# OOD Detection for Object Detectors

## CZ4079 Final – Year Project

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## Motivation:

- Autonomous Vehicles increasingly becoming popular. Object Detectors are an integral part. Safety Concerns need to be addressed.
- OOD objects in environment need to be detected. Most literature focus on Image Classification.
- Methods in Image Classification can be modified for Object Detectors.

### Methodology

Modify OOD Detection technique from the image classification literature called 'Detecting Out-of-Distribution Inputs in Deep Neural Networks Using an Early-Layer Output'. Claims that there is a layer called OODL in models where the ID and OOD features are well separated. Detector can be trained on the features in this space to classify OOD inputs. Believe that there exists OODL for Object Detectors as well. However, unlike image classification where entire image is ID or OOD, in Object Detection, objects in the image are ID or OOD. So, a single image may contain multiple ID and OOD objects.

These objects from the image need to be extracted into separate images using bounding boxes and masking. Therefore, image with $n$ bounding box will be separated into $n$ separate masked imaged
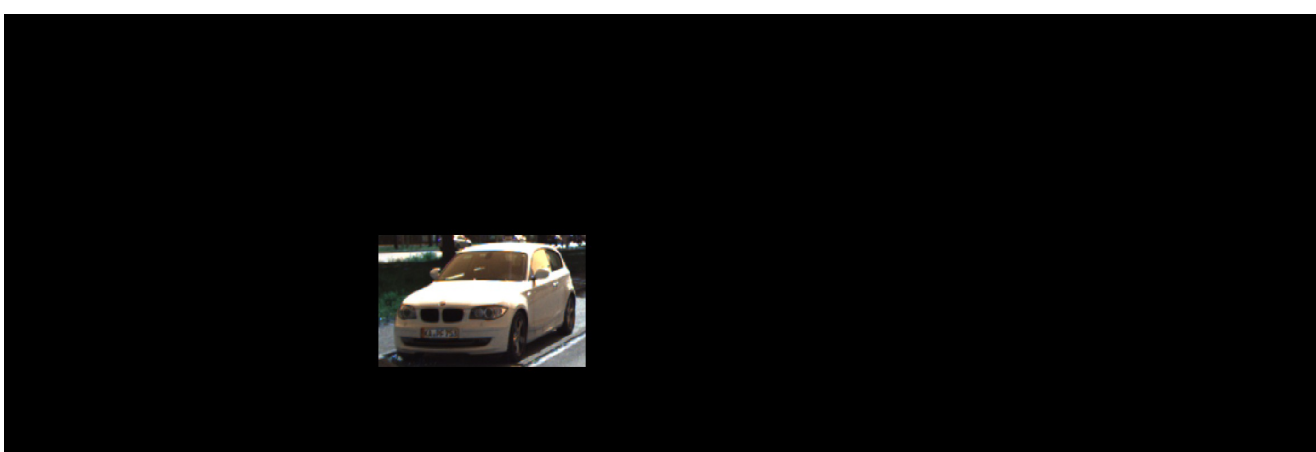


