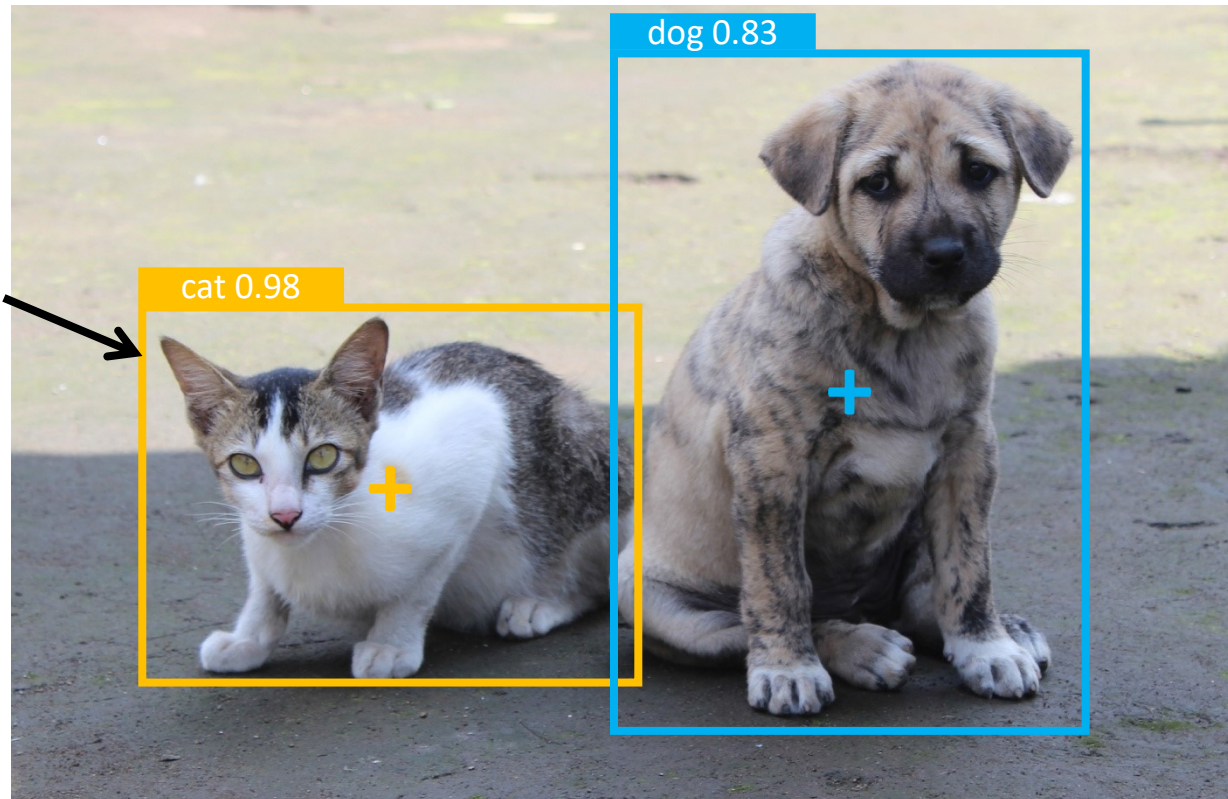
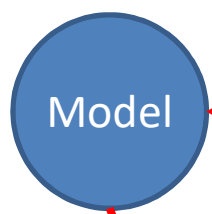


