ECE208 Project Presentation

SGNET: REAL-TIME MULTI-TASK AUTONOMOUS VEHICLE VISION

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Acknowledgement & Appreciation

Suggestion Offered by Dr. Zhiyao Duan

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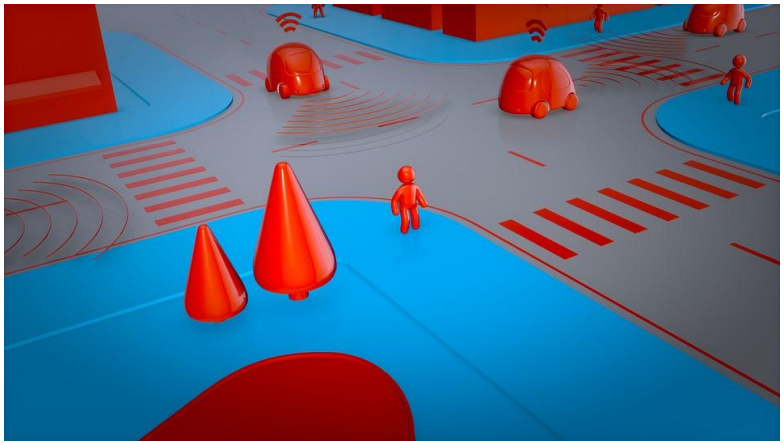
Linux Setup by Zhuo Liu & Zhenyu Pan, Ph.D Candidates, UR ECE

Structures:

1. Current Problems
2. Related Works
3. Model Description
4. Results
5. Main Contributions



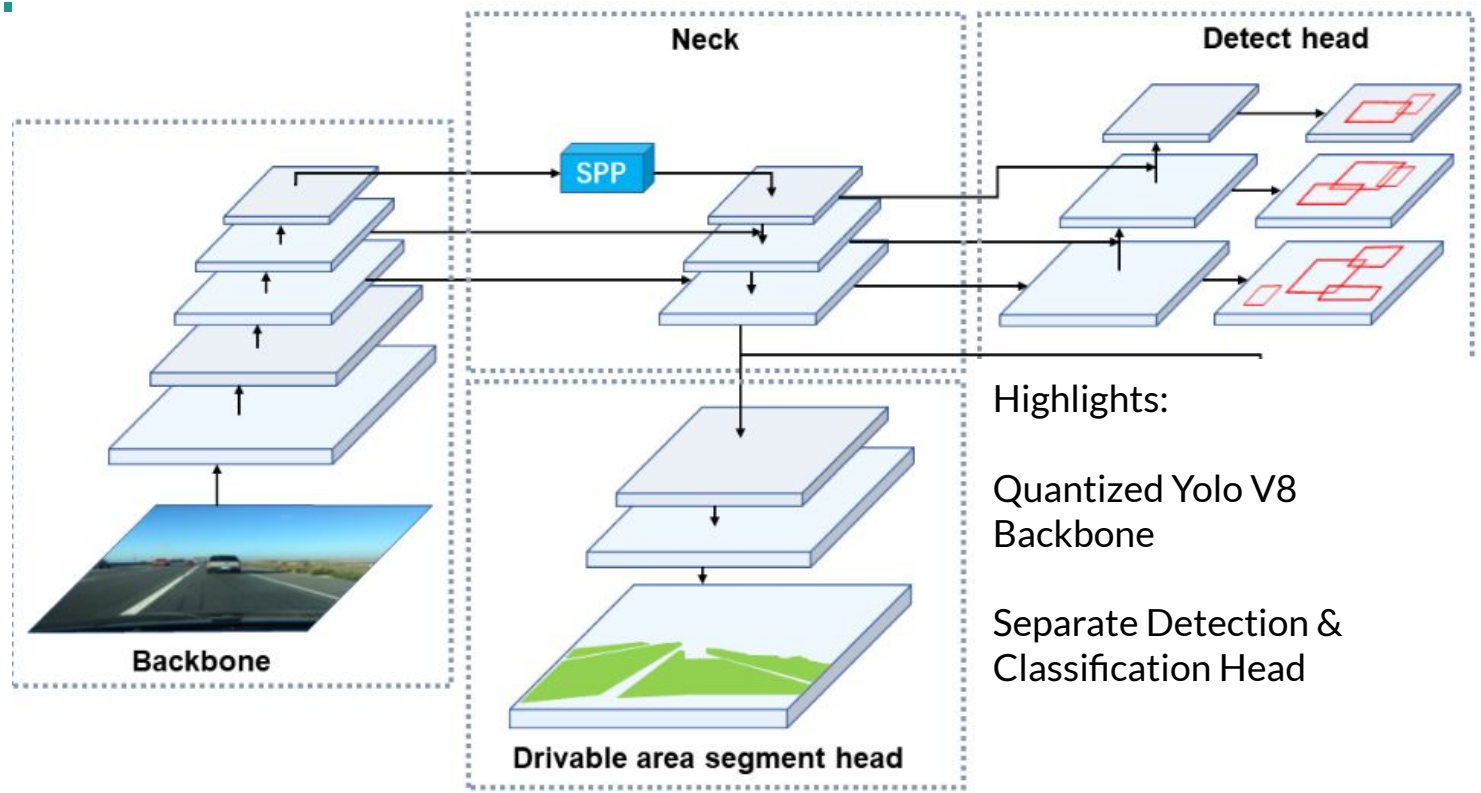
Current Solution & Problems

Multi-type sensors may not an ideal solution:

- **Fusion of different sensors- inconsistencies.**
- **Expensive sensors, intense computation needs.**

Fig 1 Autonomous Demonstration: https://vayyar.com/

Solution: Multi-task Model?



Highlights:

Quantized Yolo V8 Backbone

Separate Detection & Classification Head

Related Works : Interactive Object Detection

Two-stage algorithm- RCNN, Fast(er)-R(

Identify regions + Detect Objects

One-stage algorithm: SSD,YOLO

Fully convolution approach to dete objects

And the latest sota model is the Yo

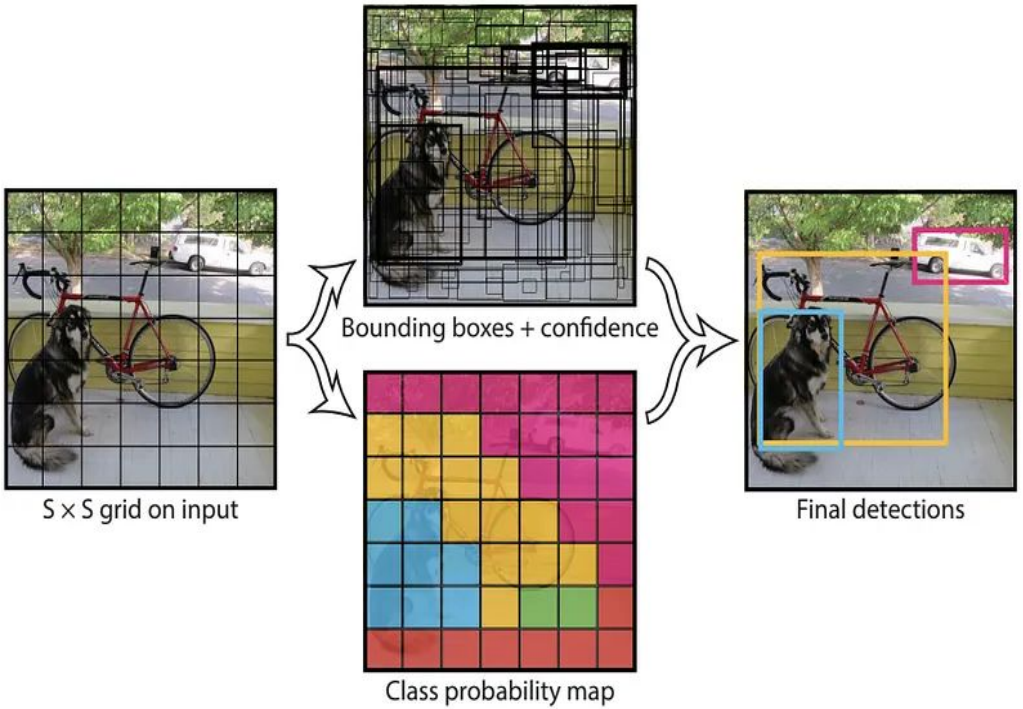


Figure 2 &3
https://towardsdatascience.com/r-cnn-fast-r-cnn-faster-r-cnn-yolo-object-detection-algorithms-36d53571365e

Related Work: SAM

Segment Anything Model:

