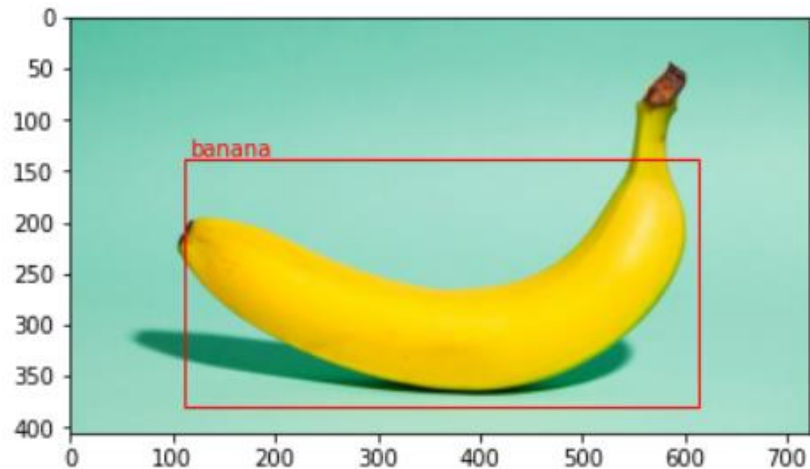


# Image Segmentation 101

# Image Segmentation

## Similar Tasks

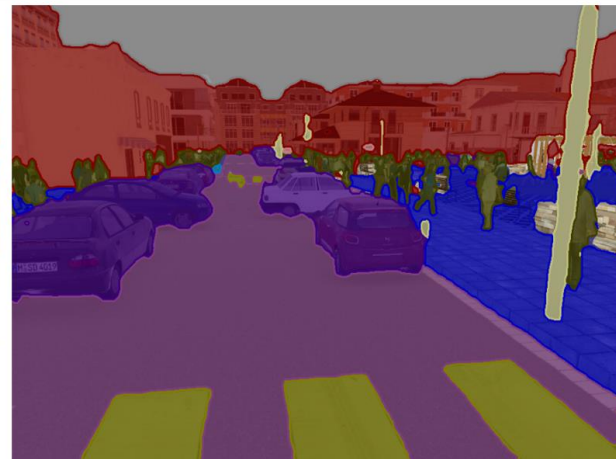
- Image Classification
  - tells us WHAT is shown on an image
- Object Detection
  - tells us WHAT and WHERE it is on an image (bounding box)



# Image Segmentation

## Introduction

- Prediction of classes for each pixel rather than for a complete image
- Applicable for
  - Medical imaging
  - Satellite image processing
  - Autonomous driving
  - ...



■ Sky ■ Building ■ Road ■ Sidewalk ■ Fence ■ Vegetation ■ Pole ■ Car ■ Sign ■ Pedestrian ■ Cyclist

Source: <https://medium.com/nanonets/how-to-do-image-segmentation-using-deep-learning-c673cc5862ef>

# Image Segmentation

## Mathematical Representation

- use color image ( $H \times W \times 3$ ) or grayscale ( $H \times W \times 1$ ) and return segmentation mask ( $H \times W \times 1$ )



Input



- 1: Person
- 2: Purse
- 3: Plants/Grass
- 4: Sidewalk
- 5: Building/Structures

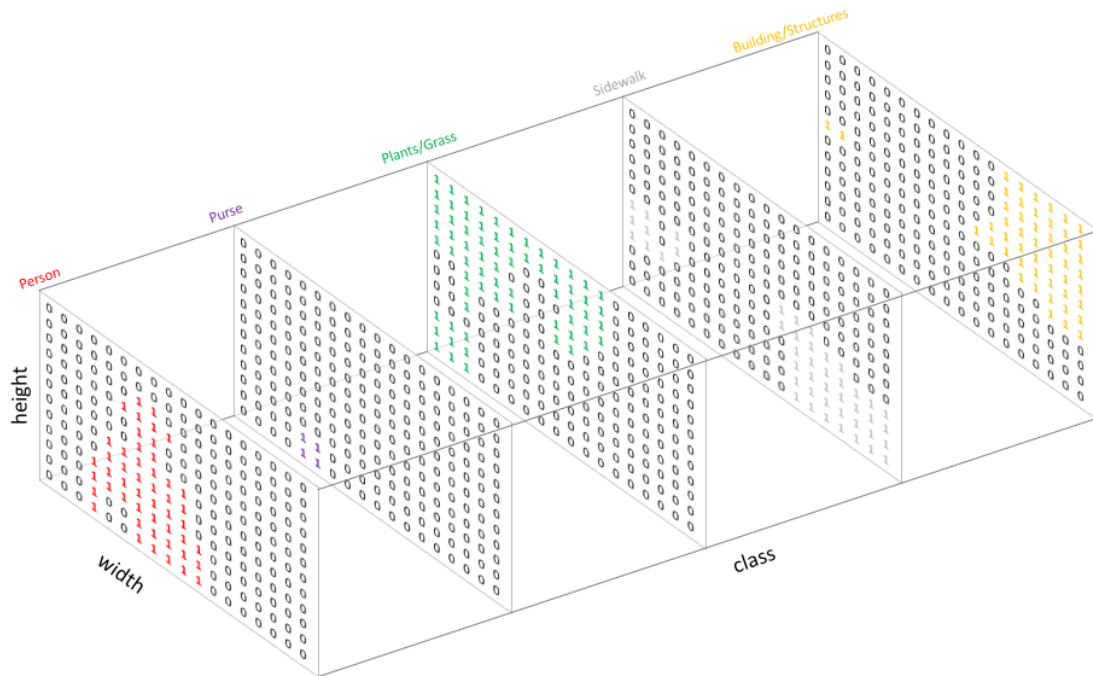
|   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 |
| 3 | 3 | 3 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 5 | 5 | 3 | 3 | 3 | 3 | 1 | 1 | 3 | 3 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 | 5 |
| 4 | 4 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| 4 | 4 | 3 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 5 |
| 4 | 4 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 3 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 3 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| 3 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |

