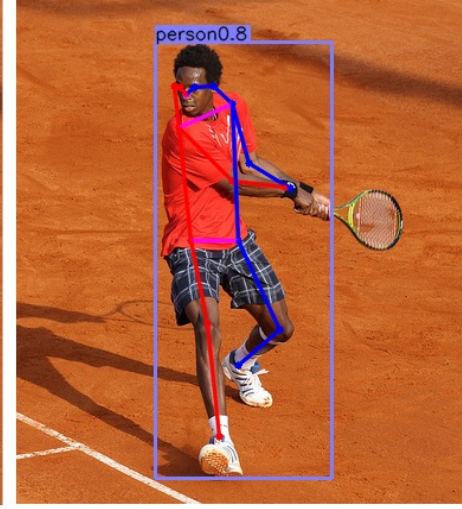
Multiclass Segmentation



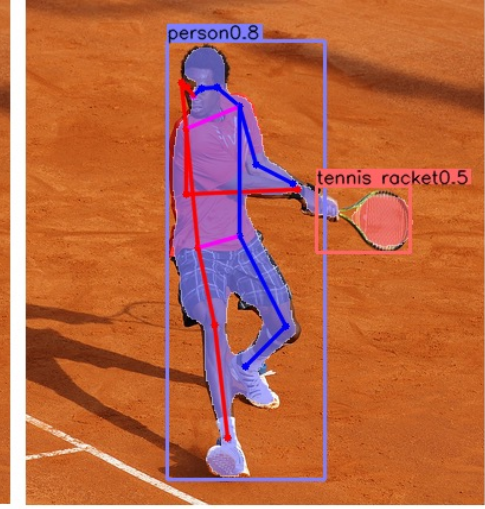
Multiclass Detection



Multiclass Segmentation
Multiclass Detection



Multiclass Detection