Advantage: Generic

Problem: Size-Speed,
Non-task-specific

Fig 4 SAM example
credit:https://segment-anything.com/

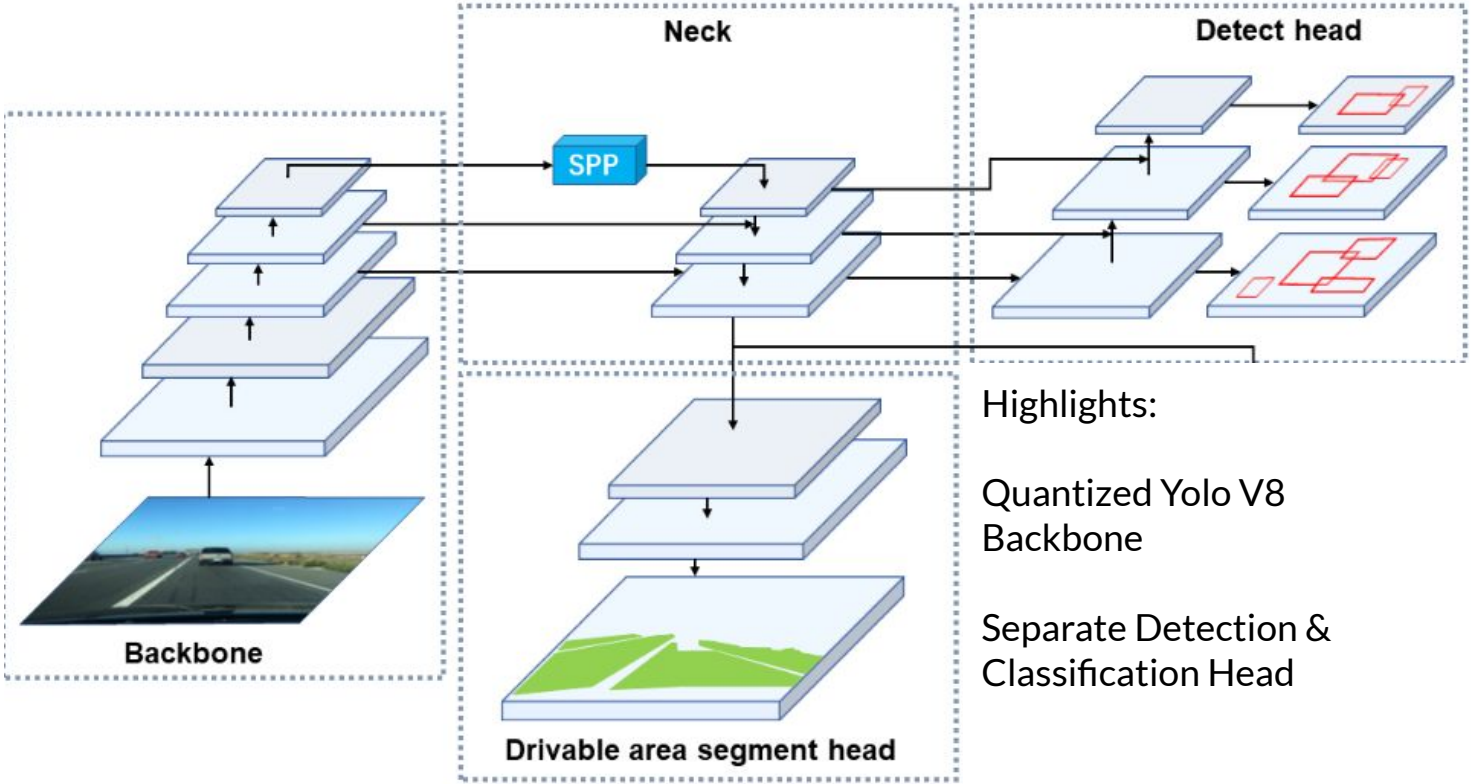
Models Description

SGnet: Detect and Segmentation Heads

Split the target into different networks (lossees) to prevent inter-limitations instead of conventional end-to-end training.

Combining real-time semantic segmentation, object detection in a single model, achieving similar accuracy and speed with single task neural network

Solution: Multi-task Model?