Computer Vision with Embedded Machine Learning

Review of Module 3

Bounding box





background

dog





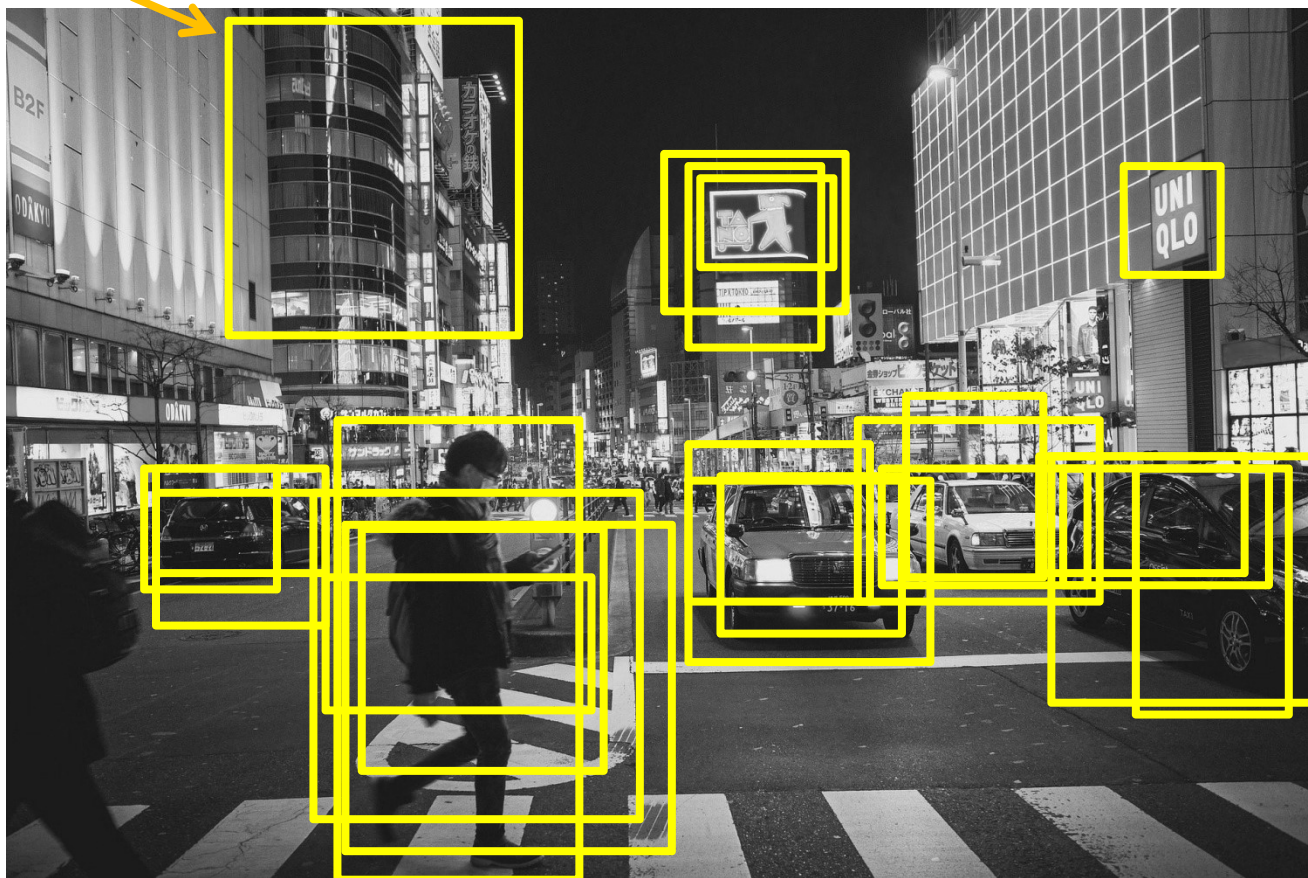
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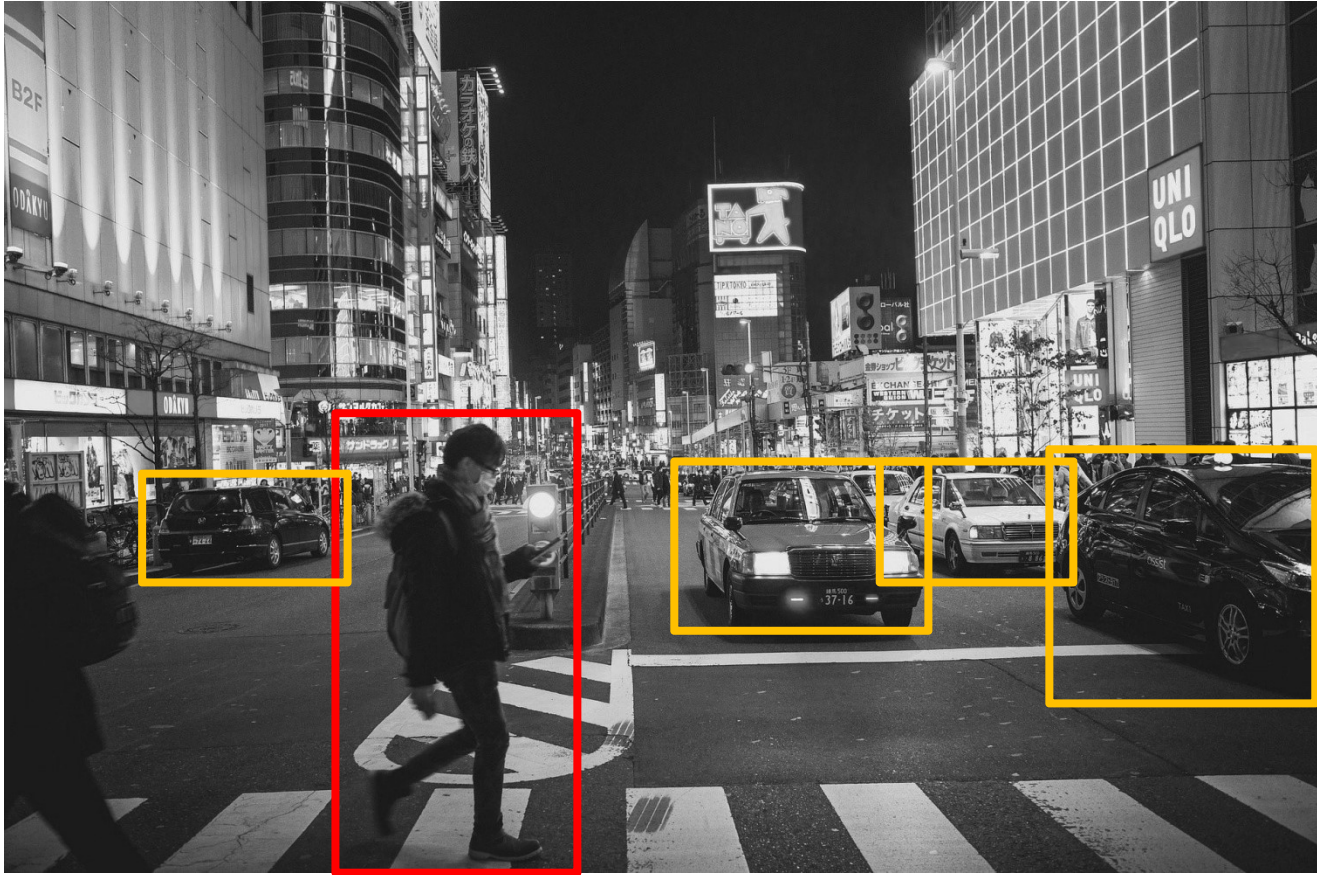