Human Pose Estimation

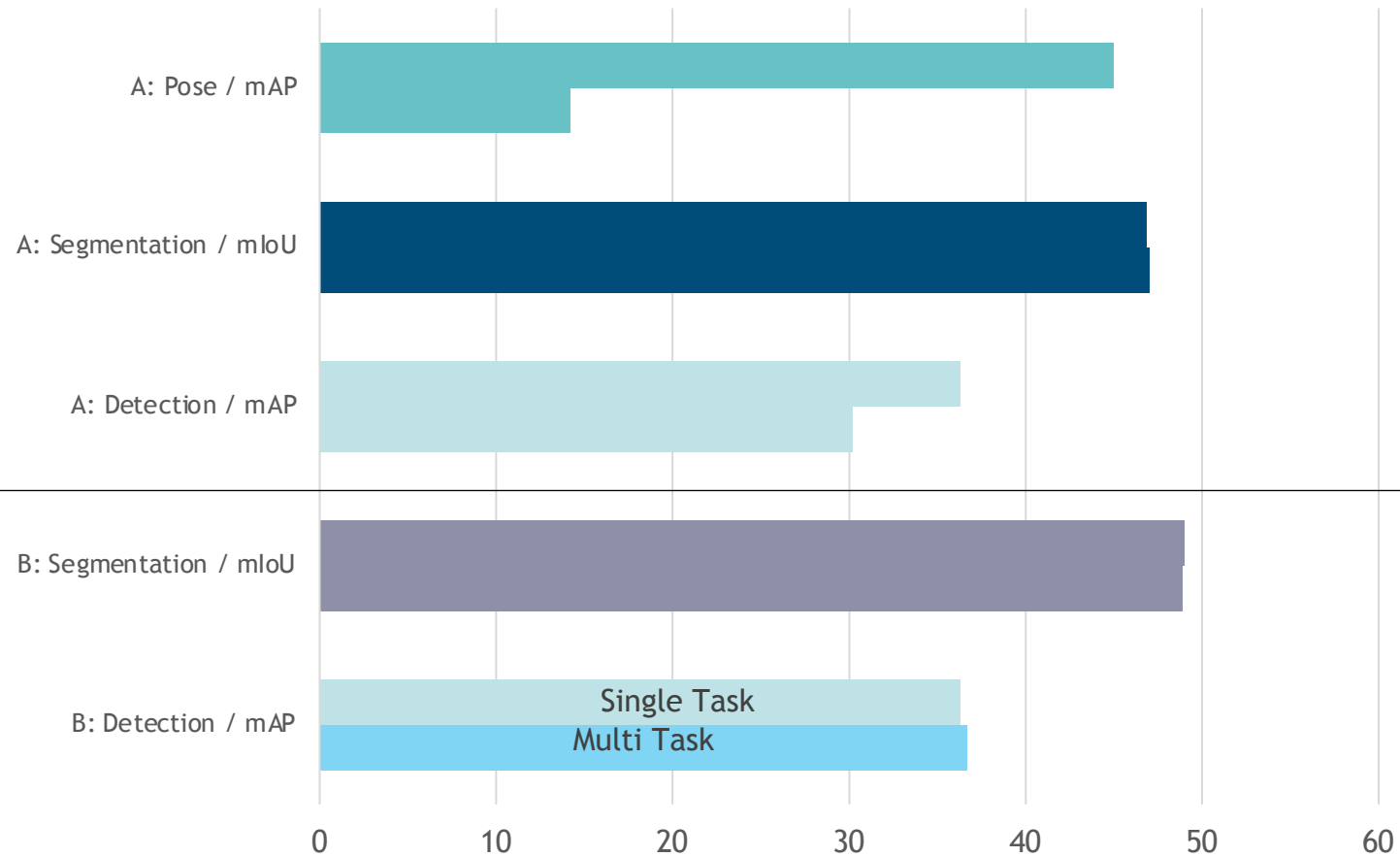


Multiclass Segmentation
Multiclass Detection
Human Pose Estimation

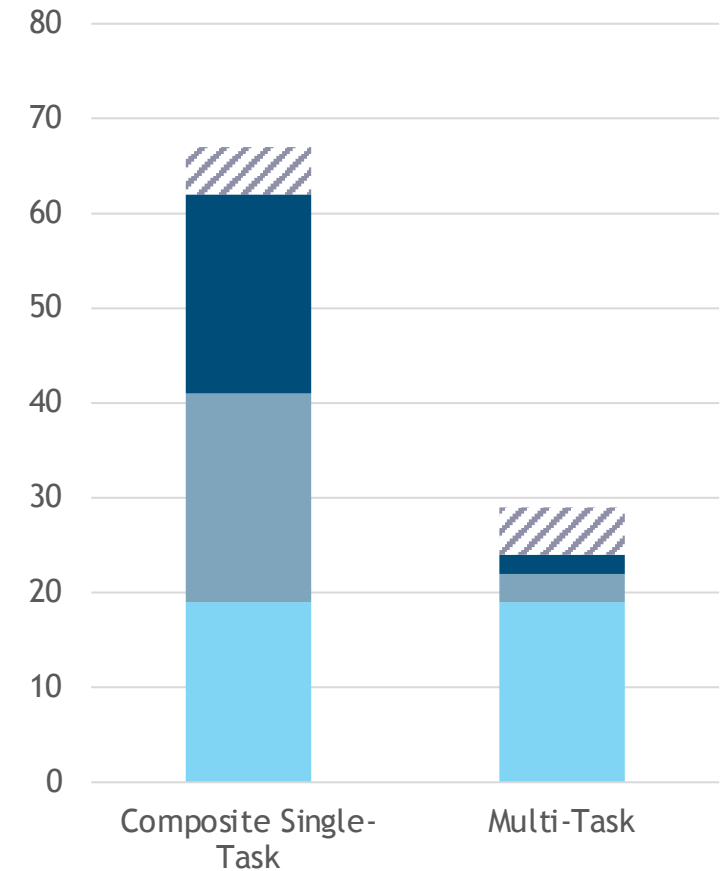


Results - Quantitative

Performance (DLA34)



