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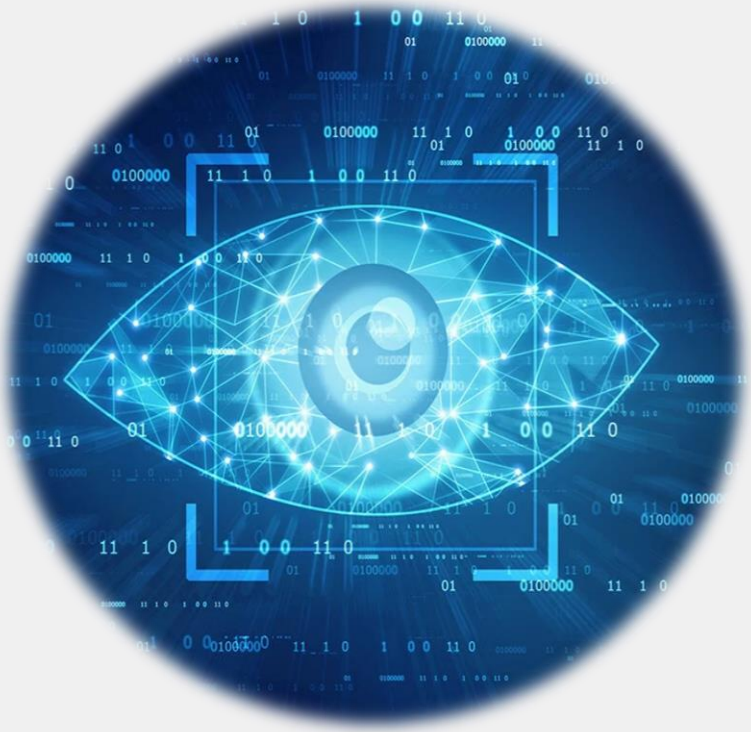
Computer Vision for Visual Perception

Semantic Segmentation for Detecting Drivable Area

Learning Objectives

- **Semantic Segmentation**
  - Definition
  - Background
- **Semantic Segmentation Task Problem Formulation**
- **Mathematical Model Formulation**
- **ConvNets for Semantic Segmentation**
- **Performance of Semantic Segmentation Model**
- **Evaluation Matrics for Semantic Segmentation**
- **Summary**
- **References**



Semantic Segmentation – Definition

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- **It is the process of partitioning a digital image into multiple image segments known as image regions or image objects.**

Semantic Segmentation – Background

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- Self-Driving Cars
- Medical Image Segmentation
- ConvNets

Semantic Segmentation – Task Problem Formulation

Image without Segmentation

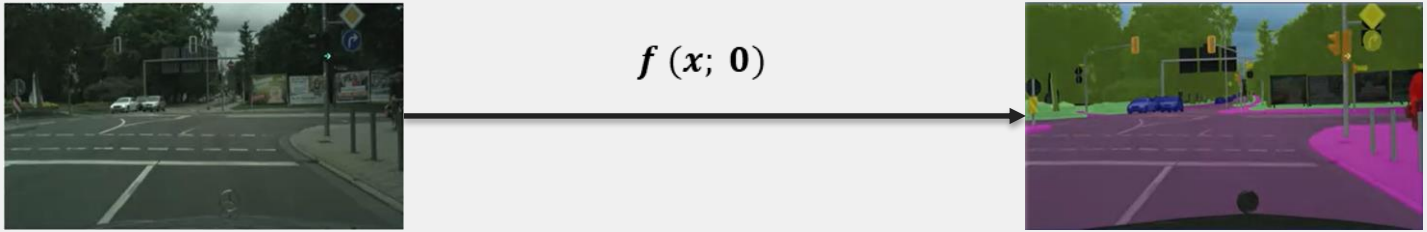
Semantic Segmentation – Task Problem Formulation

Segmented Image

Semantic Segmentation – Task Problem Formulation

Real & Segmented Image

Mathematical Problem Formulation



$$f\ (x; 0) = [S_{class-1}, \dots \dots S_{class-k}]$$

Semantic Segmentation is Not Trivial!