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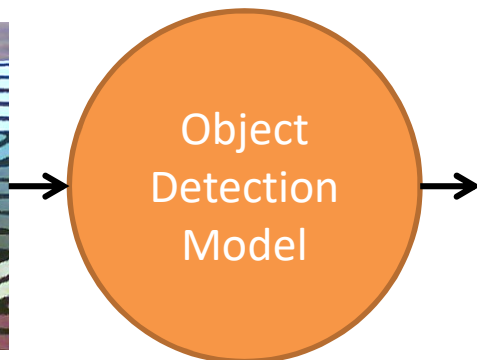
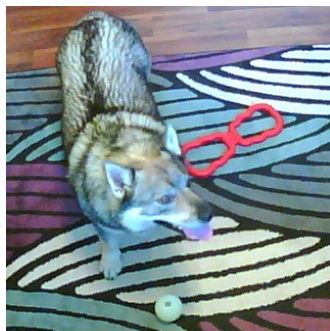
Region of Interest (ROI)

Region Proposal

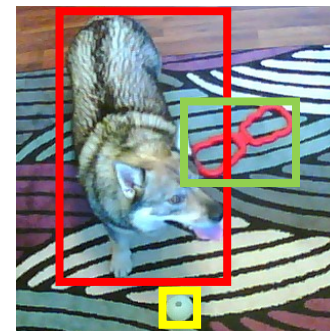




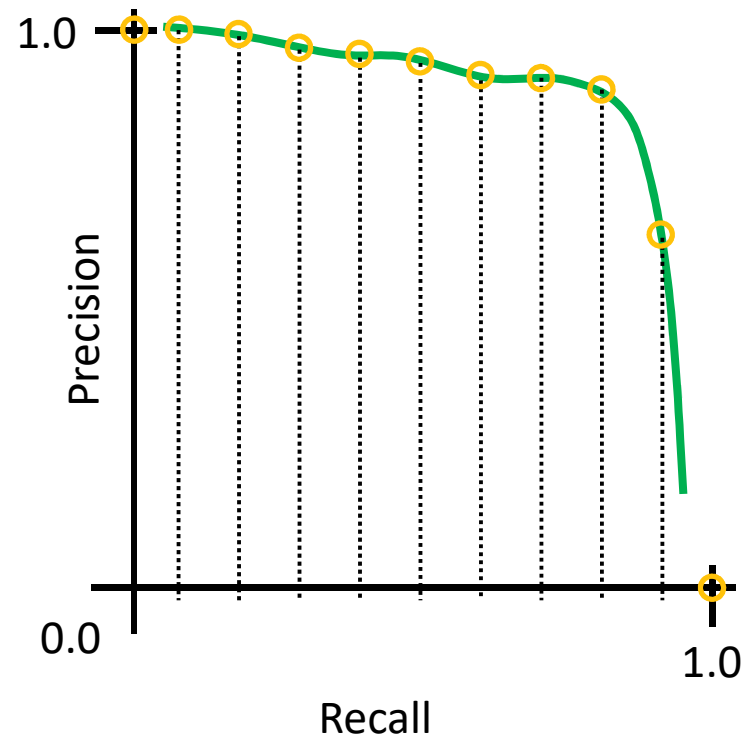
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- **Object 1**
 - Class: dog (0.92)
 - Bounding box
 - (x_1, y_1)
 - (w_1, h_1)
- **Object 2**
 - Class: toy (0.85)
 - Bounding box
 - (x_2, y_2)
 - (w_2, h_2)
- **Object 3**
 - Class: ball (0.77)
 - Bounding box
 - (x_3, y_3)
 - (w_3, h_3)



Average Precision (AP) approximation



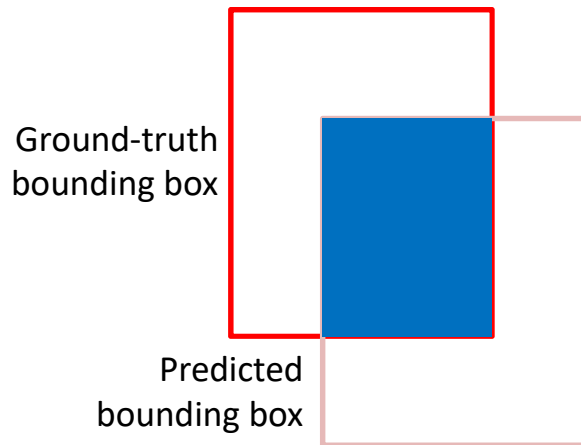
PASCAL Visual Object Classes
(VOC) Challenge (2009):

$$AP = \frac{1}{11} \sum_{r_i} p(r_i)$$

where $r_i = [0.0, 0.1, 0.2, \dots, 1.0]$

Intersection over Union (IoU)

