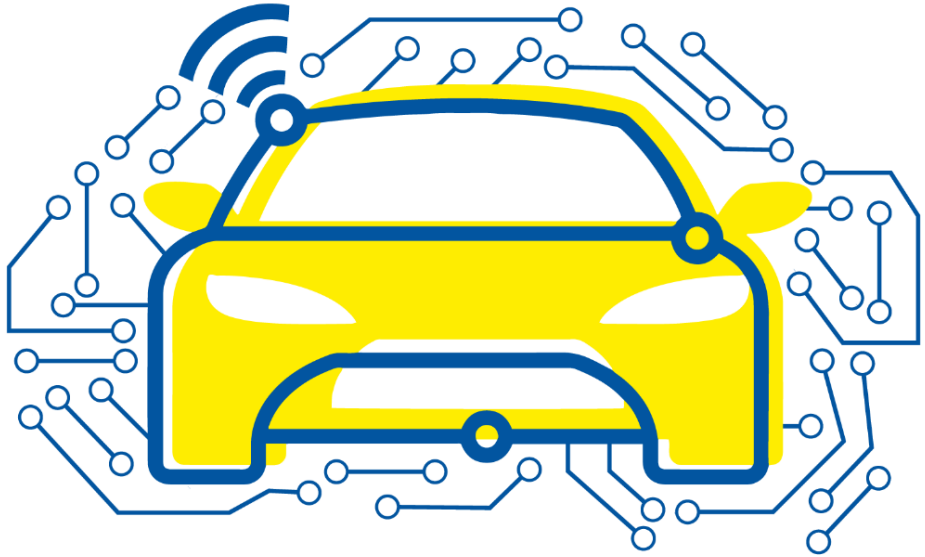
Automated and Connected Driving Challenges

Section 2 – Sensor Data Processing

Semantic Point Cloud Segmentation

Introduction



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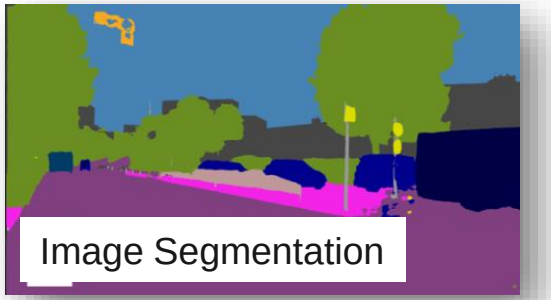
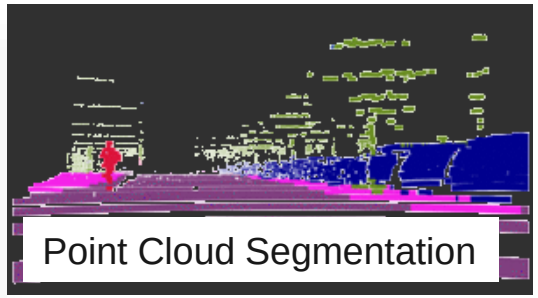
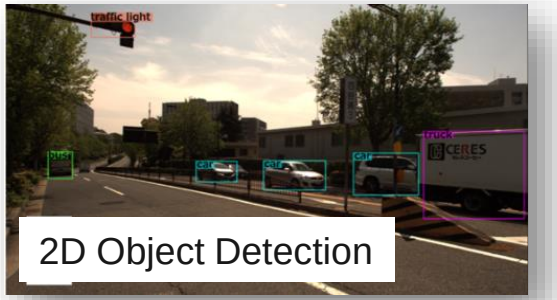
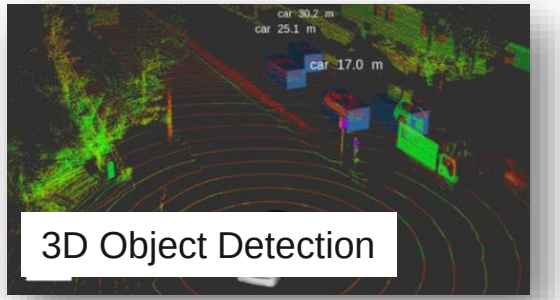
Semantic Point Cloud Segmentation - Introduction