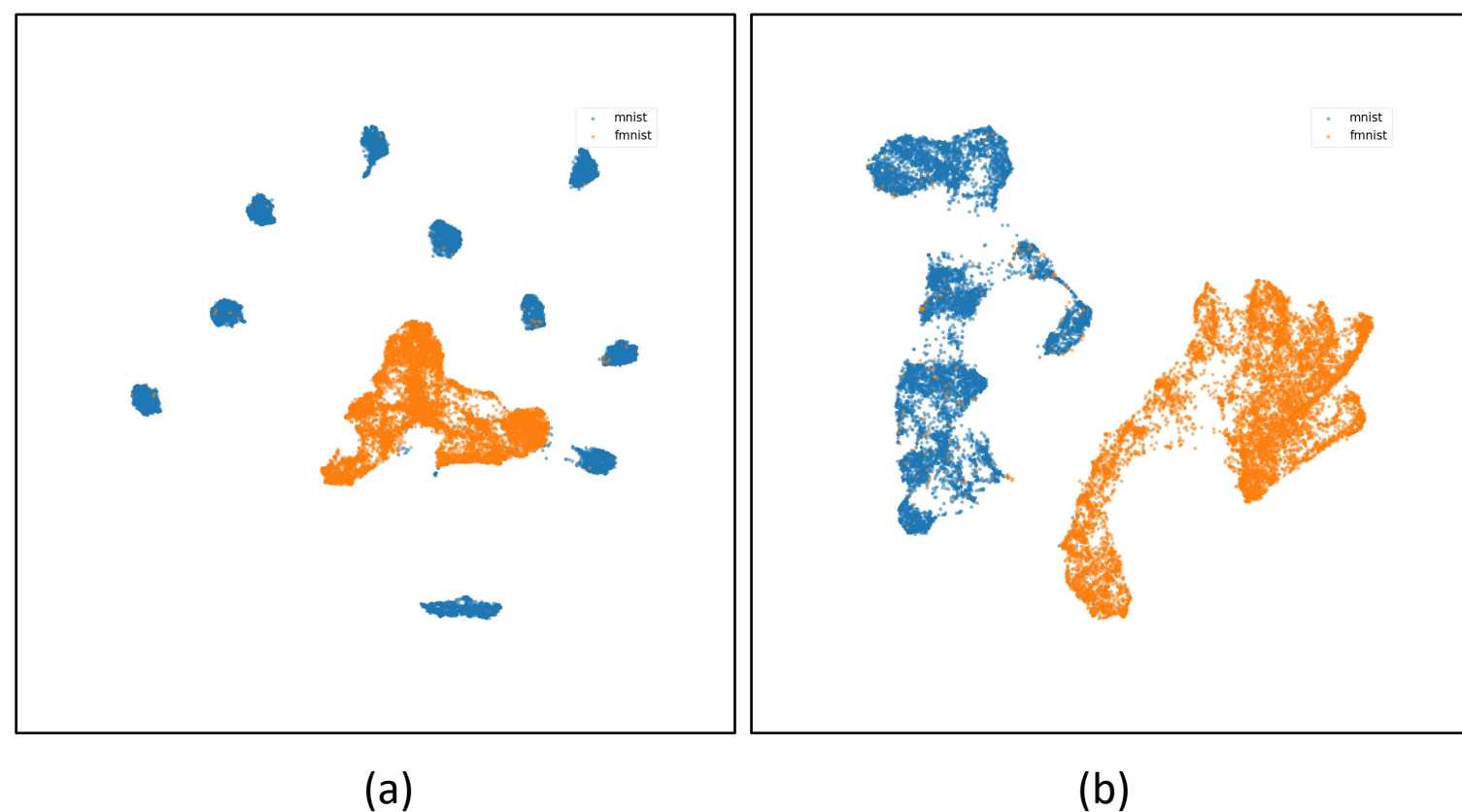(a)                    (b)

**Figure 1**: Distribution of features of a CNN from Penultimate layer for MNIST(blue) and FMNIST(orange) vs features from OODL.

Repeating this process gives ID and OOD object dataset needed to train OOD classifier and find the OODL. Empirically prove the efficacy of this approach by applying it to YOLOv3 model.



**Figure 2**: YOLOv3 Network Architecture

### Findings

- OOD Detection algorithms in image classification can be modified to perform adequately at the object level.
- For the OOD Detection task, the AUROC and AUPR are satisfactory, however improvement in FPR @ 95% TPR metric possible.

### Conclusion and Future works

- The era of AVs is near. OOD Detection is empirical.
- In the future, investigate how other methods in image classification can be modified for object detectors.
- Masking, context of objects is lost. Investigate novel methods which can incorporate context of objects.



**Figure 3**: Illustration of masking to extract ID and OOD objects