Intersection: Area of overlap



Union: Area encompassed by both boxes



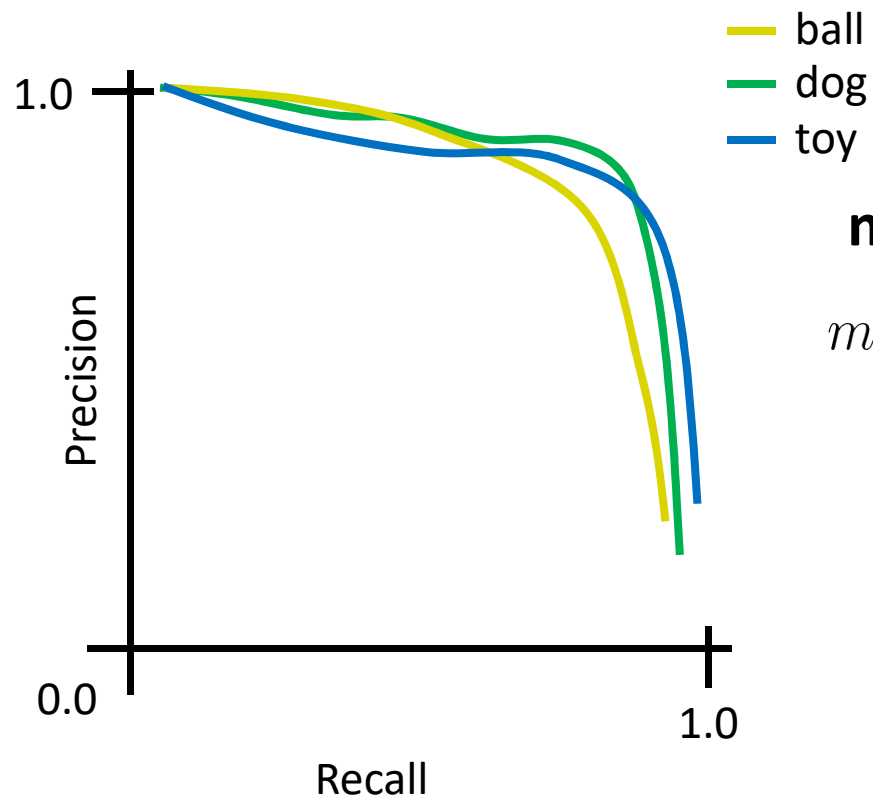
$$IoU = \frac{Intersection}{Union} = \frac{area\ of\ overlap}{area\ of\ union}$$

0.0 = complete miss

1.0 = perfect match

Object: IoU \geq 0.5

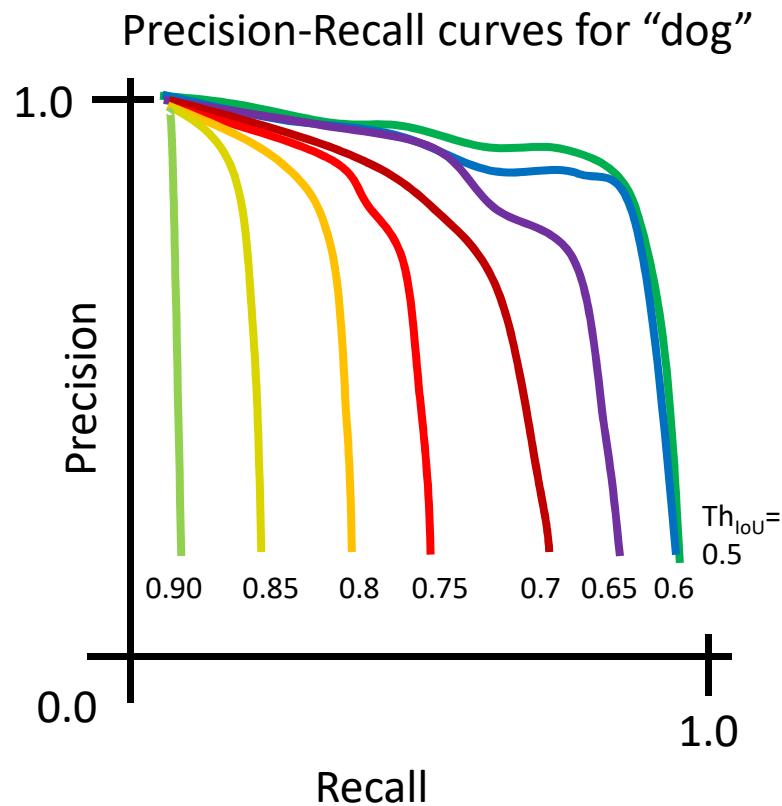
Precision-Recall curve (for IoU ≥ 0.5)



mean Average Precision (mAP)

$$mAP_{0.5} = \frac{1}{3}(AP_{ball} + AP_{dog} + AP_{toy})$$

mAP (for several IoU thresholds)



mean Average Precision (mAP)