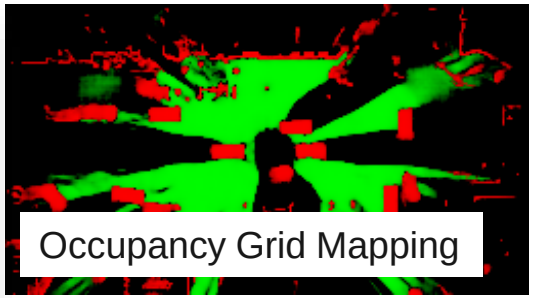
Computer Vision Approaches











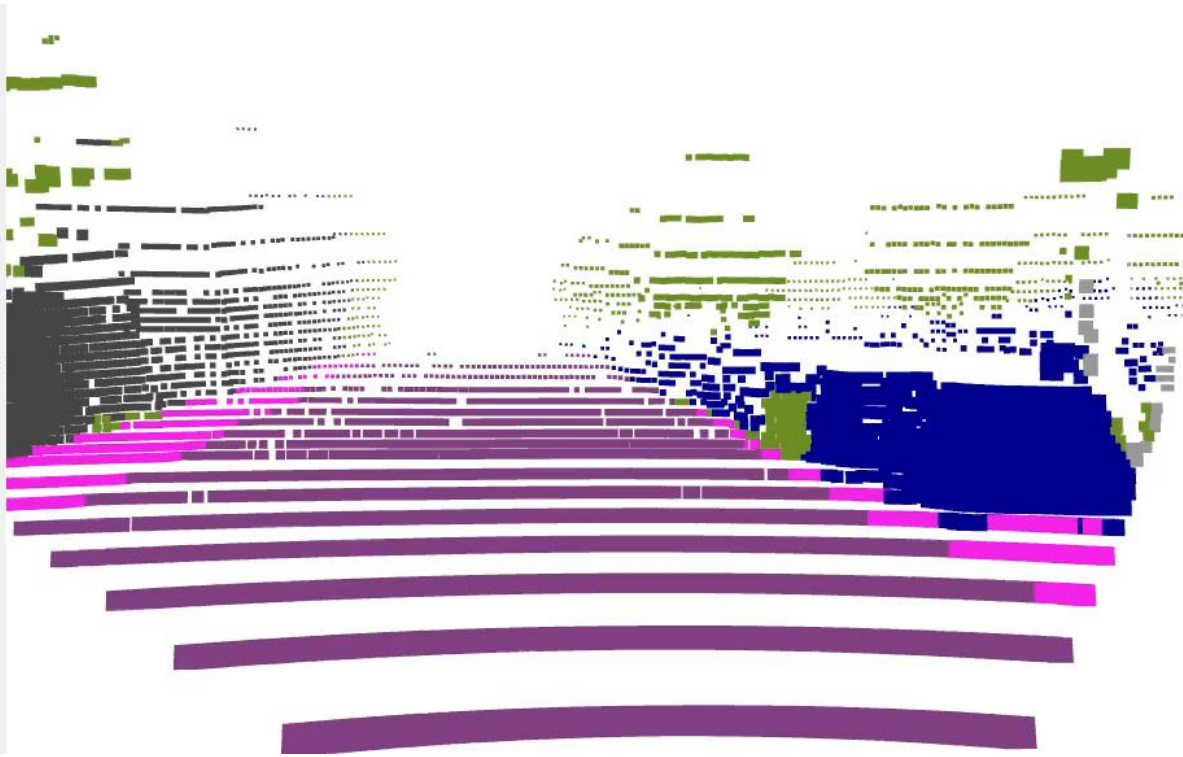
Single Object

Multi Objects

Images: fka, ika, IEEE Access

Semantic Point Cloud Segmentation - Introduction

Introduction



Video: ika

Semantic Point Cloud Segmentation - Introduction