Highlights:

Quantized Yolo V8 Backbone

Separate Detection & Classification Head

Credit: Wu, D., Liao, MW., Zhang, WT. *et al.* YOLOP: You Only Look Once for Panoptic Driving Perception. *Mach. Intell. Res.* 19, 550–562 (2022). https://doi.org/10.1007/s11633-022-1339-y

Convolution Quantization- A Modified DSConv

Weight Quantization: similar weights grouped

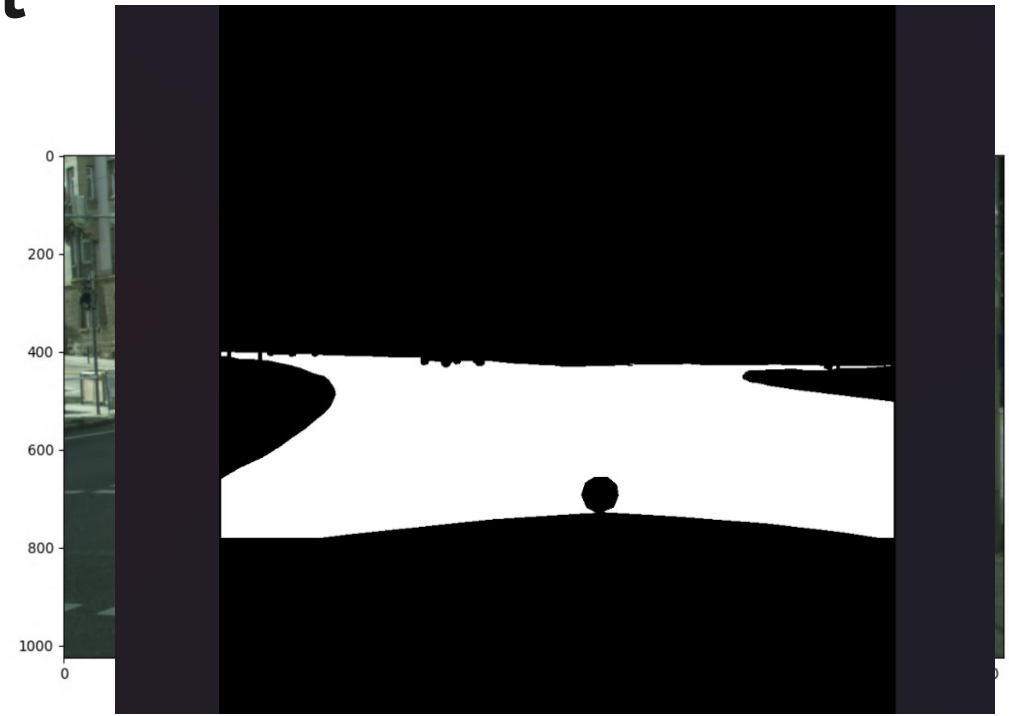
Dynamic Sparsity: non-zero weights change pattern during training

Competitive Accuracy: Dropout Effects in Neural Network

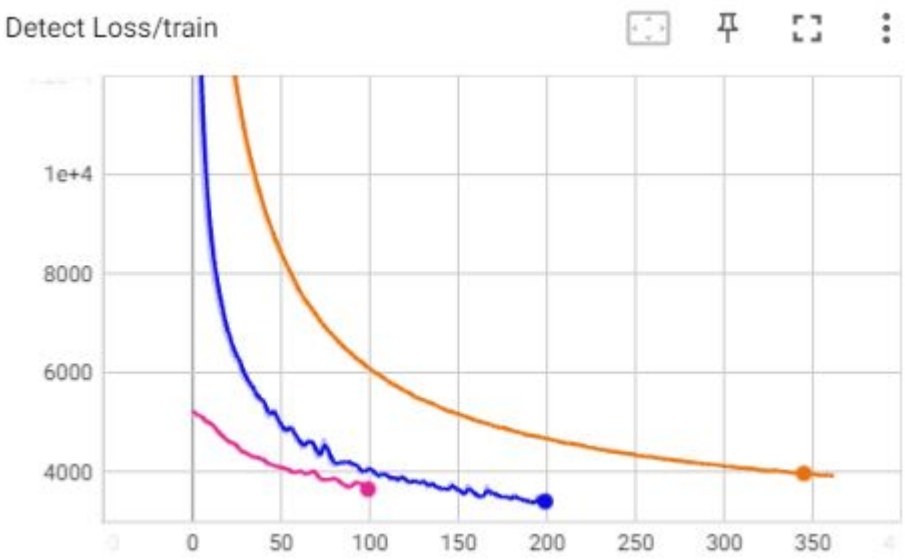
*Gennari, M., Fawcett, R., & Prisacariu, V. A. (2019). DSConv: Efficient Convolution Operator. arXiv preprint arXiv:1901.01928.