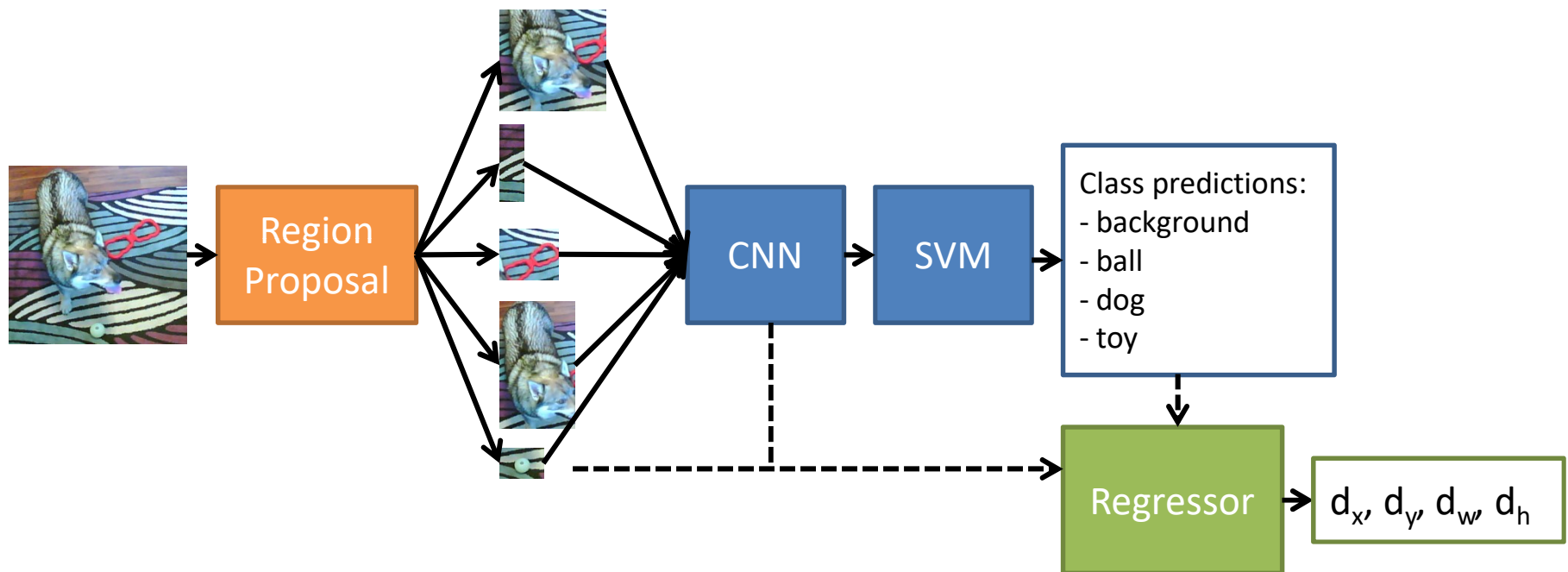
$$mAP_{0.5} = \frac{1}{3}(AP_{ball} + AP_{dog} + AP_{toy})$$

COCO 2017 Challenge:

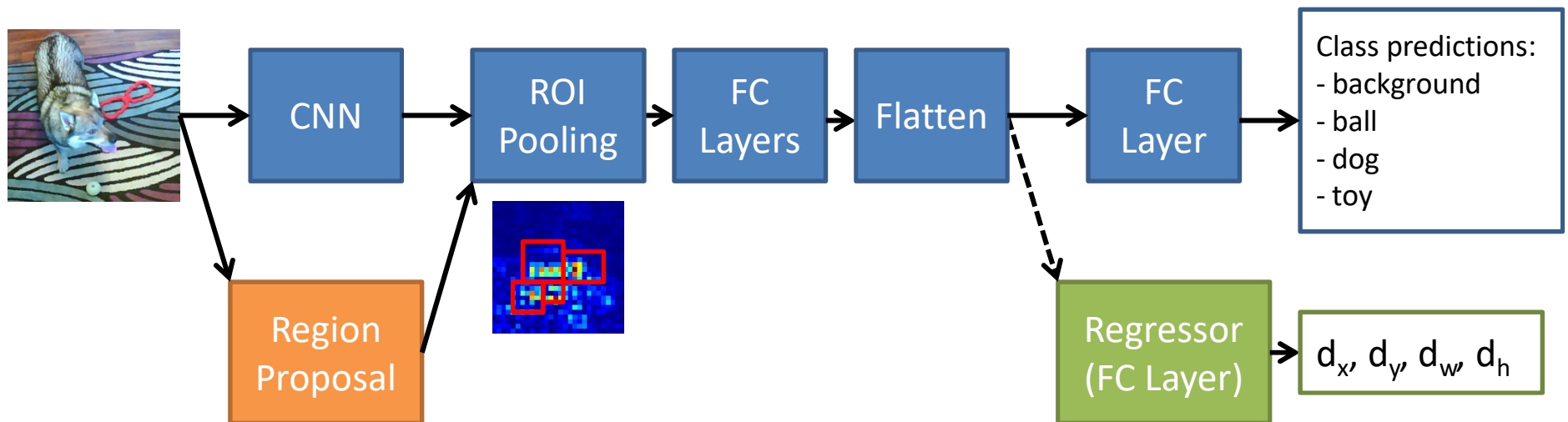
$$mAP = \frac{1}{10} \sum_i mAP_i$$

where $i = [0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8, 0.85, 0.9, 0.95]$