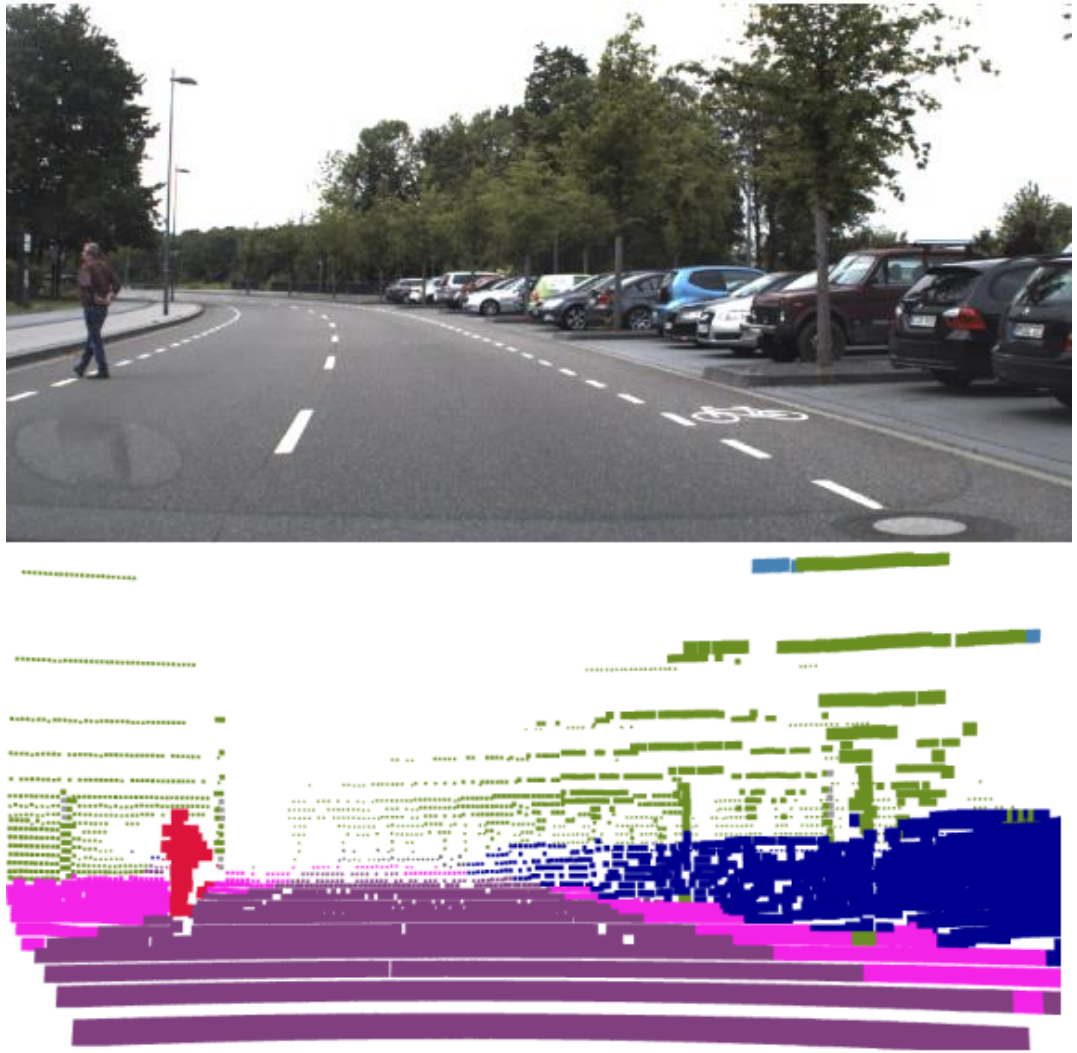
Definition

- **Goal**: Given a point cloud, assign a class from a fixed set of classes to every point in the point cloud

- Fixed set of classes:
  - **Road**
  - **Sidewalk**
  - **Pedestrian**
  - **Car**
  - **Bus**
  - **Motorcycle**
  - **…**