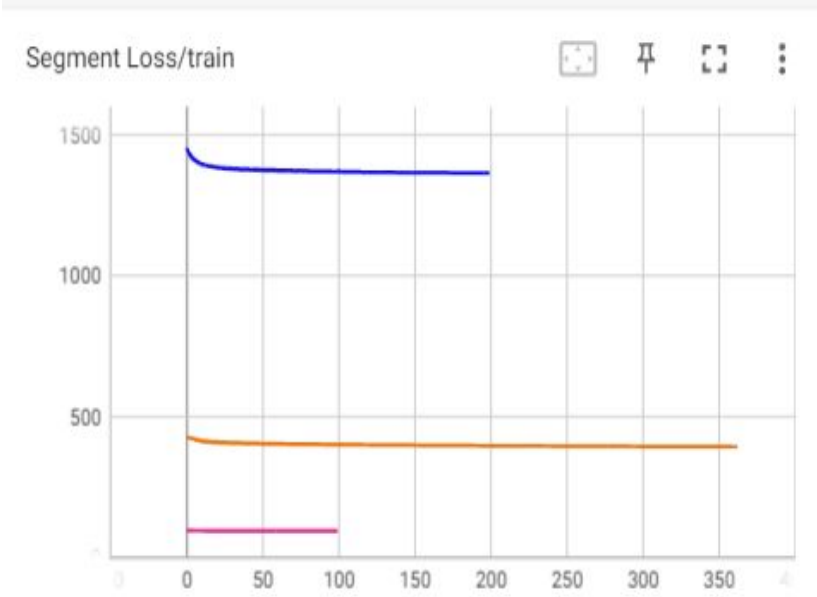
Experiments: Dataset

- Fine segmentation from Cityscapes, bbox generated using conversion tool
- Self-labeled traffic lights by Anylabeling tool.
- Classes: Car, Pedestrian, Truck/Bus, Rider, Traffic Light, Bicycle
- Train: 2975, Test: 500



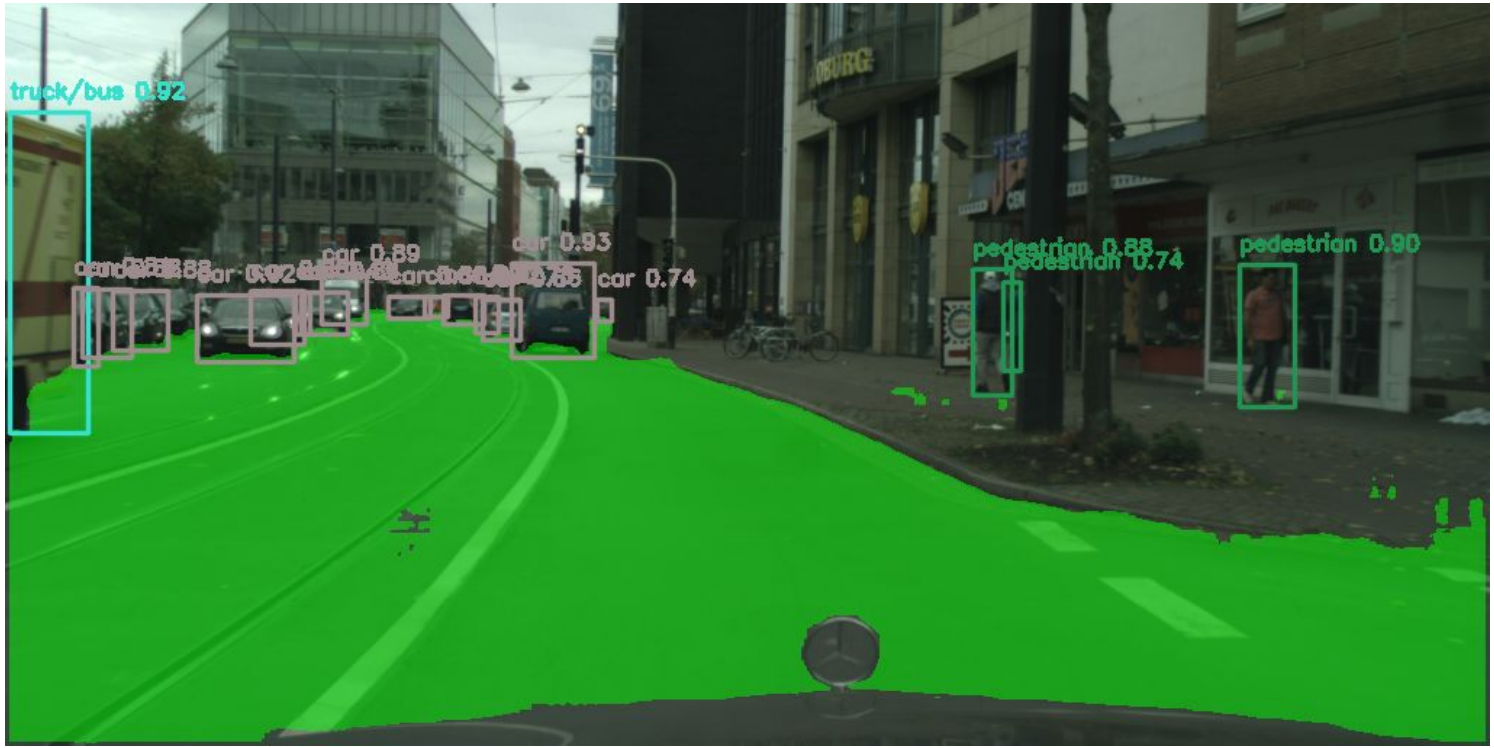
Results of Loss:





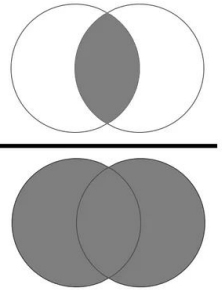
* Trained & Evaluated on Single Nvidia RTX 3090 GPU

Qualitative Result



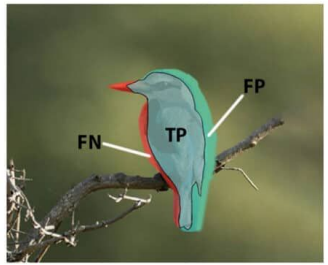
Quantitative Results: Evaluation on Segmentation

$$IoU = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



Ground Truth Mask

Predicted Mask



Network	mIoU(%) [train]	mIoU(%) [test]	Speed(fps)
DSNet	94.2	88.5	96.4
Yolo V8	93.8	88.8	99.4

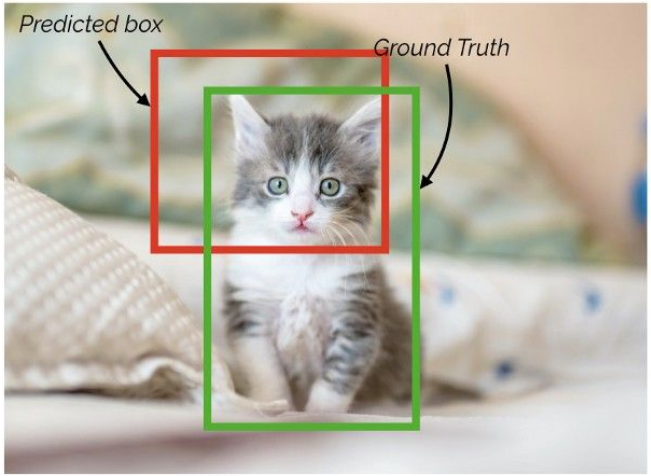
Quantitative Results: Precision & Recall

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

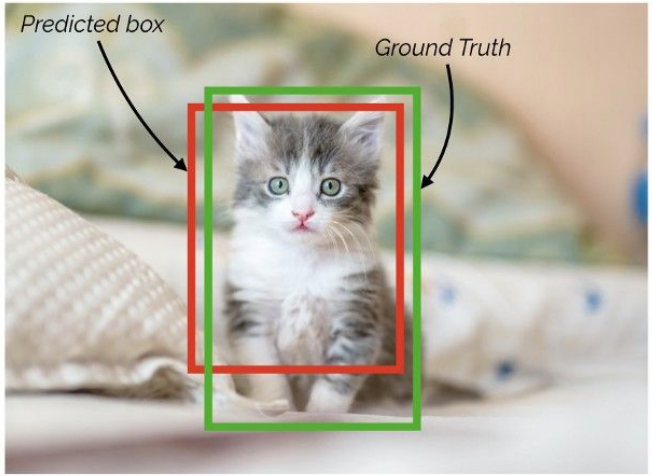
If IoU threshold = 0.5

False Positive (FP)