Inference Time (DLA34)





Inference Samples Detection/Multi-Task

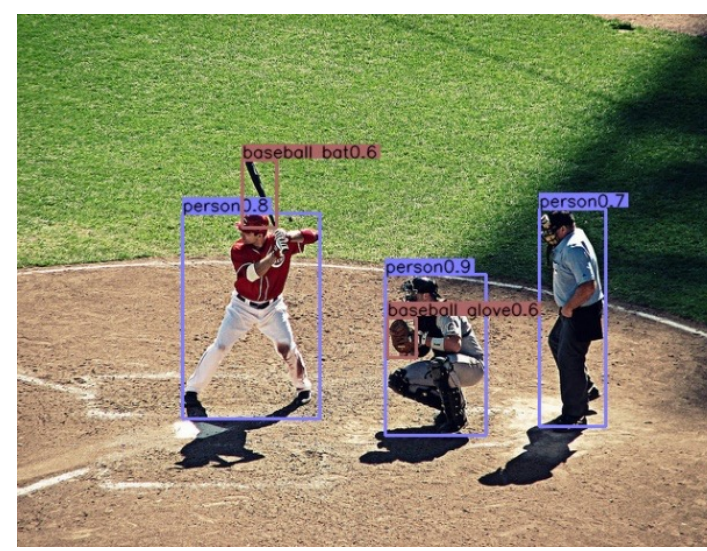
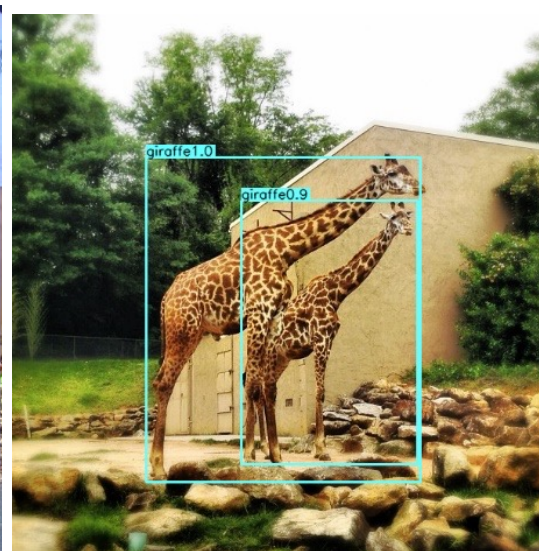
