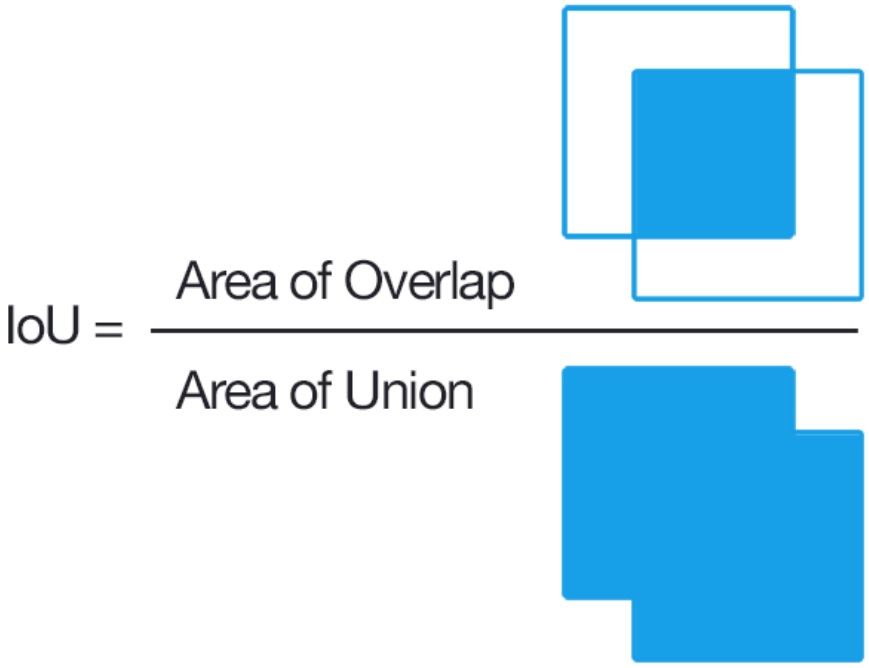
TDT4265 - Computer Vision and Deep Learning Assignment 4

Thomas Aven

March 12, 2019

1 - Object Detection Metrics

a) Intersection over union for object detection is a metric used to evaluate the accuracy of an object detector (e.g. YOLO). Given an image, an object detector will produce predictions for bounding boxes that contain objects. These predictions can be compared to so-called *ground truth* bounding boxes from a test set by means of the intersection over union. The intersection over union metric gives the area of overlap between the two bounding boxes *per area of union*. It is best illustrated with a drawing, which is taken from `https://www.pyimagesearch.com/2016/11/07/intersection-over-union-iou-for-object-detection/`:



b) A true positive is a prediction made for a class when there actually is a an object of that class. A false positive is a prediction made for a class but there is no object of that class.

c) Given true positives (TP), false positives (FP) and false negatives (FN), we have:

$$Precision = \frac{TP}{TP + FP},$$

$$Recall = \frac{TP}{TP + FN}.$$

d) We have two classes, thus we have to get the average AP (average precision) over these two classes. To calculate the AP, we iterate over recall levels in the range 0.0, 0.1, .., 1.0, and sum the largest precisions p with recall value greater than the current recall