- **Classification** task for every data point

- **Scene Understanding**

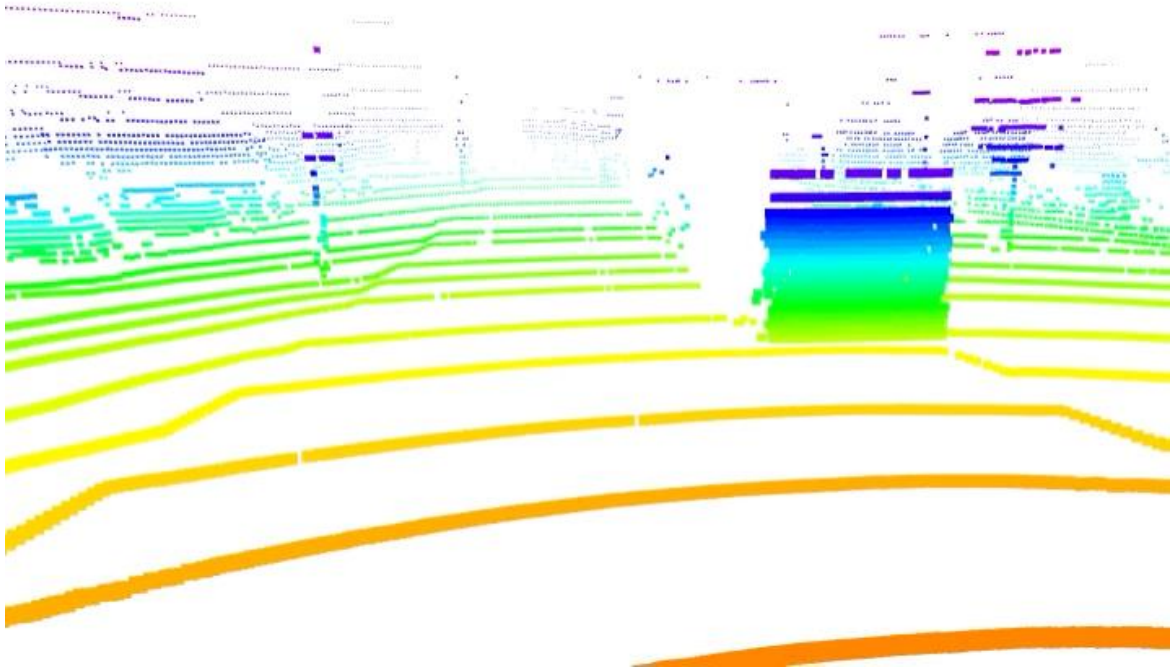


Images: ika

Semantic Point Cloud Segmentation - Introduction

Main Challenges

- **Point clouds** are unstructured
  - Different number of points in each sample
  - Sparse representation



Video: ika

Semantic Point Cloud Segmentation - Introduction

Main Challenges

- **Point clouds** are unstructured
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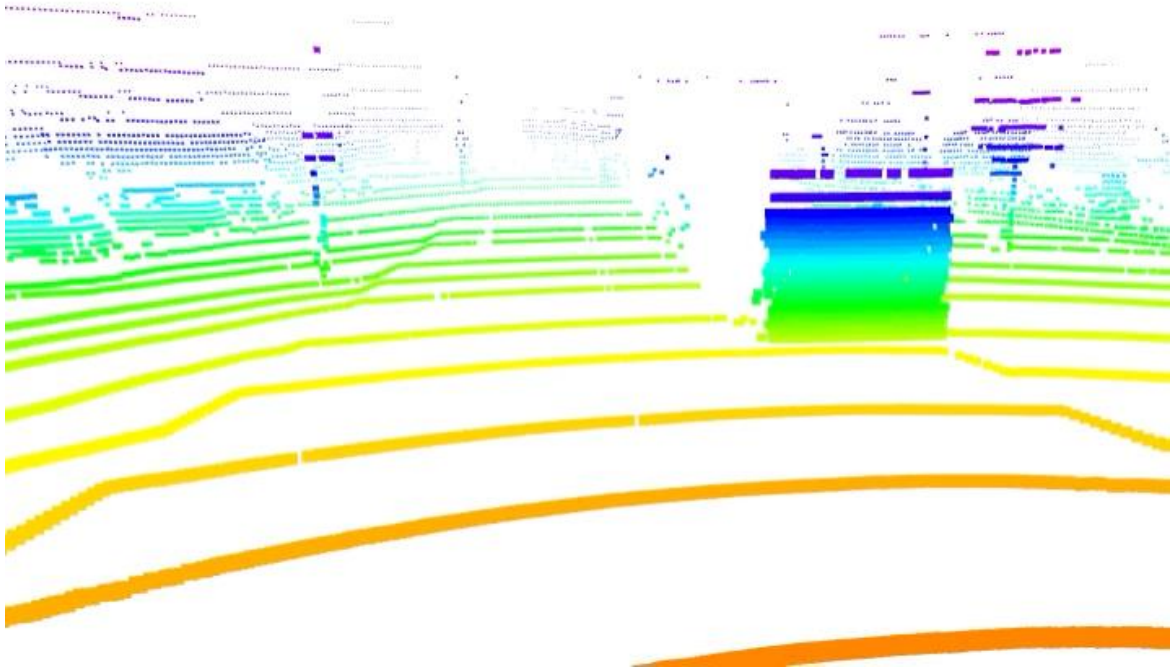
- **Class ambiguity**
  - Practically “unlimited” number of possible classes that can look similar in point cloud