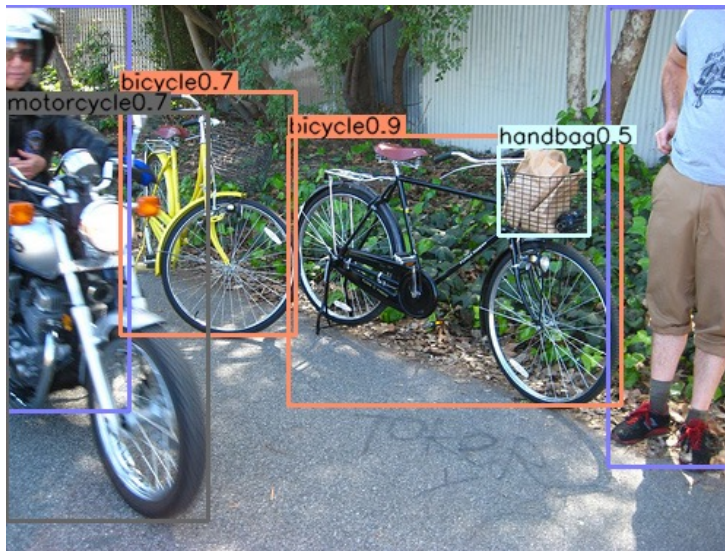
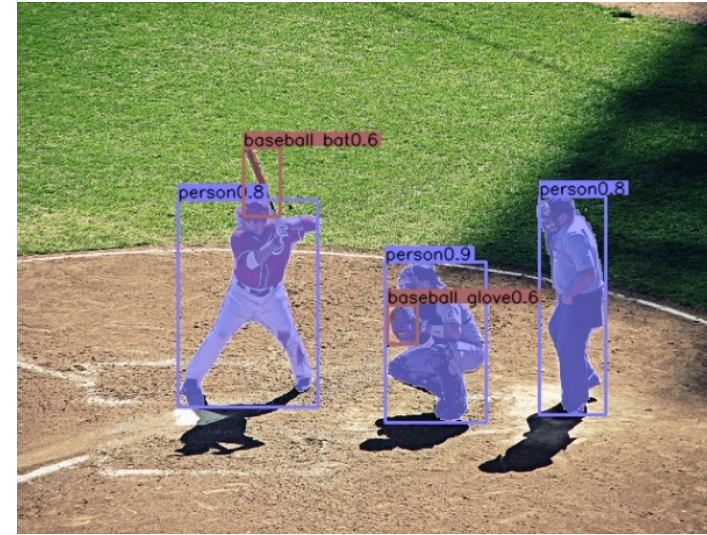
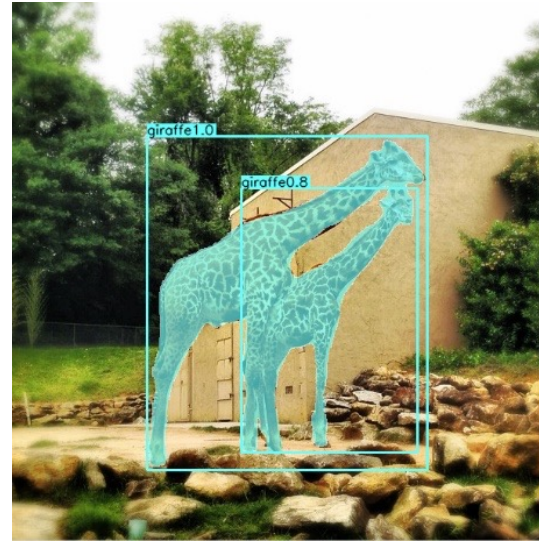
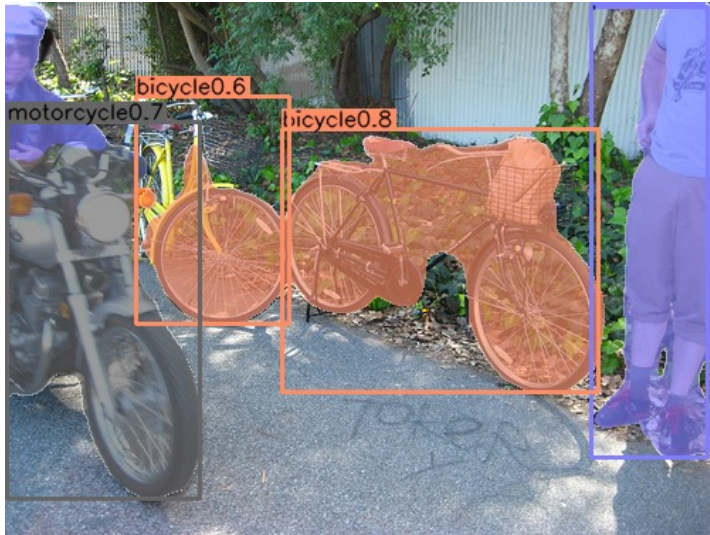