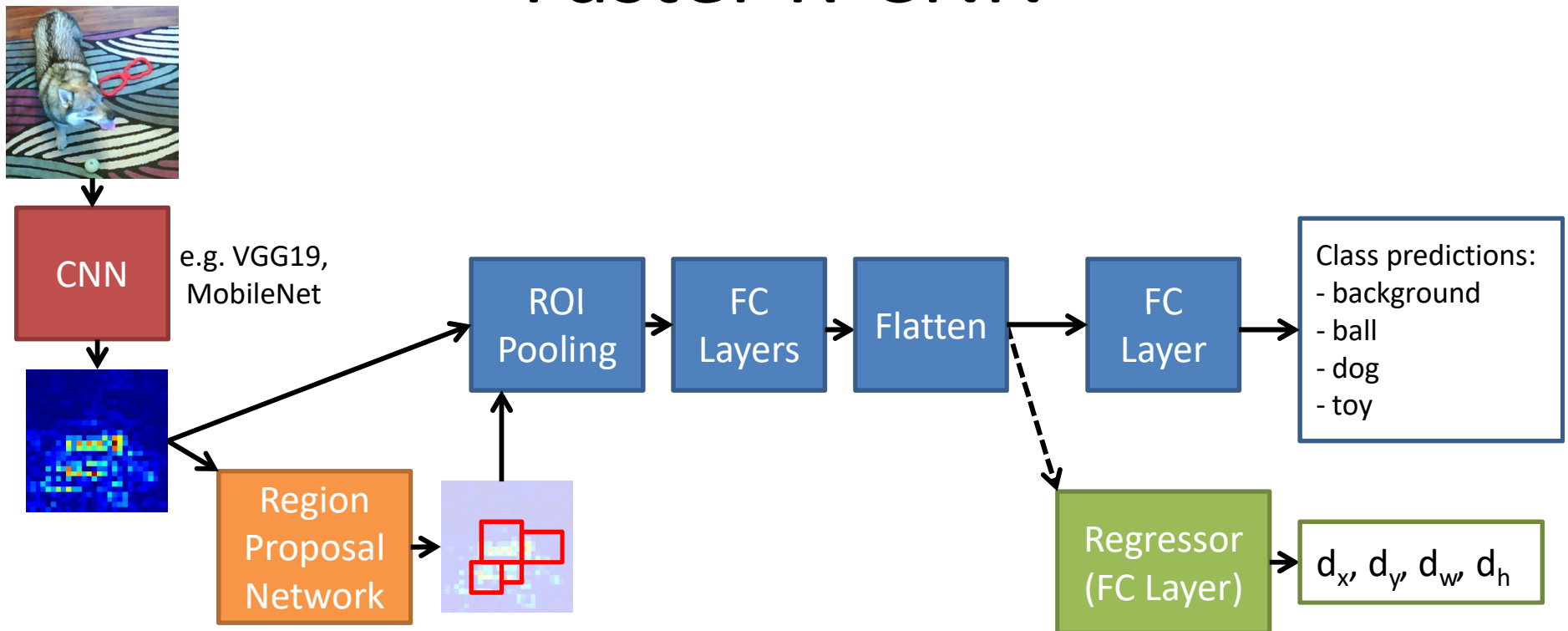
R-CNN



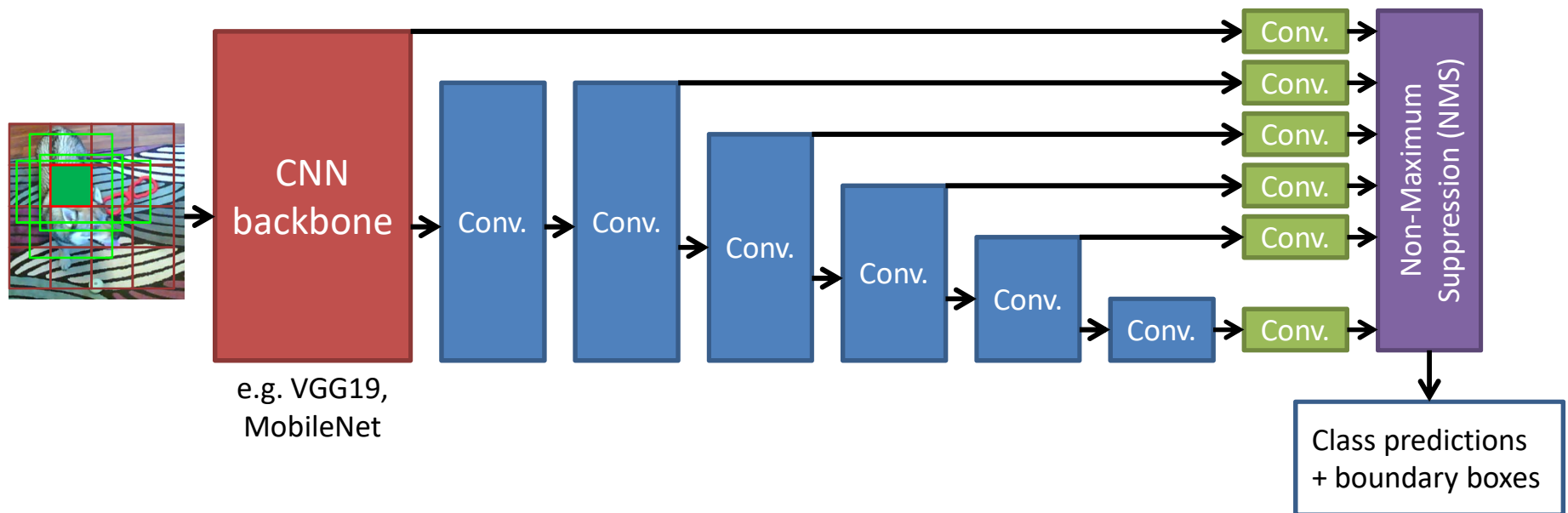
Fast R-CNN

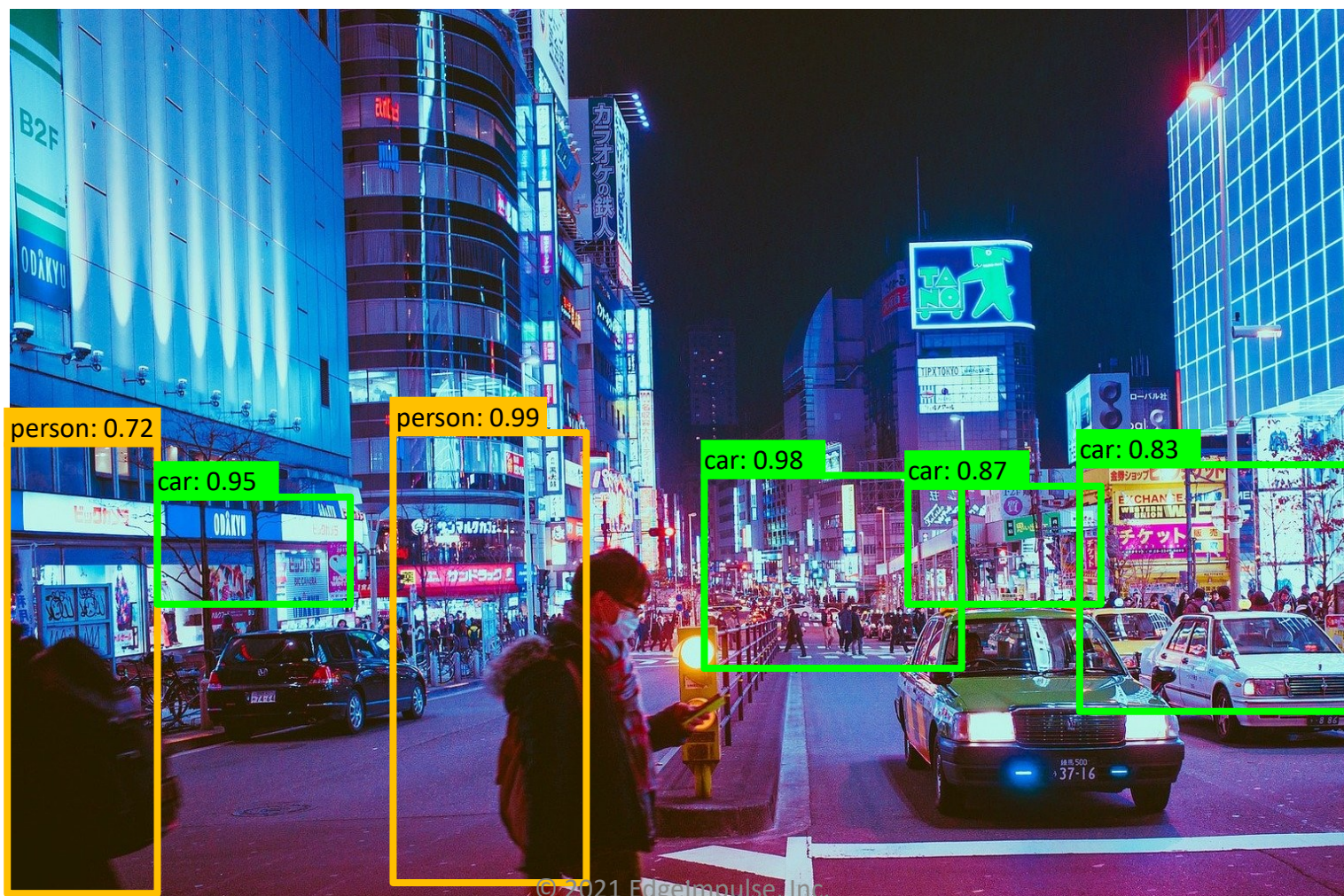