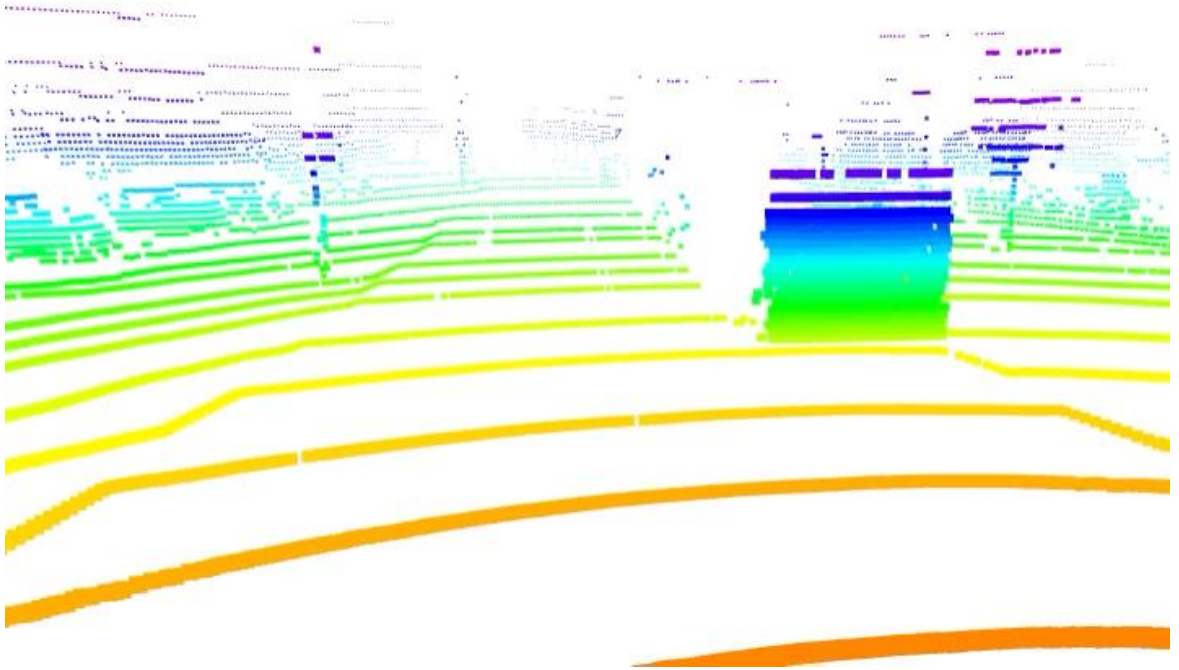


Video: ika

Semantic Point Cloud Segmentation - Introduction

Main Challenges

- **Point clouds** are unstructured
  - Different number of points in each sample
  - Sparse representation
- **Class ambiguity**
  - Practically “unlimited” number of possible classes that can look similar in point cloud
- **Class imbalance**
  - Relatively frequent classes: **road**, **sidewalk**, **building**
  - Relatively rare classes: **person**, **truck, bicycle**
- Lack of **public datasets**
  - High manual effort for creating own datasets
  - Solution: Automatic labeling approaches
- Different sensor **characteristics**
  - Number of layers
  - Horizontal and vertical resolution



Video: ika

Semantic Point Cloud Segmentation - Introduction

Approaches

- Traditional **Machine Learning** approaches:
  - **Clustering**
    - k-Means Clustering, DBScan
    - Find and segment **objects**
  - **RANSAC (*ran*dom *sa*mple *c*onsensus)**
    - Iterative method to detect **inliers** and **outliers**
    - **Road segmentation** in point clouds

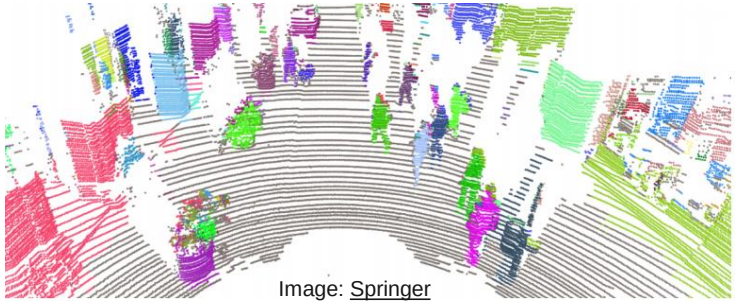


Image: Springer

Image: Springer

- **Deep Learning based** approaches**:**
  - **Dataset** with annotations
  - Convert the point cloud to **image-like tensor**
  - Use **Convolutional Neural Networks**
  - E.g. DarkNet, SqueezeSeg

