

Challenge 1

Name: *Dalen Hsiao*

Andrew ID: *tungyuh*

Collaborators: *kaiyug*

• IoU Calculation

IoU is computed following these steps:

1. The intersection area is computed by finding the overlapping area between the ground truth box and the predicted box, where we use the relatively small value of each entry of the input arrays to calculate the intersection area.
2. The union area is computed by summing the area of the ground truth box and the predicted box while subtracting the intersection area.
3. The IoU scores for each box are calculated by dividing the intersection area with the union area.

The concept is illustrated as follow:

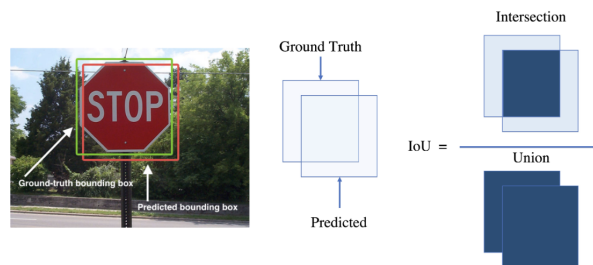


Figure 1: Calculation of IoU (source: Challenge 1 description)

• Results Discussion

The calculations of precision and recall are as follow:

$$precision = \frac{TP}{TP + FP}$$

$$recall = \frac{TP}{TP + FN}$$

With varying IoU thresholds, we can expect that the higher the threshold, the likelihood of *FalsePositive* instances appearing will decrease due to the increased confidence of the model. This occurs because the criterion for making positive predictions becomes stricter, essentially forcing the model to be more certain about all the positive predictions it makes. Therefore, at IoU thresholds greater than 0.7, we can start to observe a noticeable deviation between the Raw curves and the Orange curves, and the later is calculated by $p(r) = \max_{r' \leq r} p(r')$. As the

FP rate decreases, at the same level of recall rate, a lower precision could be expected and is understandable. From Table 1, we can see that the average precision (AP) trend reflects our initial assumption about the effect of the IoU threshold. Starting at an IoU threshold of 0.7, we observe a drop in AP, which continues as the threshold increases.

- P-R curves to each IoU

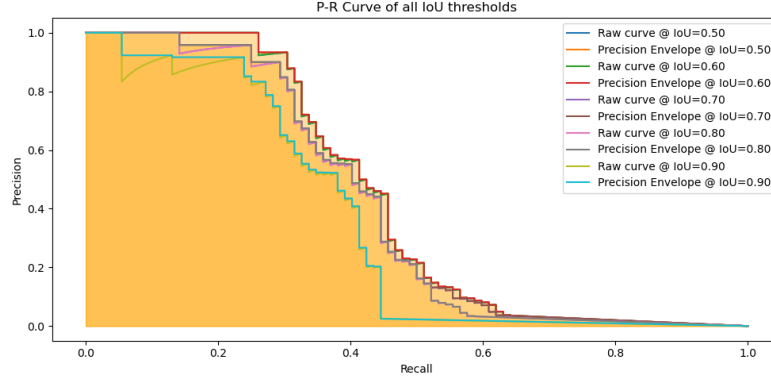


Figure 2: All P-R Curves

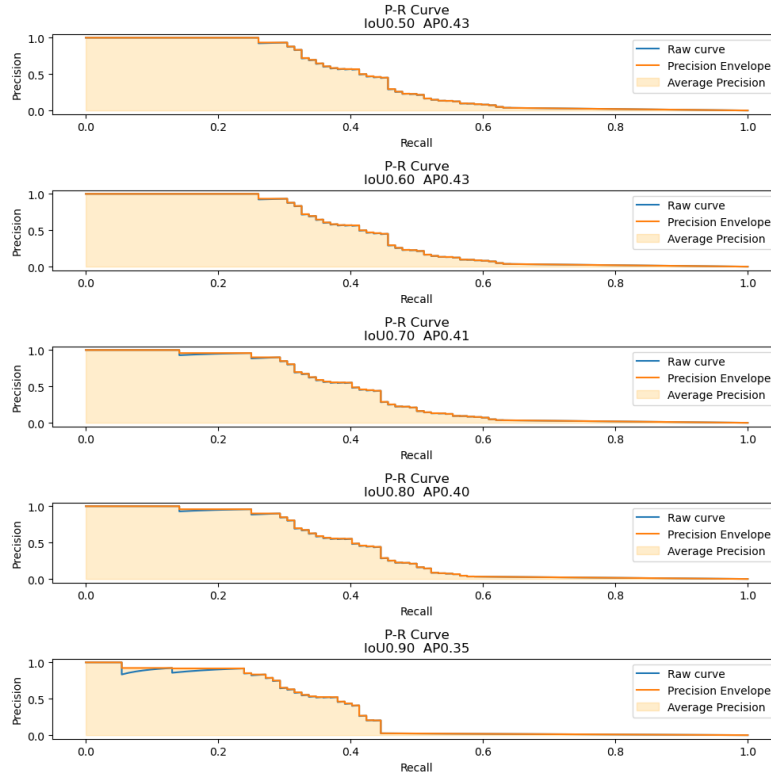


Figure 3: P-R Curves

- **IoU Threshold & Average Precision**

IoU Threshold	AP
0.50	0.4272559074361477
0.60	0.4272559074361477
0.70	0.40686292416368364
0.80	0.4018855902817313
0.90	0.3466670309329718

Table 1: IoU Threshold vs AP