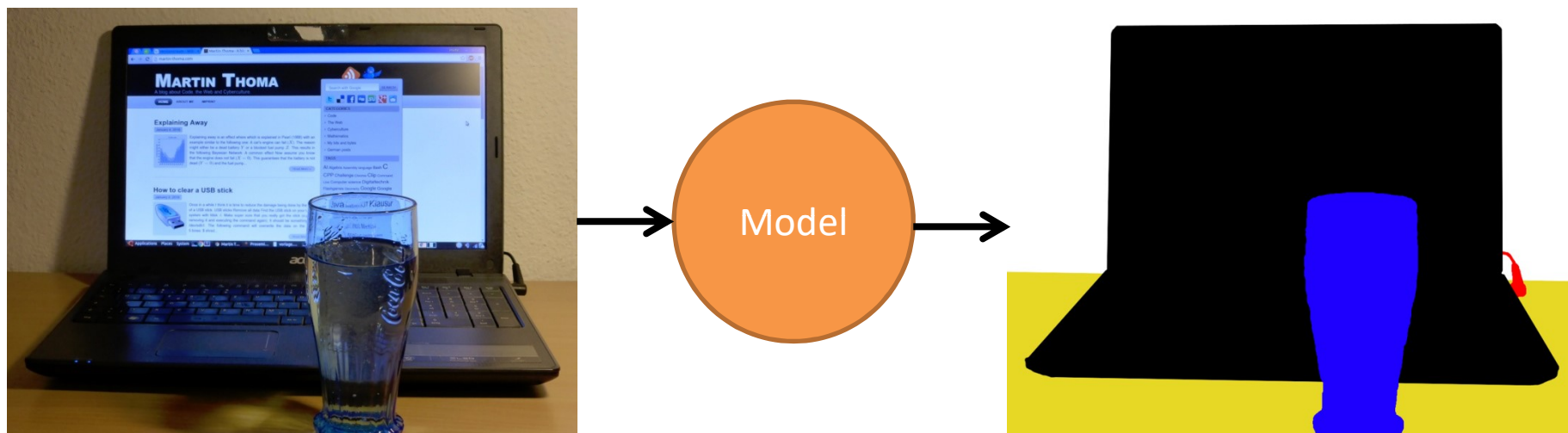
Faster R-CNN

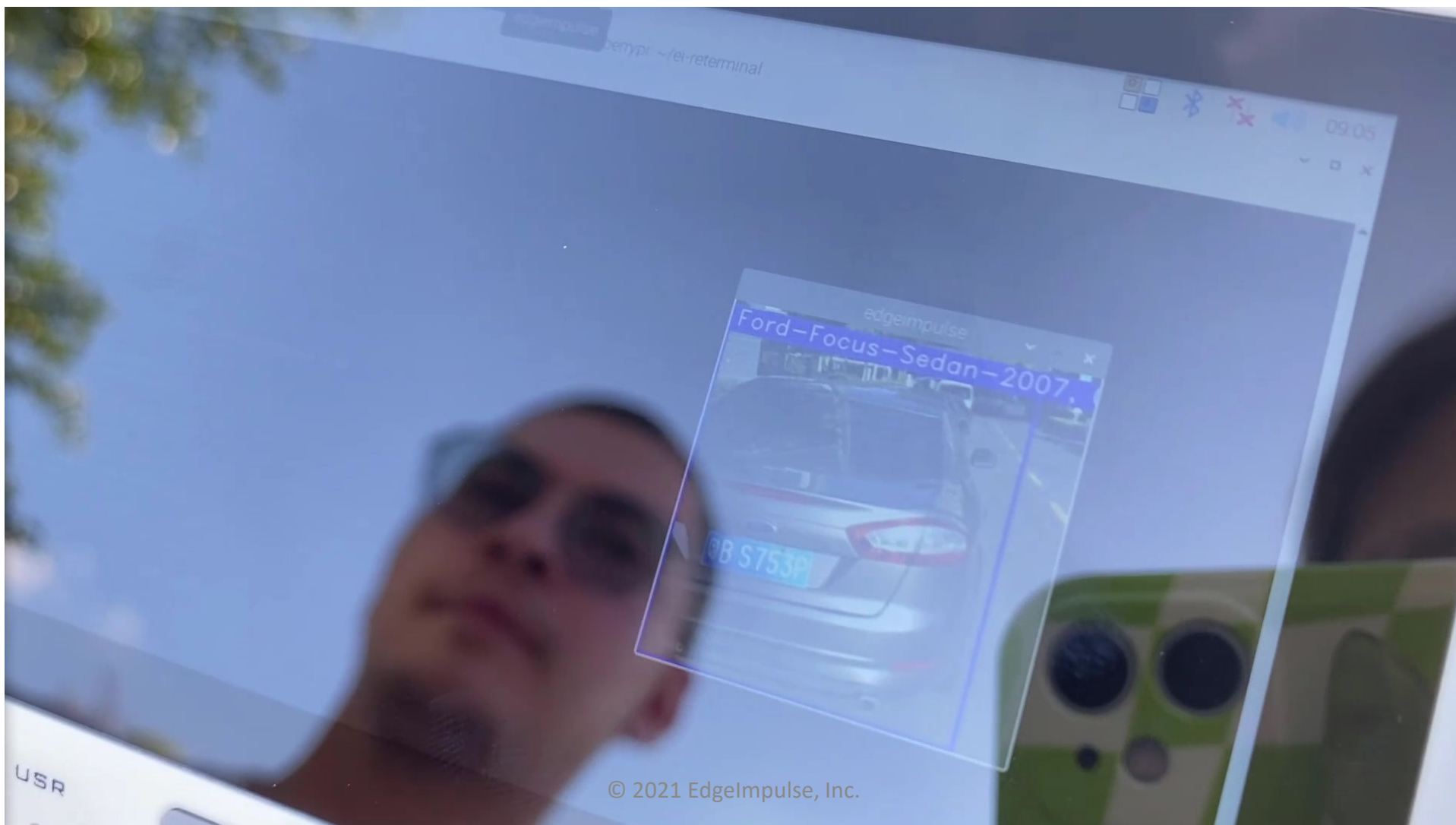


Single Shot MultiBox Detector (SSD)









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reusing representations (by contrasting)