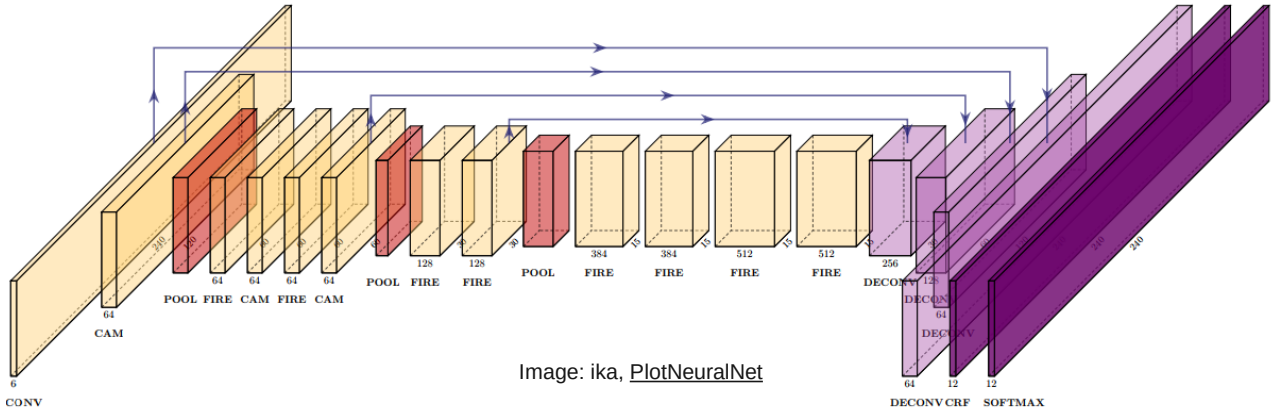


Image: ika, PlotNeuralNet

Semantic Point Cloud Segmentation - Introduction

Summary

- **Computer Vision** problem for scene understanding
- Similar approach to **semantic image segmentation**
- Assign a **semantic class** to data points of the point cloud
- Modern Approaches rely on **Deep Neural Networks** and **labelled datasets**

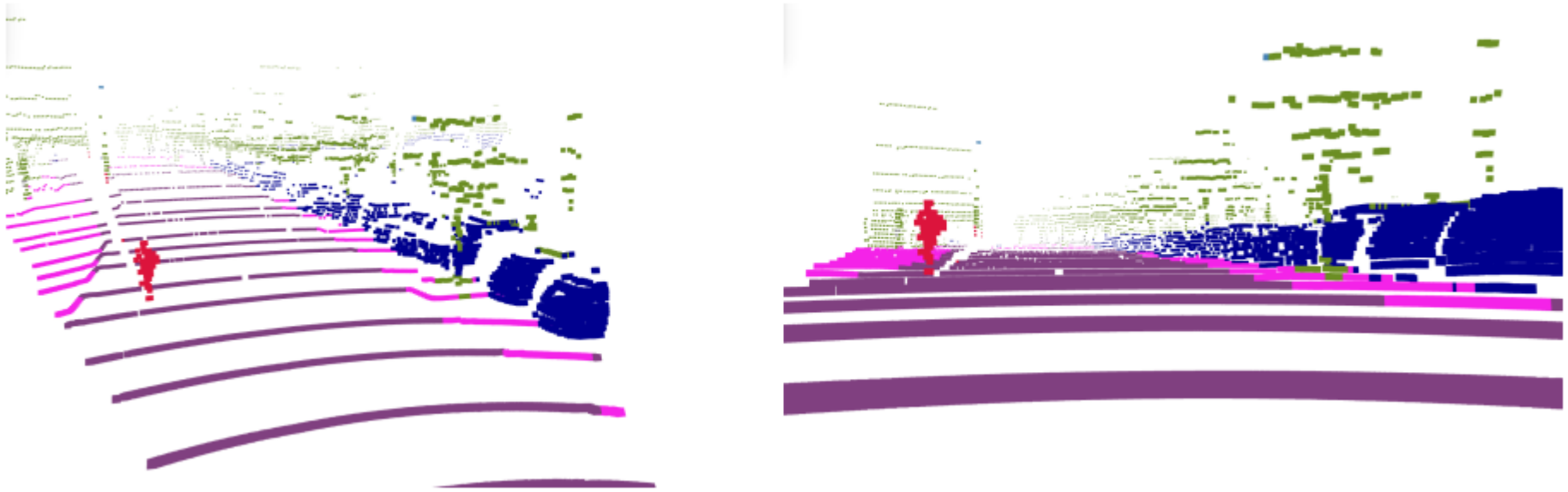


Image: ika