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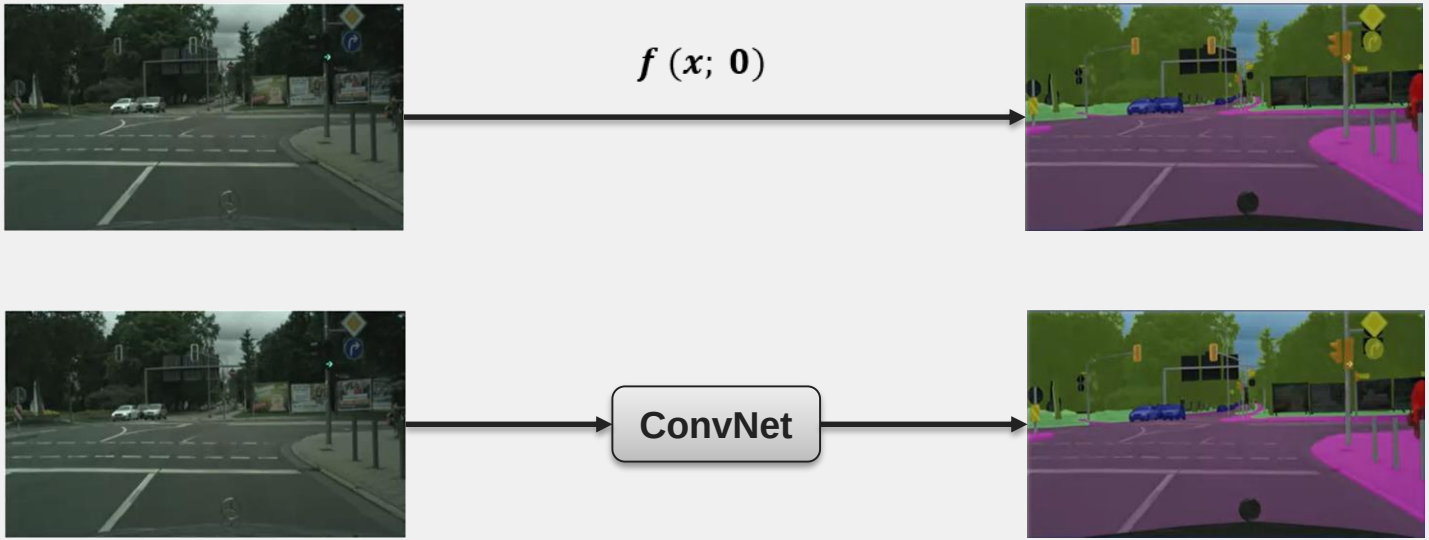
- **Occlusion**
- **Truncation**
- **Scale**
- **Illumination Changes**
- **Smooth Boundaries**

ConvNets for Semantic Segmentation



Evaluation Matrics

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- **True Positive (TP)**
  - **No. of correctly classified pixels belonging to class X**
- **False Positive (FP)**
  - **No. of pixels that do not belong to class X but are classified**
- **False Negative (FN)**
  - **No. of pixels that do belong to class X but are not classified**

$$IOU_{class} = \frac{TP}{TP + FP + FN}$$

Evaluation Matrics

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Ground Truth

R	R	R
R	R	S
S	S	S

Prediction

S	R	S
R	R	S
S	S	S

Class: Road

TP = 3
FP = 0
FN = 2

$$IOU_{Road} = \frac{3}{3+0+2} = \frac{3}{5}$$

Evaluation Matrics

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Ground Truth

R	R	R
R	R	S
S	S	S

Prediction

S	R	S
R	R	S
S	S	S

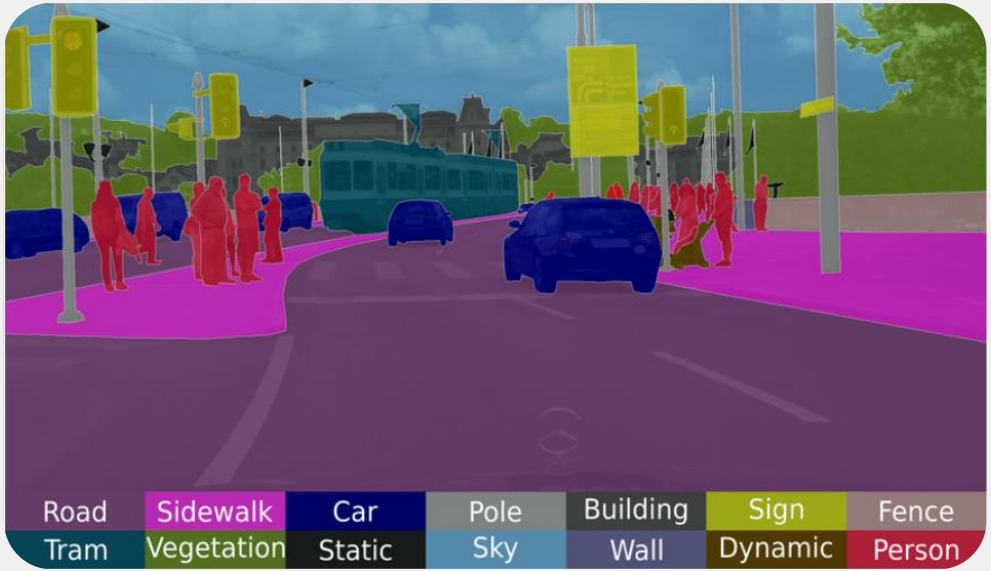
Class: Sidewalk

TP = 4
FP = 2
FN = 0

$$IOU_{Road} = \frac{4}{4+2+0} = \frac{4}{6}$$

Evaluation Matrics

- Class IOU over all the data is calculated by computing the sum of TP, FP, FN for all images first.
- Averaging the class IOU is usually not a very good idea!
- CityScapes Segmentation Dataset



Summary

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References

1. https://www.jeremyjordan.me/semantic-segmentation/

2. https://www.archives-ouvertes.fr/hal-03434796/

3. https://link.springer.com/chapter/10.1007/978-3-030-63467-4_18

4. https://www.researchgate.net/figure/Semantic-segmentation-of-a-scene-from-the-Cityscapes-dataset-by-Cordts-et-al-2016_fig24_316270100

Thanks