Semantic Labels

# Image Segmentation

## Mathematical Representation

- use color image ( $H \times W \times 3$ ) or grayscale ( $H \times W \times 1$ ) and return segmentation mask ( $H \times W \times 5$ )



Source: <https://www.jeremyjordan.me/semantic-segmentation/>

# Image Segmentation

Semantic vs. Instance vs. Panoptic Segmentation



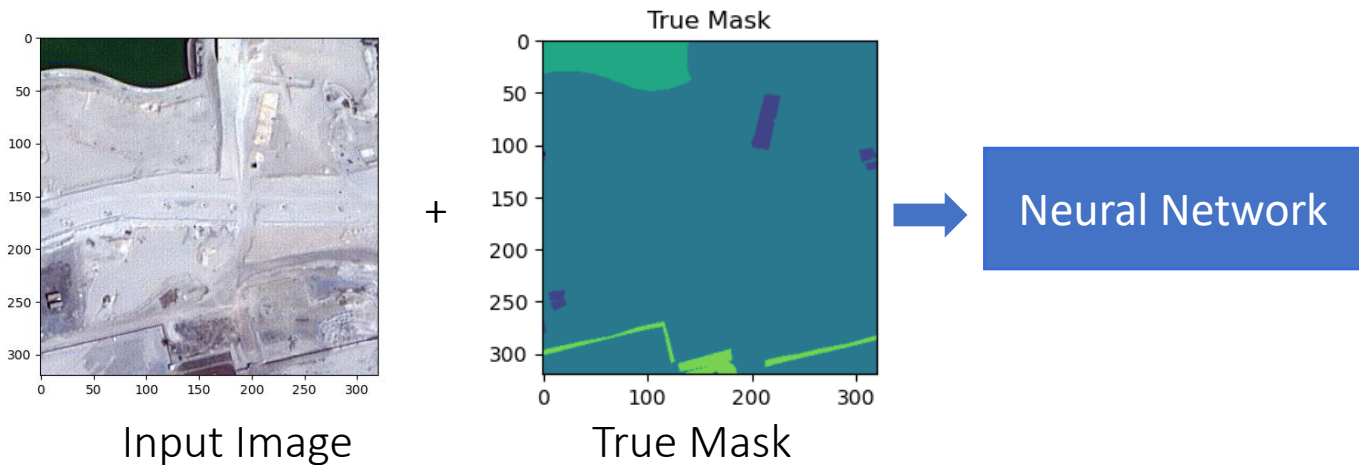
(a) Image

Source: Changhao Chen, et. al „A Survey on Deep Learning for Localization and Mapping: Towards the Age of Spatial Machine Intelligence“

# Image Segmentation

What we will develop in this course

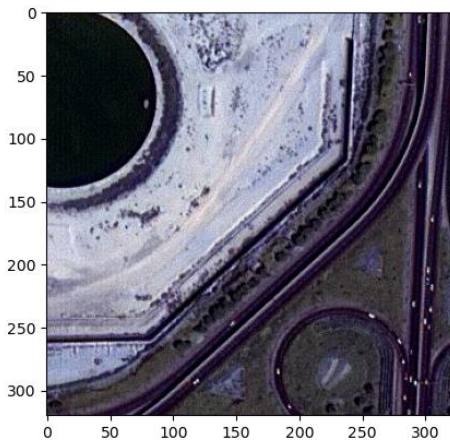
- satellite images
- 6 classes: building, land, road, vegetation, water, unlabeled



# Image Segmentation

What we will develop in this course

- satellite images
- 6 classes: building, land, road, vegetation, water, unlabeled



Input Image