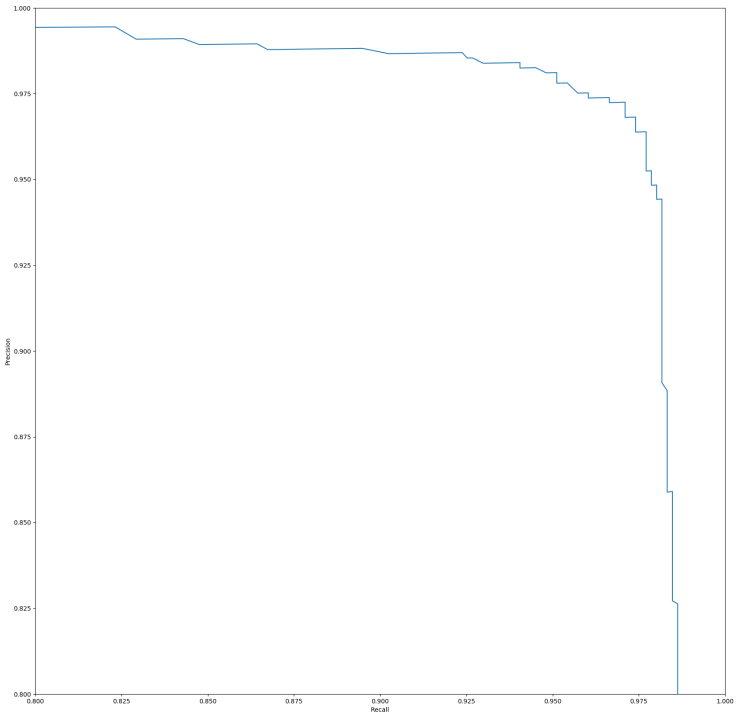
value. For the two classes, we get (where each cell is the largest p with recall bigger than or equal to the given r-value):

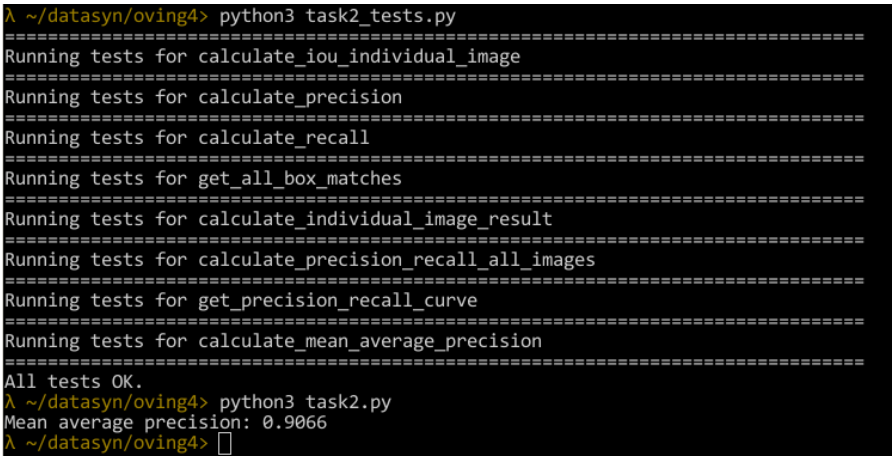
	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	Sum
Class 1	1.0	1.0	1.0	1.0	1.0	0.5	0.5	0.5	0.20	0.20	0.20	7.1
Class 2	1.0	1.0	1.0	1.0	0.80	0.60	0.5	0.5	0.20	0.20	0.20	7.0

Which gives $AP = 7.1/11 \approx 0.65$ for the first class, and $AP = 7.0/11 \approx 0.64$ for the second class. The mAP thus becomes $mAP = (0.65 + 0.64)/2 = 0.645 \approx 0.65$.

2 - Implementing Mean Average Precision

f) Below is the final precision-recall curve from implementing all the functions (which is equal to the one given in the assignment lecture), as well as a screenshot of running `task2` and all the tests.





3 - You Only Look Once

a) l

b) l

c) l

d) l

4 - Object detection with YOLO

I was a bit confused on this task by the fact that I thought the images were given as `x, y, width, height`, and that I thus had to translate the points to create `xmin, ymin, xmax, ymax`. When I used this translation, I ended up with only 6 boxes, but looking at `draw_boxes` in `drawing_utils.py`, I realized that the boxes were actually given as `top, left, bottom, right`, which gave the correct 7 boxes. All the other tests within the notebook ended up correct in both cases.

Below are the classified bounding boxes with scores and class names, as well as the original image overlayed with the object detections.

```
Found 7 boxes
car 0.60 (925, 285) (1045, 374)
car 0.66 (706, 279) (786, 350)
bus 0.67 (5, 266) (220, 407)
car 0.70 (947, 324) (1280, 705)
car 0.74 (159, 303) (346, 440)
car 0.80 (761, 282) (942, 412)
car 0.89 (367, 300) (745, 648)
```