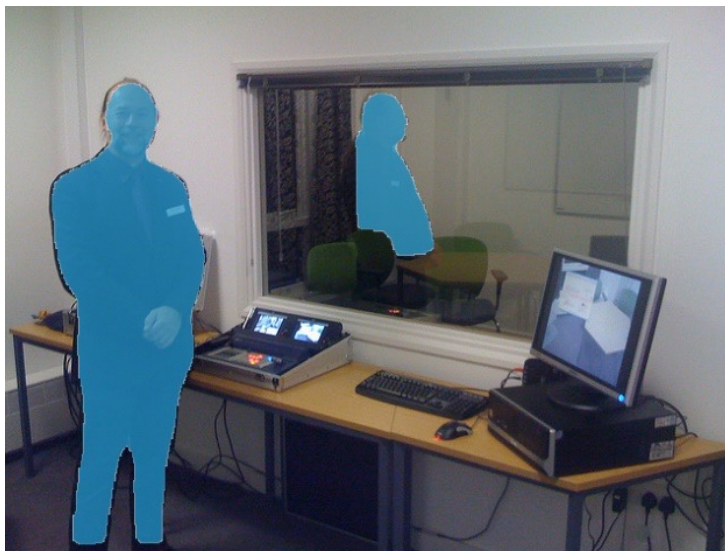
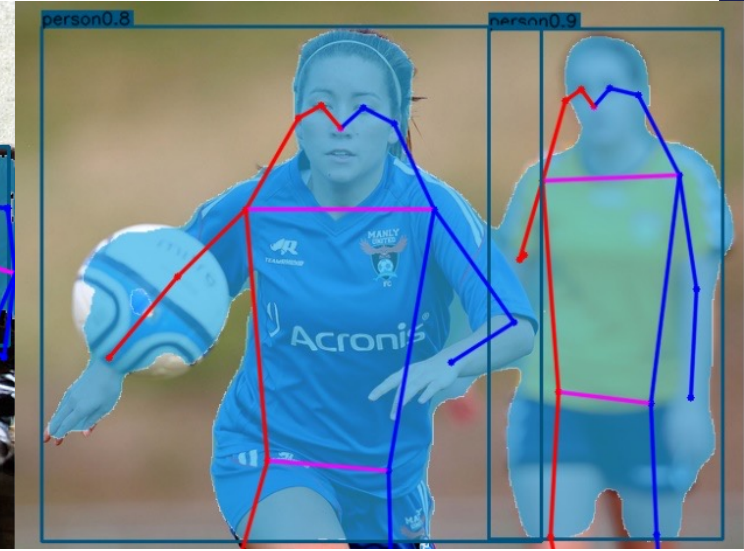
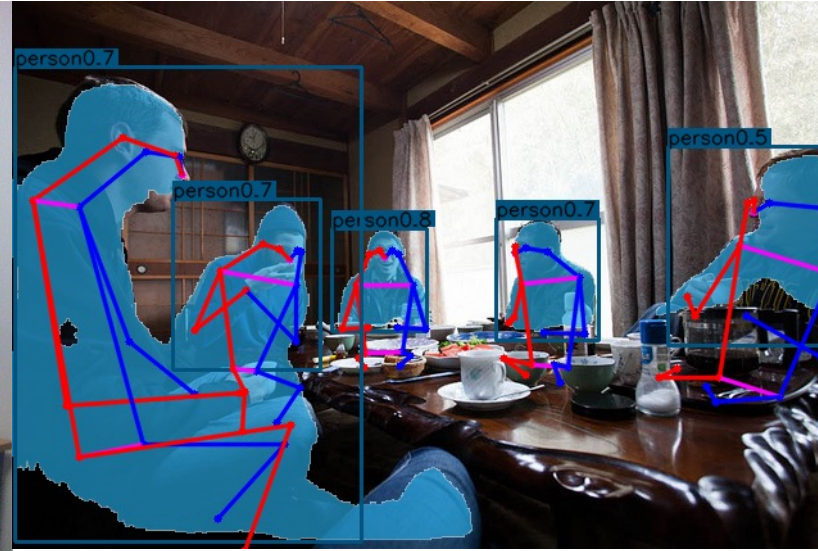
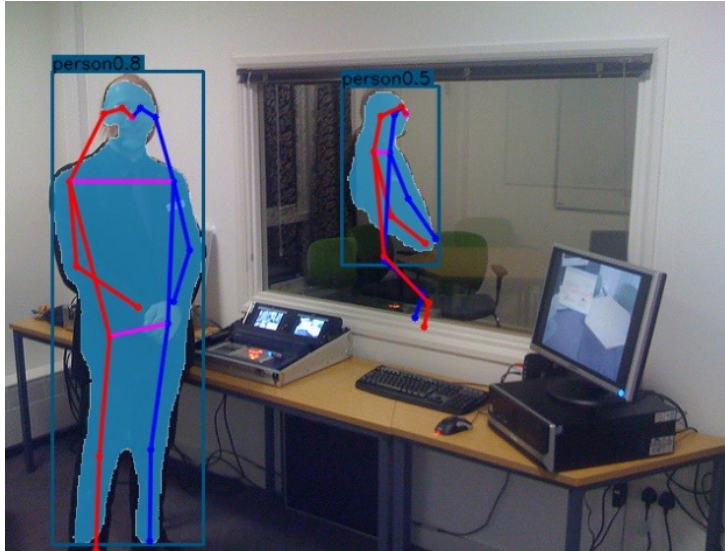