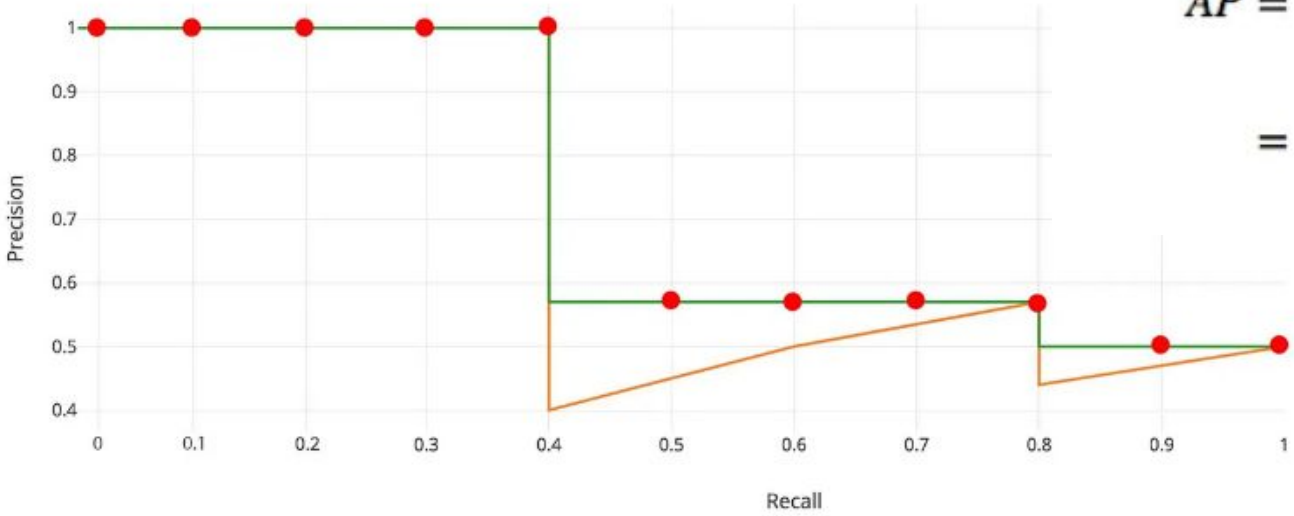
IoU = ~0.3

True Positive (TP)



