Street-Map Based Validation of Semantic Segmentation in Autonomous Driving

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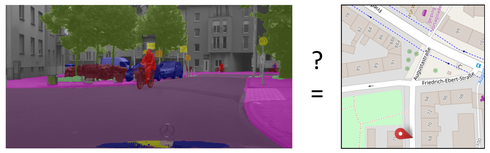
Research Question

Can semantic segmentations be validated with street maps in order to identify prediction errors?



Motivation: Robust artificial intelligence systems are important for safe autonomous driving!

Metric Definition

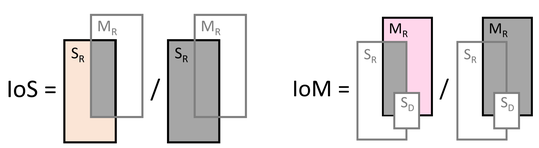
The consistency of the semantic segmentation with the street map can be quantified by two new validation metrics.

Intersection over Segment (IoS): The share of the semantic road segment that is covered by the map

$$IoS = \frac{S_R \cap M_R}{S_R} = \frac{TP}{TP + FP}$$

Intersection over Map (IoM): The share of the road in the map that is covered by the semantic segment

$$IoM = \frac{S_R \cap M_R}{M_R - (M_R \cap S_D)} = \frac{TP}{TP + FN}$$



S_R := Road in segmentation
S_D := Dynamic objects in segmentation (e.g. car)
M_R := Road in map
TP := Road in segmentation and map
FP := Road in segmentation, but not inmap
FN := Road not in segmentation, but in map

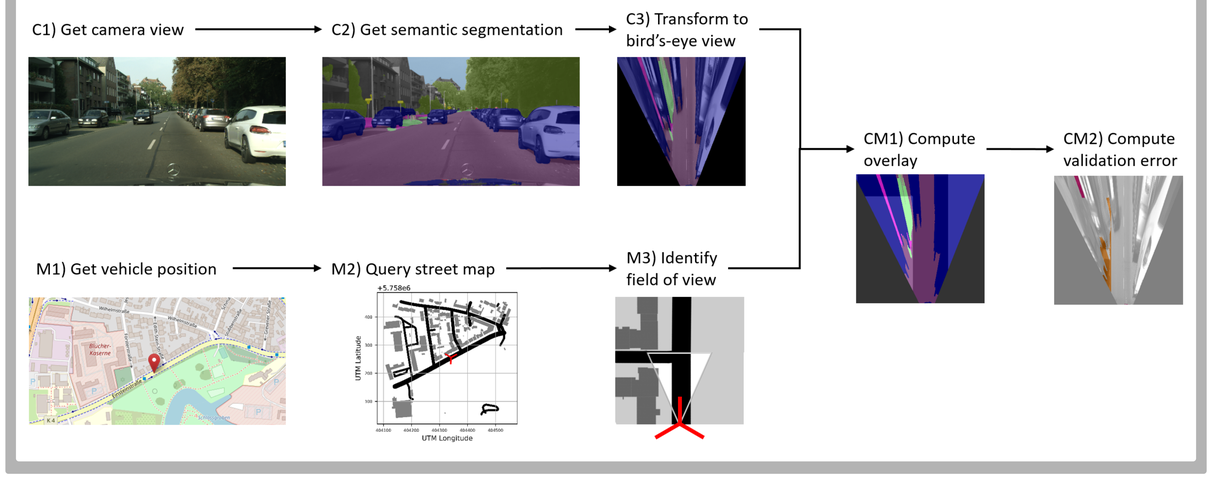
Semantic Segmentation

We process vehicle's front views of traffic scenes. Here, we use the Cityscapes [1] dataset.
We train a neural network to predict a segmentation mask that maps each image pixel to a set of pre-defined class labels. In particular, we use the ERFNet encoder-decoder architecture, which is designed for real-time application [3].

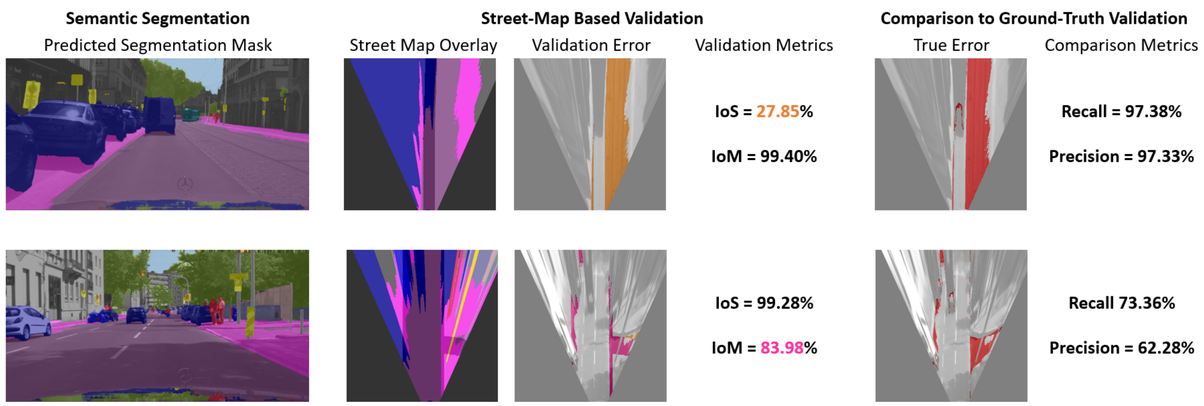
Street Map

For the given vehicle's latitude and longitude we get a street map graph for the surrounding area. For our analysis we use data from OpenStreetMap [2]. The graph contains a street network, where roads are given as connected line segments. For each, the geographical start and end coordinates are given, as well as the road type (motorway, residential, etc.).

Approach Overview

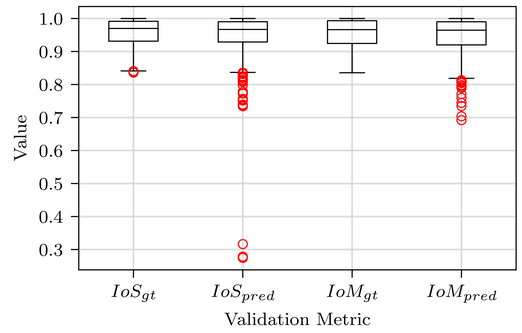


Example Results



Dataset Results

The validation metrics *IoS* and *IoM* contain outliers for the predicted segmentation masks and thus help to identify potential errors.



Conclusion

The roads in semantic segmentation masks can be validated with street maps. This approach detects similar prediction errors as using ground truth.

References

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