Image credits: MS Coco 2017

Inference Samples Segmentation/Multi-Task



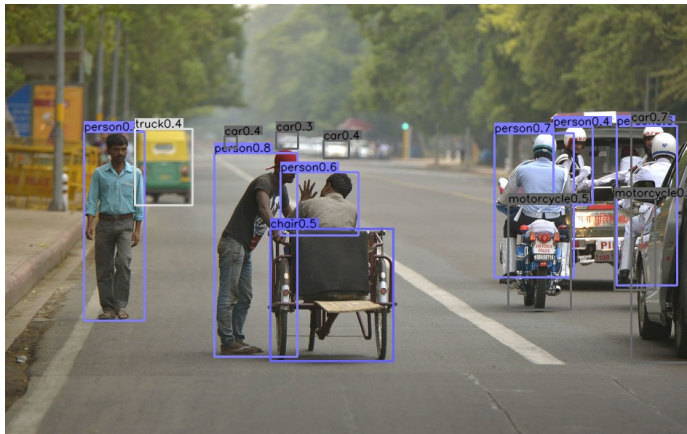


4

Knowledge Distillation for Automotive Multitask Datasets



Dataset Fusion with Knowledge Distillation



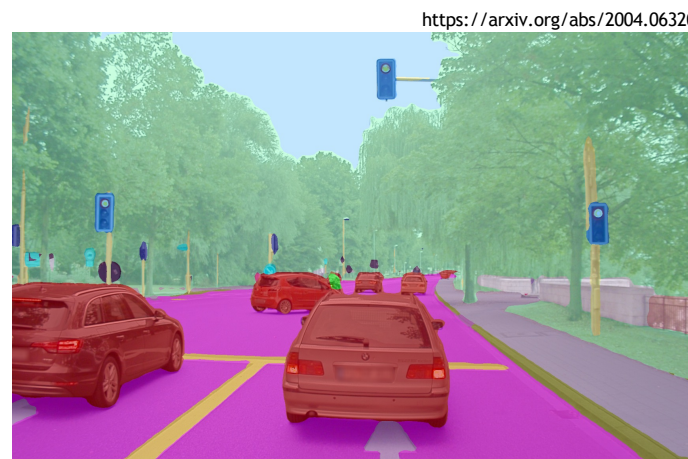
Object Detection



Pose Estimation



Path Prediction



Semantic Segmentation



merge

- How to train on tasks with labels from multiple Datasets?
 - Train specialist networks on individual tasks
 - Use them to generate pseudo-labels for all tasks on a joint dataset
 - Train the Multi-Task network on the joint dataset



Results - Quantitative





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»» Thank you for your attention



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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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