IoU = ~0.7

Quantitative Results: Evaluation on Object detection

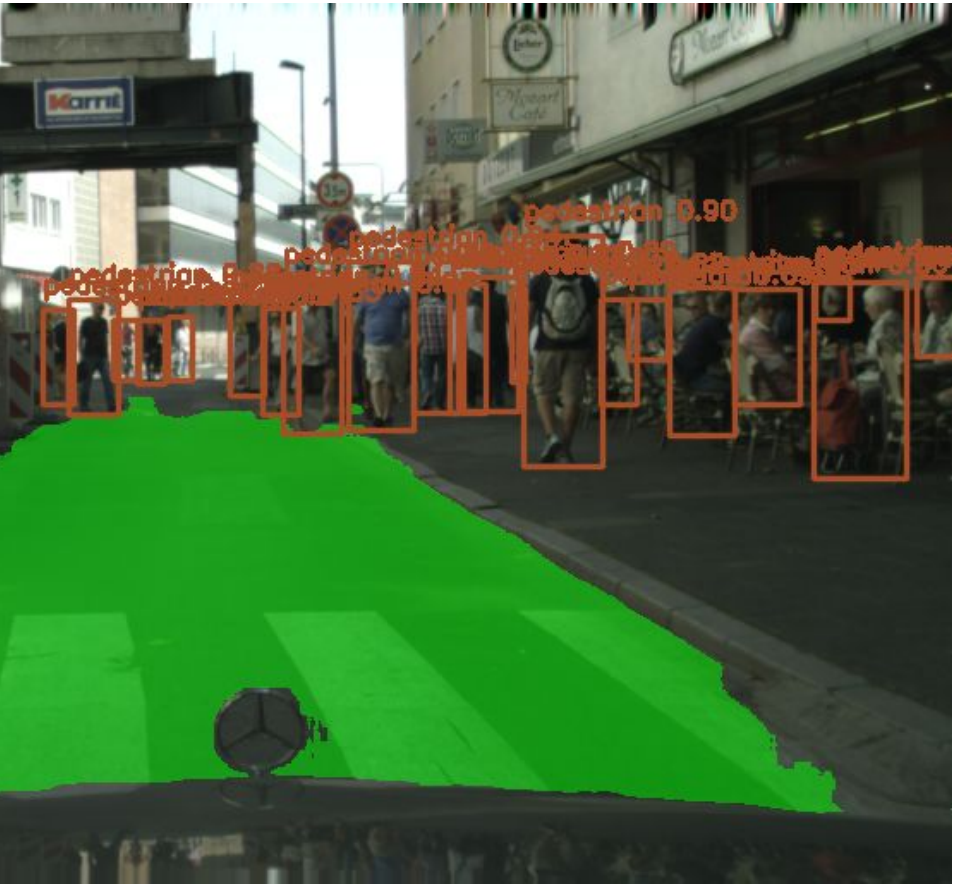


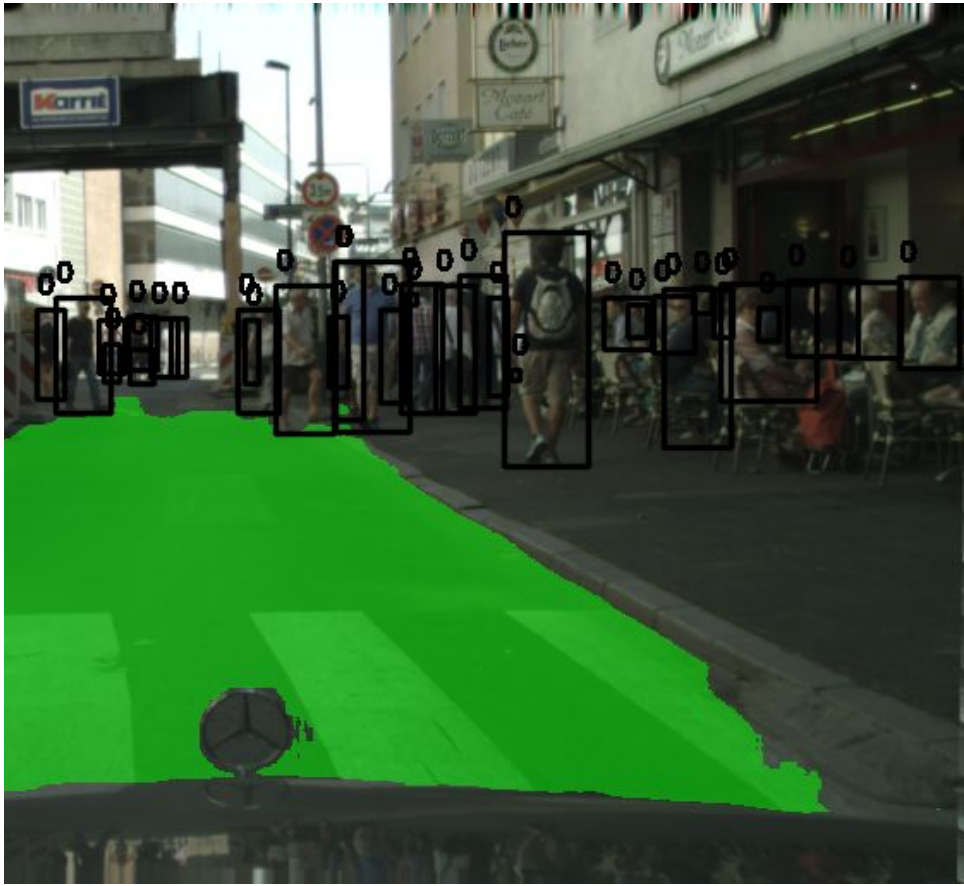
$$AP = \frac{1}{11} \sum_{r \in \{0.0,\ldots,1.0\}} AP_r$$

$$= \frac{1}{11} \sum_{r \in \{0.0,\ldots,1.0\}} p_{interp}(r)$$

Network	mAP50(%) [train]	mAP5095(%) [train]	mAP50(%) [test]	mAP5095(%) [test]	Speed(fps)
DSNet	90.7	75.3	44.0	22.6	96.4
Yolo V8	90.4	71.7	42.0	22.5	99.2

Low mAP, Data or Code?





Conclusion & Contribution

- **Offer Concept for Vehicle Perceptron with Monocular Images**
- **Enable Human-alike Pipeline for Autonomous Driving**
- **Base Model for Further Research on Trajectory Prediction**